FEBI (Focused Interaction-Based Education) Education Model with Application in Blood Glucose Control in Type 2 Diabetes Mellitus Patients

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ABSTRACT

Background: *Optimal blood glucose control is the main key to preventing complications of type 2 Diabetes Mellitus (DM). However, many patients have difficulty maintaining glycemic control due to limited knowledge, ongoing education and lack of therapeutic interaction. The FEBI Education Model (Focused Interaction-Based Education) is designed to increase patient engagement through an interactive educational approach based on digital applications.* ***Objective:*** *This study was to test the effectiveness of the FEBI Education Model in helping control blood glucose in patients with type 2 DM.* ***Method:*** *The study used a quasi-experimental design with a one-group Pretest-Posttest design approach. With a sample of 30 patients with type 2 DM in the working area of Andalas Health Center and Ambacang Kuranji Health Center, with a purposive sampling technique and data analysis using Paired T-test samples. The FEBI model integrates self-education, glucose monitoring, medication reminders, and online consultative interaction features. The main parameters measured were changes in knowledge and attitudes and glycated albumin levels during one month of intervention.* ***Results:*** *The results of the study showed that there was an increase in knowledge and attitudes with a p-value of 0.00 and a decrease in glycated albumin levels with a -value of 0.025, statistically it can be concluded that there is an influence of the FEBI education model with an increase in knowledge and attitudes and a decrease in glycated albumin levels.* ***Conclusion:*** *The application-based FEBI Education Model is effective in improving blood glucose control in patients with type 2 DM. This interactive approach has the potential to be an innovative strategy in supporting technology-based diabetes management.*

Keywords: *Type 2 Diabetes Mellitus, Interactive Education, Mobile Application, Blood Glucose Control*

INTRODUCTION

The prevalence of diabetes mellitus (DM), especially type 2 DM, has increased significantly in various countries, both developed and developing countries. Worryingly, this disease is increasingly being diagnosed among adolescents and young adults. According to the International Diabetes Federation/IDF(Ogurtsova et al., 2022), and the American Diabetes Association/ADA (ADA 2020) more than 500 million people worldwide are estimated to be living with diabetes. This figure is predicted to triple by 2030, potentially reaching 16.7 million cases by 2045. The prevalence of diabetes in people aged over 15 years increased from 10.9% in 2018 to 11.7% in 2023. This shows that this disease is not only a problem for the elderly but also attacks the productive age group. The main causes are unhealthy diet, lack of physical activity and obesity.

Indonesia faces a similar situation, with a high prevalence rate that contributes to high health care costs. Early diagnosis and comprehensive management of diabetes are essential in reducing morbidity and mortality. The number of diabetes sufferers in Indonesia increased by more than 20% of the total population from 2013 to 2018. Diagnosed cases are around 2% of the total population, while around 70% are still undiagnosed. Most cases occur in the productive age group

and urban areas, making diabetes the third leading cause of death in Indonesia. Worryingly, only a quarter of diabetes sufferers are aware of their condition, so three-quarters of them have uncontrolled diabetes ((Kementerian Kesehatan RI Badan Penelitian dan Pengembangan., n.d.).

The pattern of disease in Indonesia is currently shifting from infectious diseases to degenerative diseases. This pattern is accompanied by the problem of a double burden of disease. The incidence of degenerative diseases is increasing along with changes in lifestyle and environmental behavior. One of the threats of degenerative diseases to public health is diabetes mellitus (Ministry of Health RI, 2020). In West Sumatra, the total prevalence of diabetes was 1.6% of the population in 2018, placing the province in 21st place out of 34 provinces in Indonesia. According to the West Sumatra Provincial Health Office, in 2018 there were 44,280 cases of diabetes, increasing to 59,024 cases in 2022, with the highest concentration in Padang City (Badan Pusat Statistik Provinsi Sumatera Barat, 2023).

Diabetes can cause acute and chronic complications that attack various body systems. Fifty percent of deaths from diabetes are caused by coronary heart disease, and 30% are caused by kidney failure. In addition, diabetes contributes significantly to disability, with 30% of patients experiencing blindness due to retinopathy and 10% undergoing limb amputation. Reported that around 2.5 million people, or 1.3% of the Indonesian population, die each year due to complications of diabetes (Mashudi., 2011).

One effort to avoid complications of diabetes is to control blood glucose in people with diabetes. Controlling blood glucose in people with diabetes is very important, as with other chronic diseases, diabetes is a burden for sufferers and their families, and the cost of treating people with diabetes is two to three times higher than for people without diabetes. In addition to increasing medical costs, long-term and short-term complications cause serious problems not only for people with diabetes, but also for their families. To avoid complications of diabetes and reduce the risk of death from diabetes, sufferers need long-term blood glucose control (Ali et al., n.d.)

Management of type 2 diabetes mellitus requires a comprehensive approach involving long-term behavioral modification. Previous studies have shown that the success of glycemic management is greatly influenced by the level of knowledge and attitudes of patients towards their disease. Lack of understanding of diabetes, complications, and the importance of self-control are often factors that cause failure in achieving glycemic management targets, including high levels of glycated albumin as an indicator of medium-term glycemic control (Negash W, Assefa T, Sahiledengle B, Tahir A, Regassa Z, Feleke Z, 2022).

Health education is a key intervention in blood glucose control, conventional education methods are often unable to maintain patient motivation and engagement in the long term. As technology advances, a mobile application-based approach offers an innovative solution to overcome these limitations. Mobile applications can present information interactively, provide reminders, and provide real-time feedback, thereby increasing the effectiveness of learning and facilitating behavioral change (Zhao et al., 2023).

The development of the FEBI (Focused Interaction-Based Education) Education Model based on applications aims to optimize the education process through proven pedagogical and psychological principles. By integrating these theories, the FEBI Model not only aims to increase knowledge and form positive attitudes, but also targets objective biological changes through decreasing glycated albumin levels. The implementation of this model is expected to provide empirical evidence that an interactive application-based education approach can be an effective tool in supporting more independent and sustainable diabetes management. Given the importance of evidence-based interventions in improving the quality of life of T2DM patients and reducing long-term complications, this study is relevant to test the effectiveness of the application-based FEBI Education Model in improving clinical outcomes and patient behavior. This study is expected to provide significant contributions to the development of technology-based intervention programs in the field of chronic disease management, especially type 2 diabetes mellitus.

METHODS

This study was a quasi-experimental study with a one group pretest-posttest design. This design was used to evaluate the effect of the implementation of the application-based FEBI

Education Model on changes in the level of knowledge, attitudes, and glycated albumin levels in patients with type 2 diabetes mellitus. The research location was the working area of Andalas Health Center and the working area of Ambacang Health Center with a sample size of 30 people with the following criteria: patients with type 2 diabetes mellitus with a diagnosis of at least 6 months, aged 30–65 years, have an Android/iOS smartphone and are able to use the application and are willing to participate in the education and re-measurement program, with a purposive sampling technique.

RESULTS

Based on the research results, the frequency distribution of respondents' answers through pre-test and post-test questionnaire statements regarding the level of knowledge, attitudes and direct examination of blood glucose levels, especially glycated albumin, can be seen in full in Table 1.1 below.

Table 1 Average Knowledge, Attitudes and Glycated Albumin Levels before the intervention

Knowledge, Attitudes and Glycated Albumin Levels	n	Mean	SD
Prior Knowledge	30	16.10	2.203
Attitude before	30	41.63	2.526
Glycated Albumin before	30	18.20	4.229

Based on table 1 above, the average knowledge before the FEBI model education intervention was 16.10 with a standard deviation of 2.203. While the average attitude was 41.63 with a standard deviation of 2.526 and the average glycated albumin level was 18.20 with a standard deviation of 4.229. After implementing FEBI education for approximately 4 weeks, the results of the average knowledge, attitude and glycated albumin levels were obtained which can be seen in Table 2 below.

Table 2 Average Knowledge, Attitude and Glycated Albumin Levels after the intervention

Knowledge, Attitudes and Glycated Albumin Levels	n	Mean	SD
Knowledge After	30	20.23	2.487
Attitude after	30	46.13	3.181
Glycated Albumin after	30	15.09	2.966

Based on table 2 above, the average knowledge after the FEBI model educational intervention was 20.23 with a standard deviation of 2,487. While the average attitude was 46.13 with a standard deviation of 3,181 and the average glycated albumin level was 17.20 with a standard deviation of 3,906. This figure shows that there was an increase in the level of knowledge, attitudes of respondents and a decrease in glycated albumin levels after the FEBI model educational intervention was given. The differences in the level of knowledge, attitudes and glycated albumin levels of respondents before and after this educational intervention were then analyzed using a paired t-test or dependent t-test, the results of the analysis can be seen in Table 3 below.

Table 3 Analysis of Differences in Mean Levels of Knowledge, Attitudes and Glycated Albumin Levels Before and After the FEBI Model Educational Intervention

Level of Knowledge	n	Mean	SD	Std Error	Selisih mean	p- value
Before - after knowledge	30	16.10	2.345	0.428	-4.133	0.00
	30	20.23				
Attitude	**n**	**Mean**	**SD**	**Std Error**	**Selisih mean**	**p- value**
Before-After attitude	30	41.63	4.041	0.738	-4.500	0.00
	30	46.13				
Glycated Albumin Levels	**n**	**Mean**	**SD**	**Std Error**	**Selisih mean**	**p- value**
Before-After Glycated Albumin Levels	30	18.20	2.330	0.425	1.003	0.025
	30	17.20				

Based on table 3. above, the average knowledge, attitude and glycated albumin levels before and after the FEBI education intervention were obtained, with the t-dependent statistical test,

p-value = 0.000 was obtained for knowledge, p-value = 0.000 for attitude and p-value 0.013 for glycated albumin levels, which means p-value <0.05 can be interpreted as an influence of the level of knowledge, attitude and glycated albumin levels with the provision of android-based FEBI education.

DISCUSSION

1. Average Knowledge, Attitude and Glycated Albumin Levels before the intervention

Based on the results of the study before the FEBI model education intervention, the results of knowledge were obtained with a mean of 16.10 with a standard deviation of 2.203, while attitudes with a mean of 41.63 with a standard deviation of 2.526 while glycated albumin levels with a mean of 18.20 with a standard deviation of 4.229.

FEBI model education with the DiaEdu application was implemented for four weeks with control of respondents carried out every week, and the trial ended with a post-test questionnaire to determine changes in knowledge, attitudes and glycated albumin levels. According to Perkeni, (2021) glycated albumin examination can be used to assess the glycemic control index that is not influenced by hemoglobin metabolism disorders and erythrocyte life span such as HbA1c. HbA1c examination is a long-term glycemic control index (2 to 3 months). Meanwhile, the albumin metabolic process occurs faster than hemoglobin with an estimated 15 to 20 days so that glycated albumin is a medium-term glycemic control index. However, some disorders such as nephrotic syndrome, steroid treatment, severe obesity and thyroid dysfunction can affect albumin levels which have the potential to affect the measurement value of glycated albumin. In the management of diabetes mellitus, complications often occur, including hyperglycemia and hypoglycemia. Hypoglycemia is characterized by a decrease in blood glucose levels <70 mg/dL.

According to (PERKINI, 2021) Hypoglycemia is a decrease in serum glucose concentration with or without signs and symptoms of the autonomic system. Some patients with diabetes may show signs and symptoms of low blood glucose but blood glucose levels are normal. On the other hand, not all diabetic patients experience signs and symptoms of hypoglycemia even though their blood glucose levels are low. Decreased consciousness that occurs in diabetic patients should always be considered as being caused by hypoglycemia. Hypoglycemia is most often caused by the use of sulfonylureas and insulin. Hypoglycemia due to sulfonylureas can last a long time, so it must be monitored until all the drug is excreted and the drug's working time has run out. Blood glucose monitoring of patients should be carried out for 24-72 hours, especially in patients with chronic kidney failure.

According to the results of (Yunir, E., Hidayah, C. D., Harimurti, K., & Kshanti, 2022) research entitled Risk factors for severe hypoglycemia in patients with type 2 diabetes mellitus in outpatient clinics of tertiary hospitals in Indonesia, the results showed that the proportion of severe hypoglycemia was 25.4%. And of the 291 respondents, most subjects received insulin therapy (60.8%). In their study, 20.6% of subjects had a history of previous severe hypoglycemia. The average duration of diabetes was 12 (5–19) years, with an average HbA1c level of 7.5 (6.5–8.7). Meanwhile, most subjects had stage II CKD (33.7%). and the proportion of severe hypoglycemia was 25.4%. Bivariate analysis showed a relationship between HbA1c levels of less than 7%, with the subject's understanding of hypoglycemia symptoms, and the results of the study explained that the use of sulfonylureas, and insulin use were associated with the incidence of hypoglycemia. Multivariate analysis showed a history of previous severe hypoglycemia with a value (OR 5.864, p≤0.001), eGFR less than 60 mL/minute/1.73 m2 (OR 1.976, p=0.028), and insulin use (OR 2.257, p=0.021) were significantly associated with the incidence of severe hypoglycemia.

To prevent complications of hypoglycemia, primary prevention of type 2 diabetes is needed, which is carried out by providing counseling or education and management aimed at community groups who are at high risk of type 2 diabetes and glucose intolerance. Prevention efforts are carried out mainly through lifestyle changes. Strong evidence suggests that lifestyle changes can prevent type 2 diabetes. Lifestyle changes should be an early intervention for all patients, especially high-risk groups. Lifestyle changes can also simultaneously improve components of diabetes risk factors and other metabolic syndromes such as obesity, hypertension, dyslipidemia and hyperglycemia.

Indicators of successful lifestyle interventions are weight loss of 0.5 - 1 kg/week or 5 - 7% weight loss in 6 months by regulating diet and increasing physical activity. The Diabetes Prevention Program (DPP) study showed that intensive lifestyle interventions can reduce the incidence of type 2 diabetes by 58% in 3 years. Follow-up of the DPP Outcome Study showed a decrease in the incidence of type 2 diabetes by 34% and 27% in 10 and 15 years (PERKINI, 2021).

2. Average Knowledge, Attitude and Glycated Albumin Levels after the intervention

Based on the results of the study after the FEBI model education intervention, the results of knowledge were obtained with a mean of 20.23 with a standard deviation of 2,487, while attitudes with a mean of 46.13 with a standard deviation of 3,181 while glycated albumin levels with a mean of 15.09 with a standard deviation of 2,966.

The results of the study showed that the application of the FEBI (Interaction-Based Education Focus) education model had a positive impact on increasing knowledge, attitudes, and blood glucose control in patients with Type 2 Diabetes Mellitus. After the intervention, respondents' knowledge showed a significant increase, with an average (mean) of 20.23 and a standard deviation of 2.487. These results indicate that interactive education provided through the application is able to improve participants' understanding of Diabetes Mellitus management, including important aspects such as diet management, physical activity, medication adherence, and blood glucose monitoring. The relatively small standard deviation indicates that the variation in knowledge levels between respondents after the intervention is not too large, so that the level of knowledge increase tends to be even.

This finding is in line with Orem's Self-Care Deficit Nursing Theory, which states that education that increases patient knowledge is key to developing independence in self-care, including in the management of chronic diseases such as diabetes. Good knowledge is the main foundation for sustainable behavior change. In addition, research by (Oyarce-Calderón et al., 2023) shows that interactive technology-based diabetes education can significantly increase patient knowledge compared to conventional methods. In this context, the use of applications in the FEBI model strengthens patient involvement through more flexible and easily accessible media.

In the attitude aspect, there was an improvement reflected in the mean of 46.13 with a standard deviation of 3.181. This shows that the intervention not only improves the cognitive aspect (knowledge), but also the affective aspect of respondents in managing their disease. The positive attitude that is formed can contribute to increased compliance with recommended diabetes management behaviors, such as diet control, regular exercise, and taking medication as prescribed. The standard deviation in the attitude aspect which is slightly larger than knowledge indicates individual variation in acceptance and attitude change, which can be influenced by personal factors such as motivation, previous experience, and social support.

According to the Health Belief Model (HBM) theory, attitudes toward disease and its management are influenced by individual perceptions of disease severity, susceptibility, benefits of action, and barriers to behavioral change. Through the FEBI model, participants gain an interactive educational experience, strengthening the perception of the benefits of diabetes self-management and reducing psychological barriers. Similar research by (Handayani et al., 2020) also found that an interaction-based educational program increased the perception of self-control over diabetes, which ultimately contributed to positive attitudes toward lifestyle change.

Meanwhile, glycated albumin levels reflecting medium-term blood glucose control showed an average of 15.09 with a standard deviation of 2.966. The decrease in glycated albumin levels indicates the success of the educational intervention in helping participants control their blood glucose levels. Glycated albumin is an important biomarker in monitoring glycemic control in the last 2-3 weeks, so these results provide strong evidence that behavioral changes driven through the FEBI model have a real clinical impact in a relatively short time. The fairly small standard deviation also shows that the results of the decrease in glucose levels are relatively consistent among participants.

In theory, improved glucose control following educational interventions is supported by the Behavioral Self-Management Model, which emphasizes that empowering patients through education will improve their skills in monitoring and controlling chronic conditions. These results

are also consistent with a meta-analysis by (Nanayakkara et al., 2021). Showing that diabetes education interventions, especially those integrating technology, can significantly reduce HbA1c and since glycated albumin is a short-term marker of blood glucose, a similar decrease in glycated albumin further strengthens the evidence for the effectiveness of the FEBI model. Overall, these findings reinforce that an interactive educational approach integrated with a digital application such as the FEBI model is effective in not only improving knowledge and attitudes, but also contributing to improved clinical outcomes. These results are consistent with previous literature suggesting that technology-based and interactive educational interventions can improve self-management.

3. The Influence of FEBI Education Model on Knowledge, Attitude and Glycated Albumin Levels

Differences in the level of knowledge, attitudes and glycated albumin levels of respondents before and after the implementation of the FEBI education model were analyzed using a paired t-test, and the results were significant with a p-value = 0.00, for knowledge and attitudes and a p-value = 0.025 for glycated albumin levels. This means that it can be concluded that there is an influence of the application-based FEBI education model on the level of knowledge, attitudes and results of glycated albumin levels in people with diabetes mellitus. This study evaluated the effect of the implementation of the application-based FEBI (Focused Interaction-Based Education) education model on knowledge, attitudes, and glycated albumin levels in people with Type 2 Diabetes Mellitus. Statistically, the comparison between the values before and after the intervention showed significant results in all variables measured, with a p-value <0.05 for knowledge (p-value = 0.00), attitude (p-value = 0.00), and glycated albumin levels (p-value = 0.025). These findings indicate that the application-based FEBI education model has a significant effect on improving knowledge, attitudes, and blood glucose control in people with diabetes.

The significant increase in knowledge after the intervention indicates that the application-based FEBI model is very effective in improving patient understanding of diabetes and how to manage it. In accordance with Constructivism Theory (Piaget & Vygotsky) explains that individuals learn by building new knowledge based on their experiences. In the context of FEBI education, the application allows active participation of users in the learning process, such as through self-evaluation, interactive feedback, and repetition of materials that are appropriate to individual needs. Piaget stated that effective learning requires active involvement in cognitive activities. Vygotsky emphasizes more on social and contextual interactions in learning. The FEBI model supports both of these concepts by providing digital social interactions through applications that allow patients to learn independently while receiving feedback from the system or community.

According to Information Processing Theory by Atkinson & Shiffrin emphasizes that information is processed in the short-term storage stage which is then translated into the long term if it is maintained through repetition and conditioning. In the FEBI model, this application allows for structured repetition of information through testing and exercises that strengthen understanding and retention of information.

Comparison with Previous Research in this case by (Pekmezaris, R., Williams, M. S., 2022) shows that the use of applications for diabetes education can significantly improve patient knowledge because the technology-based approach activates the learning process in a more interactive and adaptive way. The results of this study are in line with existing findings, that digital technology in the context of health education is more efficient than conventional methods.

The significant decrease in glycated albumin levels after the intervention shows that the FEBI education model not only has an impact on cognitive and affective aspects, but also produces changes in clinically measurable blood glucose management. Self-Management Theory by Lorig & Holman (2003) explains that managing chronic diseases such as diabetes requires skills to plan, implement, and evaluate certain actions aimed at controlling the disease. Through the application, the FEBI model supports patients in planning and implementing daily actions aimed at maintaining blood glucose levels within safe limits. The use of this interactive application leads to increased adherence to diet, exercise, and medication management, which directly contributes to decreased glycated albumin levels. Reinforcement Theory by Skinner suggests that reinforced behavior tends to be repeated. In the context of the FEBI education model, the application provides positive

reinforcement (direct feedback) that strengthens behavioral changes related to diabetes management. This finding is consistent with research findings showing that better glycemic control is achieved after improvements in attitudes and knowledge.

CONCLUSIONS

Based on the research results, the implementation of the FEBI Education Model (Focused Interaction-Based Education) based on the application showed a significant effect on increasing knowledge, forming positive attitudes, and decreasing glycated albumin levels in patients with type 2 diabetes mellitus. Analysis using a paired t-test showed a significant difference between before and after the intervention, with a p-value = 0.000 for knowledge and attitudes, and a p-value = 0.025 for glycated albumin levels, all of which were below the significance threshold of 0.05, which means that there is an effect of providing FEBI education with a significant increase in knowledge and attitudes and a decrease in glycated albumin levels.

ACKNOWLEDGMEN

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