Comprehensive Intervention Module to Improve Foot Self-Care Knowledge in Patients with Diabetes Mellitus

Módulo de intervención integral para mejorar el conocimiento del autocuidado de los pies en pacientes con diabetes mellitus

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SUMMARY

Diabetes-related foot problems can occur and develop into diabetic foot ulcers (DFU). Correct knowledge prevents DFU and strengthens patients' self-care practices. This study aims to analyse the provision of health education through a Comprehensive Intervention Module on Foot Self-Care to increase patients with Diabetes Mellitus (DM) 's knowledge of foot self-care. This research employed a quasi-experimental design (pre-test and post-test group design with a control group). Samples were taken from 80 adults with diabetes mellitus (DM) and divided into intervention and control groups. Each group consisted of 40 adults with DM. Evaluation of the patient's knowledge using questionnaires. Data analysis using the Wilcoxon test with p<0.05 shows statistically significant values. Analysis of knowledge about foot self-care before and after module administration revealed significant differences between the intervention and control groups (p = 0.0001). Analysis of pre-treatment knowledge showed no significant difference between the intervention and control groups (p = 0.581). Analysis of knowledge after treatment revealed substantial differences between the intervention and control groups (p-value = 0.0001). The mean knowledge score after treatment in the intervention group was 89.68, which was significantly higher than the control group's 77.80. Learning through lectures and mentoring can impart knowledge more effectively than education through lectures alone. Health Education using comprehensive intervention modules on foot care can increase patients' knowledge of self-care for their feet. Therefore, support from health workers to improve foot self-care behavior among DM sufferers is needed.

Keywords: *Diabetic foot, self-care, health education, diabetes mellitus.*

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RESUMEN

Los problemas de los pies relacionados con la diabetes pueden presentarse y derivar en úlceras del pie diabético (UPD). Un conocimiento adecuado previene las UPD y fortalece las prácticas de autocuidado de

los pacientes. Este estudio busca analizar la provisión de educación en salud mediante un Módulo Integral de Intervención sobre el Autocuidado de los Pies, con el fin de aumentar el conocimiento de los pacientes con diabetes mellitus (DM) sobre dicho autocuidado. Esta investigación empleó un diseño cuasiexperimental (diseño grupal con pretest y postest y grupo de control). Se tomaron muestras de 80 adultos con diabetes mellitus (DM) y se dividieron en grupos de intervención y de control. Cada grupo estuvo compuesto por 40 adultos con DM. Se evaluó el conocimiento de los pacientes mediante cuestionarios. El análisis de datos se realizó mediante la prueba de Wilcoxon; con p < 0,05, se mostraron diferencias estadísticamente significativas. El análisis del conocimiento sobre el autocuidado de los pies antes y después de la administración del módulo reveló diferencias significativas entre los grupos de intervención y de control, con un valor de p de 0,0001. El análisis del conocimiento previo al tratamiento entre el grupo de intervención y el grupo control no mostró diferencias significativas (p = 0,581). El análisis del conocimiento tras el tratamiento reveló diferencias significativas entre el grupo de intervención y el grupo control (p = 0,0001). La media de conocimiento después del tratamiento en el grupo de intervención fue de 89,68, significativamente superior a la del grupo de control (77,80). El aprendizaje mediante conferencias y mentoría puede transmitir conocimientos de forma más eficaz que la formación únicamente mediante conferencias. La educación en salud, mediante módulos de intervención integral sobre el cuidado de los pies, puede aumentar el conocimiento de los pacientes sobre el autocuidado de los pies. Por lo tanto, se requiere el apoyo de profesionales sanitarios capaces de mejorar las conductas de autocuidado de los pies en pacientes con DM.

Palabras clave: *Pie diabético, autocuidado, educación para la salud, diabetes mellitus.*

INTRODUCTION

Diabetes mellitus is a serious chronic disease characterized by persistent hyperglycemia, resulting from ineffective insulin utilization, insufficient insulin production, or, in some cases, a complete absence of insulin secretion (1). Diabetic Foot Ulcers (DFUs) are ulcerative lesions of the foot that occur in individuals with diabetes and are primarily associated with peripheral neuropathy, peripheral arterial disease, or both (2). More than 50 % of diabetic patients who experience severe sensory loss due to neuropathy may be asymptomatic. Ulcers can result from the patient's inability to recognize the early signs of infection, damage to skin tissue, changes in skin temperature, and insufficient vascular perfusion (3).

Diabetic neuropathy is the most prevalent chronic complication of diabetes. Its most common clinical manifestations include numbness, tingling, pain, and cutaneous damage. Peripheral neuropathy alters sensory perception in individuals with diabetes, leading to progressive loss of protective sensation, gradual numbness in the lower extremities, and an increased risk of developing foot ulcers (3,4). Peripheral arterial disease (PAD) is defined as a clinical condition characterized by stenosis or occlusion of the arteries supplying the lower extremities. PAD is a major risk factor for foot ulceration in individuals with diabetes and serves as a critical predictor of ulcer development and poor wound healing (5).

Diabetes-related foot problems can occur and can be challenging to treat. They can develop into diabetic foot ulcers (DFU), sometimes even require amputation, and may progress to death with a poor prognosis (3). Self-care practices for diabetes are essential for preventing and delaying diabetes complications and for reducing health system costs for diabetes care (1,6). Foot self-care practices in patients with DM include glycemic control, foot inspections, and appropriate, regular foot care to prevent the development of DFU (7,8).

Therefore, it is essential to provide detailed, careful information on preventive measures, including foot care, for patients with diabetes (9,10). Correct knowledge plays a vital role in preventing diabetic foot ulcers and strengthening patients' self-care practices. The evidence indicates that self-care expertise and practices are considered milestones in protecting against diabetic foot ulcers (3). A wide variety and combination of patient education interventions have been evaluated for the prevention of diabetic foot ulceration and for improving patient knowledge and behavior. These interventions vary from brief to intensive patient education, including demonstrations and 'hands-on' teaching (10).

Many studies have shown that education about foot care can improve patients with DM's knowledge and skills in caring for their feet. In addition, many kinds of methods are used to

provide education. It does not mean that the more sophisticated the technology used to provide health education is, the better the knowledge transfer process conveyed. Still, attention must be paid to the patient's background. A customized care education strategy emphasises consideration of patient preferences, values, and phenotypes (11). So, the application of this method should be based on an analysis of patient characteristics to ensure appropriate selection. This study provides the Comprehensive Intervention Module on Foot Self-Care (CIM-FSC) as an alternative to enhance patients with DM's knowledge of foot care.

Patients with DM have received information on managing their disease, including foot care. Even though patients have received the correct information, the frequency of foot care in daily life still needs improvement. This is likely because the patient is saturated, requires a better understanding, and has low awareness. Thus, patients need regular assistance and monitoring to continue foot care.

This study aims to analyze the provision of health education to increase patients with DM's knowledge of foot self-care. CIM-FSC provided health education solely through lectures, with mentoring.

MATERIAL AND METHOD

This study was a quasi-experiment (pre-test, post-test group design with a control) that compared the methods of delivering information through education, with and without assistance.

Using random sampling techniques, the sample comprised 80 adults with DM recruited from 4 Primary Health Care (PHC) centers in Surabaya, East Java. The inclusion criteria included a diagnosis of DM and being over 36 years old. The exclusion criteria were that the patients were unstable and had cognitive impairment.

Researchers divided the sample into two groups: an intervention group and a control group. Each group consisted of 40 adults with DM. The intervention group received health education through lectures and mentoring. In contrast, the control group received only health education through lectures. All study participants received the CIM-FSC book. The information in the CIM-FSC book focused on foot self-care management, including foot examination by inspection and palpation, foot care, and foot exercises. In addition to being given modules, patients were also given a package of foot care equipment. Foot self-care management was a modified combination of Diabetic Foot Management (8,12,13). The lecture method was the oral delivery of information to patients with DM in the room. Mentoring consisted of providing information reinforcement through individual meetings with patients, one week after the initial information provision.

The study was conducted from June to August 2023 at four health centers in Surabaya, East Java. All eligible participants were asked to complete self-administered questionnaires about sociodemographic characteristics, clinic characteristics, foot complaints, and knowledge of foot self-care, all written in Indonesian. The questionnaires were distributed to patients who visited the health centers. Before data collection, researchers explain the study's purpose, ensure written consent is obtained, and confirm that patient participation is voluntary.

Data collection using questionnaires consisting of characteristic data, including age, sex, smoking history, Body Mass Index (BMI), length of suffering, family history, HbA1c levels, foot complaints, DFU risk, and foot condition and collecting data on characteristics using the integrative assessment form of patients with diabetes mellitus (14) and using questionnaires to evaluate knowledge about foot self-care before and after the provision of health education. The measurement of foot self-care knowledge uses two categories: true and false. The higher the score, the better the understanding. The foot self-care management questionnaire was a modified and combined version of the Self-Care of Diabetes Inventory (SCODI) (15) and Diabetic Foot Management (16,17). The number of foot self-care knowledge questions was 16. This questionnaire has been assessed for its validity and reliability. The result was that from 16 question items, there were two invalid questions, namely questions No. 2 and 16, with a calculated R-value less than the R table; the values are 0.224 and

0.129, respectively. The value is less than 0.362 (R count). The reliability test using Cronbach's alpha indicated that 16 items were reliable, with an alpha of 0.74.

Data analysis

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to describe the distributions of patient characteristics, disease attributes, and knowledge of diabetic foot self-care. Research analysis was used to determine knowledge about foot care before and after providing comprehensive modules. The results obtained from the study subjects were tested for normality using the Shapiro-Wilk test. If the data were normally distributed, the Paired Sample T-test was applied, with $p<0.05$ indicating statistical significance. If the data distribution is abnormal, the Wilcoxon test was applied, yielding a statistically significant result ($p < 0.05$)

Ethical Considerations

Ethical approval was obtained from the Poltekkes Ethics Institute of the Ministry of Health Surabaya: No. EA/1533/KEPK-Poltekkes_Sby/V/2023 and administrative documents were obtained from the Surabaya Health Office for each selected PHC before data collection.

RESULTS

Characteristics of Patients with DM

Eighty diabetic patients participated in the study and were divided into two groups. In the control group, 37.5 % were 56-65 years old, while in the intervention group, 42.5 % were 46-55 years old. More than half of the patients with diabetes were women in both the control (67.5 %) and intervention (80 %) groups. 16 study participants (40 %) in the control group had a BMI >27 %, while the BMI in the intervention group (50 %) was within the typical range. 55.0 % of the study participants in both the control and intervention groups had DM for less than 5 years. 62.5 % of the diabetes patients in the control group had a family history of DM, and 67 % had no family history of DM. Most patients took oral medication

in control (82.5 %) and intervention (85.0 %) groups. Regarding HbA1c levels, 47.50 % of the control group had HbA1c >7 %, compared with 60.0 % in the intervention group (Table 1).

Table 1. Characteristics of Patients with DM

Characteristics	Control n = 40	%	Treatment n = 40		%
Age (years)					
36-45	9	22.50	5	1	2.50
46-55	8	20.00	17		42.50
56-65	15	37.50	16		40.00
>65	8	20.00	2		5.00
Gender					
Man	13	32.50	8		20.00
Woman	27	67.50	32		80.00
BMI (%)					
<18.5	4	10.00	1		2.50
18,5-25	14	35.00	20		50.00
>25-27	6	15.00	5		12.50
>27	16	40.00	14		35.00
DM duration (years)					
< 5	22	55.00	24		60.00
5-10	14	35.00	12		30.00
>10	4	10.00	4		10.00
History					
Yes	25	62.50	13		32.50
No	15	37.50	27		67.50
Type of medication					
Oral	33	82.50	34		85.00
Injection	2	5.00	3		7.50
Combination	5	12.50	3		7.50
HbA1C (%)					
>7	19	47.50	24		60.00
≤ 7	21	52.50	16		40.00

Source: Primary Data, 2023

Normality Test Data Knowledge of Foot Care

The results of the normality analysis of foot care knowledge data showed p-values of 0.072 and 0.068, indicating differences in the distributions of data between the educational treatment groups with and without assistance before and after treatment. Thus, it can be concluded that the data in both groups are not normally distributed. Thus, the Wilcoxon Test was used to analyze the data and answer research questions or test research hypotheses 1 and 2, rather than the Paired Sample t-test. For

hypotheses 3 and 4, the Mann-Whitney Test was used, rather than the Independent Sample t-test.

Early and final knowledge of DM patients about foot care in the education group, accompanied by assistance using the comprehensive intervention module media, and unassisted education

The analysis of patients' knowledge of DM before treatment showed a p-value of 0.581, indicating that knowledge did not differ significantly between the treatment and control groups. The analysis of patient knowledge after treatment between the treatment and control groups yielded a p-value of 0.0001, indicating that the knowledge of DM patients after treatment differed significantly between the groups. Knowledge of DM patients after treatment differed substantially between the treatment group (education and mentoring) and the control group (education only). Because the value of expertise after treatment differed significantly between the two groups, testing was continued to determine the effectiveness of the two treatments by comparing the mean values between the groups. The mean value after treatment in the education-assistance group was 89.68, which was greater than the unassisted education group's 77.80, indicating that education and assistance were better than education alone (Table 2).

Table 2. Early and Final Knowledge of Patients with DM about Foot Self-care.

	Group	Mean	P value
Preliminary knowledge	Treatment	68.93	0.581
	Control	67.73	
Final knowledge	Treatment	89.68	0.0001
	Control	77.80	

DISCUSSION

This study has applied a comprehensive intervention model based on Self-Care of Chronic Illness to diabetic foot prevention in DM patients in the city of Surabaya by providing a complete intervention module for foot care for DM patients. There was a significant difference in knowledge before and after education, with modules supplied to both the control and treatment groups. Providing this education is essential to prevent the development of DFU. Currently, most educational foot care intervention programs focus on a single intervention. However, there is insufficient evidence that a single educational intervention effectively reduces the incidence of foot ulcers and amputations, or improves patient knowledge and behavior (10). Other research has guided existing expertise and highlighted the need for programs to address barriers in foot care management, particularly in skills and attitudes (18). The present research has combined education and mentoring, yielding better results than single education. Assistance serves as a reminder for patients to perform foot care consistently.

DM patients' knowledge of foot care in both the treatment and control groups was low, with an average level of understanding, which is a factor that may trigger DFU. Evidence has shown that poor foot care knowledge and behavior are associated with the development of DFU (19). Thus, there is a need for a program to improve foot care knowledge and reduce diabetes-related distress among patients with diabetes, especially in Indonesia. In implementing such programs, families should be involved to increase support for self-care and foot-care behaviors among patients (6,20), which are beneficial for preventing DFU. Poor foot-care practices significantly increase the risk of developing foot ulcers (21-23). Ensuring that patients have accurate and comprehensive knowledge is essential for preventing diabetic foot ulcers and reinforcing effective self-care behaviors.

In addition to low knowledge, patients with DM in this study had characteristics that can be risk factors for DFU, such as obesity, duration of DM, and blood glucose levels. In this study, participants' BMI classifications ranged from underweight to obese; however, the majority fell within the overweight and obese categories, both of which are commonly considered risk factors for diabetic foot ulcer (DFU) development. Despite this, the literature reports inconsistent associations between BMI status and DFU risk. Some studies suggest that obesity is not significantly linked

to DFU occurrence (25). In line with this, Ledoux et al. (26) observed that patients with diabetes who were obese had a lower risk of developing DFU. Additional evidence proposes potential protective mechanisms associated with obesity. For example, Biasucci et al. (27) found that severely obese individuals exhibited better vascular function than normal-weight and moderately obese subjects, along with elevated levels of endothelial progenitor cells—factors known to confer vascular protection against atherosclerosis.

In this study, most patients had been diagnosed with diabetes for less than five years. Numerous studies have demonstrated that a longer duration of diabetes is strongly associated with an increased risk of developing diabetic foot ulcers (DFU). The present findings are consistent with those of Syauta et al. (2012), who reported that patients with diabetes for more than 8 years had a significantly higher likelihood of DFU (25). Similar associations have been documented in studies conducted in Saudi Arabia, Southern Ethiopia, and Iran, where diabetes duration exceeding 10 years was positively and significantly associated with DFU risk (28-30). The duration of diabetes is also closely related to the development of diabetic peripheral neuropathy (DPN), a major precursor of DFU (31). Although most participants in this study had diabetes for less than five years, many had already presented with additional complaints or comorbid conditions. This may reflect delayed recognition of early diabetes symptoms, leading to late diagnosis and the earlier onset of complications.

In this study, most participants in both the treatment and control groups had HbA1c levels above 7 %, a threshold commonly associated with poor glycemic control and an increased risk of developing a diabetic foot ulcer (DFU). Meta-analytic evidence supports this association, showing that elevated blood glucose levels—as reflected by high HbA1c—significantly contribute to DFU progression (32). Similarly, a study from Ethiopia reported that nearly half of the patients exhibited poor glycemic control, and those with uncontrolled blood glucose were more likely to undergo amputation compared with individuals who maintained adequate glycemic control (33).

The biological mechanisms linking hyperglycemia to DFU are well established. Chronic hyperglycemia promotes the formation of advanced glycation end products (AGEs) and activates alternative metabolic pathways, such as the polyol pathway. Excess glucose accumulation leads to oxidative stress, axonal degeneration, and demyelination, ultimately resulting in neural dysfunction. In the polyol pathway, aldose reductase converts surplus glucose into sorbitol, which reduces levels of myo-inositol and nerve growth factor—key contributors to the development of diabetic neuropathy (34,35). Consequently, maintaining optimal glycemic control is a fundamental preventive strategy.

For many individuals with diabetes, regular blood glucose monitoring is essential for achieving glycemic targets and preventing complications associated with persistent hyperglycemia (36). Self-monitoring enables patients and clinicians to make timely adjustments to lifestyle behaviors—such as diet and physical activity—as well as medication regimens (37).

Patients often have limited knowledge about how foot ulcers develop. Many report that ulcers seem to appear "suddenly," beginning as small, unnoticed lesions that are only detected once they have already progressed (38). In this study, several factors placed patients with diabetes at increased risk for diabetic foot ulcers (DFU), including low levels of knowledge, elevated BMI, the presence of comorbidities, and HbA1c values above recommended targets. Providing structured education—particularly through comprehensive foot-care intervention modules—can enhance patients' understanding of proper foot-care practices and support consistent, appropriate self-care behaviors. Education should also address the various risk factors associated with DFU development. By improving awareness of these risks, patients may become more proactive in recognizing early signs and symptoms and in taking preventive measures to reduce the likelihood of DFU.

Implications and limitations

The findings of this study have important implications for individuals with diabetes, their families, and the healthcare professionals who

support ongoing diabetes self-care, particularly foot-care practices. Participants in this study were at risk of developing diabetic foot ulcer (DFU) complications, as many presented with HbA1c levels above 7 % and reported symptoms such as numbness, tingling, reduced sensation, dry skin, calluses, and pain. These indicators highlight the need for continuous patient education. As key educators, nurses must provide ongoing, tailored instruction to help patients maintain their health and prevent complications. Educational strategies should be regularly evaluated and adapted to patient characteristics to prevent fatigue or disengagement.

This study was conducted among a general group of patients with diabetes. It did not differentiate between those who were only at risk for DFU and those who had already experienced ulcers. Consequently, the foot-care education provided was not specific to either prevention or wound management. Future educational interventions should be tailored to patients' clinical status—whether they are at risk or already experiencing foot complications—to ensure relevance and effectiveness. Additionally, because this study focused on a specific patient group, the findings cannot yet be generalized to broader populations.

CONCLUSION AND RECOMMENDATION

This study provides health education to patients with DM as a promotive and preventive effort to reduce or delay the onset of complications. Health education using CIM-FSC can increase patients with DM's knowledge of foot care. Health education through lectures and mentoring improved patients' understanding of foot care in patients with DM. Patients with DM are expected to minimize complaints related to the development of diabetic foot ulcers by performing proper, continuous foot care. As part of the health workforce, nurses should continue to support patients in performing self-care behaviors for their feet. Nurses should enhance trusting relationships, empower patients, improve communication, and increase patients' confidence to stay engaged in improving their quality of life.

Author contributions

Anita Joeliantina (AJ), Dwi Adji Norontoko (DAN), Sri Hardi Wuryaningsih (SHW), Siswari Yuniarti (SY), and Padoli (PDL) contributed substantially to the study design, data collection, analysis, interpretation of results, and manuscript preparation. AJ took the lead in writing the final draft and conducting data analysis.

Conflicts of interest

The authors declare no competing interests.

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