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ORIGINAL ARTICLE

INNOVATIVE FOOT CARE EDUCATION MODEL UTILIZING THE FLIPPED CLASSROOM METHOD TO IMPROVE DIABETIC WOUND PREVENTION PRACTICES

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ABSTRACT

Background: The face-to-face learning method is commonly used in diabetes mellitus (DM) education; however, it often limits opportunities for patients to engage in independent study. In contrast, the flipped classroom method—an approach that integrates both online and face-to-face learning—allows patients to access learning materials in advance, which can be reviewed multiple times to enhance understanding. This study aims to investigate the impact of flipped classrooms on diabetic wound prevention behavior.
Methods: This research was conducted using a quasi-experimental pre- and post-test design with a control group. A total of 68 patients with diabetes mellitus were selected through simple random sampling, with each group consisting of 34 participants. The research variables included the flipped classroom approach and diabetic wound prevention behavior, which were measured using the Modification of Diabetic Foot Care Behavior (MDFCB) questionnaire. Data analysis was performed using descriptive statistics and t-tests.
Results: There was a significant difference in diabetic wound prevention before (42.18±5.137) and after (46.41±5.461) being given intervention (p = 0.0001). Additionally, a significant difference in diabetic wound prevention was observed between the intervention group (46.41±5.461) and the control group (44.15±4.82) (p = 0.0001).
Conclusions: The classroom approach enhances behaviors related to the prevention of diabetic foot wounds Further research is needed to improve the effectiveness of this approach in preventing of diabetic complications.

Keywords: *Diabetes mellitus; education; wound prevention behaviors*

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BACKGROUND

Diabetic foot ulcers are among the most common complications experienced by patients with Diabetes Mellitus (DM); however, they are largely preventable through proper foot care practices (Pourkazemi et al., 2020). Insufficient knowledge and inadequate foot care practices have been identified as significant risk factors for foot problems in patients with DM (Heng et al., 2020; Singh et al., 2020). This situation is further exacerbated by the reliance on traditional face-to-face health education methods conducted at health facilities. Enhancing educational factors such as the environment and infrastructure can improve the effectiveness of the flipped classroom method in educating patients with DM(Suyanto Suyanto, Tintin Sukartini, Ferry Efendi et al., 2024).

However, this traditional method has several limitations, including the necessity for participants to be physically present at the educational site, restricted for learning, and limited opportunities to review or thoroughly understand the educational content. Consequently,, comprehension and application of the material are often insufficient (Gherheș, V.,

Stoian, C. E., Fărcașiu, M. A., & Stanici, 2021; Tolks et al., 2016).

The prevalence of diabetes mellitus (DM) in Southeast Asia reached 10.1% in 2017, with Indonesia ranking sixth among countries with the highest incidence of DM, reporting 10.3 million cases (Dinas Kesehatan Provinsi Jawa Tengah, 2019). The incidence of diabetic foot ulcers among patients with DM been reported to be as high as 25% over their lifetime (Kemenkes RI, 2018). Research conducted in Malaysia shows that a majority of patients (58%) possess insufficient knowledge about diabetes, and 61.8% of them engage in poor foot care practices.

Moreover, the prevention of diabetic foot ulcer is closely associated with knowledge levels, behavioral patterns, and family support. Family involvement plays a critical role in encouraging and supporting patients to engage in appropriate foot care. Several studies have shown that active family participation in the educational process positively influences diabetic foot ulcer prevention behaviors (Javid et al., 2021; Pender, 2011; Rahaman et al., 2018). Additionally, family participation in providing support during educational sessions for diabetes mellitus (DM) patients can be particularly effective, as learning can occur in the patient's home environment (Ha et al., 2021).

An innovative educational approach that addresses the limitations of conventional methods is the flipped classroom model. This method combines online and offline learning, allowing participants to study materials through videos at home and subsequently engage in discussions with facilitators to enhance their understanding before undergoing evaluation (Flores et al., 2016). The flipped classroom model can be implemented in patients' homes, enabling active family involvement and strengthening social support. In this context, the Health Promotion Model (HPM) is particularly relevant, as it emphasizes individual commitment and social support in the development of healthy behaviors (Khodaveisi et al., 2017). To date, no study has specifically examined the effectiveness of a Foot Care Education (FCE) model based on the flipped classroom approach that integrates family involvement to improve diabetic foot ulcer prevention practices. Therefore, this study aims to evaluate the impact of the flipped classroom method on improving diabetic wound prevention behaviors among patients with DM in the community.

METHOD

Study design

The study design utilized a quasi-experimental pre-and-post-test with control group design.

Sample

The sample forthis study consisted of respondents (34 in the intervention group and 34 in control group), selected using G*Power software (effect size = 0.8, α = 0.05, and power = 0.90) through simple random sampling. The process involved identifying the entire population of interest, assigning a number to each potential respondent, and then using a random number generator or drawing lots to select the sample from community health centers. Inclusion criteria included individuals aged 40-55, of both genders, diagnosed with diabetes diabetic for less than 5 years, compos mentis, literate, and possessing good vision and hearing.

The research instrument

The instrument utilized was the Modification of Diabetic Foot Care Behavior (MDFCB) questionnaire (Hadi Sulistyo et al., 2018), which consists of 28 items divided into four subscales: foot inspection (items 1–5), footwear use (items 6–16), toenail cutting (items 17–21), and foot hygiene (items 22–28). Respondents' answers were measured using a Likert scale, where "always" was scored as 3, "often" as 2, "sometimes" as 1, and "rarely/never" as 0. The total score range for the questionnaire was 0–84. A study conducted in Central Java from June to September 2023 compared the effectiveness of a foot care education module with a Health Promotion Model-based flipped classroom approach on diabetic foot wound prevention behavior, demonstrating validity and reliability (p-value > 0.361, Cronbach's alpha > 0.7).

The Intervention

The intervention was conducted over a total of three months (12 weeks) with the following details: 1) Week 1: pre-test; 2) Week 2: socialization of the module to patients and their families, including materials on factors that influence the prevention of foot wounds, foot wounds management, and foot care; 3) Weeks 3-11: these weeks consisted of providing online materials, followed by practical sessions with assistance for each foot care material. This stage included two sessions for each educational topic. The first session involved the delivery of materials through a 5-minute online video. At the end of this session, respondents were required to answer comprehension questions related to the video content via an online platform. The second session comprised with a 50-minute interactive discussion and hands-on practice based on the video materials. This session utilized educational props and demonstration tools relevant to the topic. At the end of each practical session, the respondents' skills were assessed through structured evaluations to determine their level of competency and understanding. 4) Week 12: post-test.

Data collection

Data collection was facilitated by a research assistant and preceded by an apperception session to align perceptions. Questionnaires were distributed to respondents, with the researcher providing explanations as needed.

Data analysis

Data analysis was conducted using SPSS version 24, encompassing both descriptive and comparative analyses. The paired t-test, independent t-test, and Mann-Whitney were utilized to evaluate the effectiveness of the educational intervention on diabetic foot wound prevention behaviors. The independent t-test was employed to compare the mean differences between the intervention and control groups, as the data distribution for the variables was confirmed to be normal and homogeneous. In instances where the assumptions of normality and homogeneity were not met, the non-parametric Mann–Whitney U test was used as an alternative.

Ethical consideration

This study has received ethical approval from the Health Research Ethics Commission at the Faculty of Nursing, Sultan Agung Islamic University, on August 23, 2022, under ethical certificate No.390/A.1-KEPK/FIK-SA/VIII/2022. Prior to commencement of the study, the researcher provided a comprehensive explanation to prospective participants. Those who agreed to participate were asked to indicate their consent by signing the informed consent form. Throughout the research, the researcher adhered to the ethical principles of informed consent, respect for human rights, beneficence, and non-maleficence.

RESULT

The observational variable showed that 85.3% of respondents were late elderly, 64.7% were male, and 56.7%

had a senior high school. Additionally, 47.1% of the respondents were housewives, and 52.9% had been diagnosed with DM for more than 5 years. Patients in both groups exhibited similar baseline characteristics, eliminating potential for confounding variables. An explanation of the results is presented in Table 1.

Table 1. Characteristics of Respondents (n=68)

Characteristics	Intervention group (n=34)		control group (n=34)		homogeneity *p-value*
	f	%	f	%	
Age					
Early elderly	5	14.7	13	38.2	0.647*
Late elderly	29	85.3	21	61.8	
Gender					
Man	12	35.3	9	26.5	0.439*
Woman	22	64.7	25	73.5	
Education					
Elementary	5	14.7	13	38.2	0.226*
Junior School	13	38.2	14	41.2	
Senior school	16	47.1	7	7	
Job					
Housewife	16	47.1	26	76.5	0.810*
Entrepreneur	14	41.2	7	20.6	
Employee	4	11.8	1	2.9	
Length of diabetes					
Under 5 years	16	47.1	26	76.5	0.693*
More 5 years	18	52.9	8	23.5	

*Note: *chi square*

A total of 34 respondents were included in each group. It was observed that the foot protection indicators in the both intervention and control groups during the pretest were predominantly categorized as poor (50% and 52.9%, respectively). However, in the post-test in the intervention group showed a significant improvement, with 76.5% of patients categorized as good, while the control group remained at 52.9% in the good category (see Table 2.).

Table 2. Descriptive analysis in Patients with Diabetes Mellitus (n= 68)

Variable	Category	Pre Test		Post Test	
		Intervention	Control	Intervention	Control
		f	%	f	%
Foot wound prevention behaviors	Not Good	17 (50%)	18 (52.9%)	8 (23.5%)	16 (47.1%)
	Good	17 (50%)	16 (47.1%)	26 (76.5%)	18 (52.9%)
Total		34 (100%)	34 (100%)	34 (100%)	34 (100%)

The results of the independent t-test statistical test conducted on foot protection between the intervention and control groups revealed a p-value of 0.0001 ($p < 0.05$). This indicates that the flipped classroom foot care education module, based on the health promotion model, had a significant effect on foot protection in patients with diabetes mellitus (see Table 3.).

Table 3. Analysis of diabetic foot wound prevention behaviors between interventionand control groups before and after flipped classroom (n= 68)

group	Tets	mean±SD	Paired t test		Independent t test	
			t	p	t	p
Treatment group	Pre-test	42.18±5.137	-8.51	0.0001	-2.197	0.032
	Post-test	46.41±5.461				
Control group	Pre-test	43.26±4.80	-3.05	0.004		
	Post-test	44.15±4.82				

DISCUSSION

The research results indicated that education using a flipped classroom approach significantly improved diabetic foot wound prevention behaviors. This educational process influences patients' motivation, learning styles, and skills (Böhme et al., 2020). Varying levels of prior knowledge can affect instructional design and skill development. Additionally, attitudes toward towards education can also be shaped by previous experiences, both positive and negative (Alkhatieb et al., 2022). A deep understanding of these prior experiences is essential for creating an effective learning environment. The flipped classroom for preventing diabetic foot wounds increases patient participation by providing interactive materials outside of class, while in-class time is dedicated to active discussions and practical application, thereby facilitating the development of foot care skills (Bobbink et al., 2022; Greenwood & Mosca, 2017; Puppe & Nelson, 2019). This approach has proven effective in increasing patient understanding and engagement, thereby reinforcing the practical roles of learning (Finnegan et al., 2020). By improving foot care behaviors, such as egular foot inspections, education plays a crucial role in preventing serious complications (Liu et al., 2020; Windani Mambang Sari et al., 2016). Additionally, education can provide psychological support, encourage early detection of foot problems, and improve the quality of life for individuals with diabetes (Babalola et al., 2021).

Cognitive influences on diabetic foot wound prevention behaviors include knowledge, self-confidence, and an understanding of risk, all of which can motivate individuals to adopt preventive measures (Muchiri et al., 2021). Conversely, affective influences encompass positive emotions, motivation, and feelings towards treatment, which can serves as a strong incentives for undertaking preventive behaviors (Hamulka et al., 2018). These two factors interact, when knowledge is balanced with fear or emotional motivation, the effectiveness of prevention can be enhanced. Support from family, eers, and healthcare professionals positively influences diabetic foot prevention behaviors in patients with DM (Kartini et al., 2018). This support fosters greater discipline in foot care, encourages attention to signs of change, and promotes adoption of healthy habits. Such support promotes better understanding, motivation, and the effective implementation of preventive action (Anggraeni et al., 2020).

An integrated approach to the flipped classroom module that incorporates the Health Promotion Model creates an integrated approach for health education (Markwick & Sacco, 2021). The prevention of diabetic foot wounds relies on ongoing education and active patient participation. This approach not only disseminates information, but also promotes deeper understanding, reflection, and the application of concepts in the daily lives of individuals with diabetes mellitus (DM). Class discussions and interactions during sessions, which typically emphasize the discussion and application of concepts, enable individuals with DM to ask questions, discuss and obtain direct feedback. This interaction can strengthen their understanding and motivation regarding foot protection for DM patients (Pence et al., 2021; Venkatesh et al., 2021).

Commitment to diabetic foot wound prevention behaviors plays a crucial role in shaping individual motivation and consistency (Fallace et al., 2019). Commitment reflects personal responsibility for one's health and can enhance persistence in adhering to a foot care routine. The degree of commitment also influences an individual's perception of risk, with highly committed individuals more likely to take preventive measures seriously (Triharini et al., 2019). Furthermore, commitment is often related to a willingness to make lifestyle changes that support foot health (Alhaiti et al., 2020). Social support is instrumental in increasing commitment and assisting individuals in adopting preventive behaviors (Yoon et al., 2022). Comprehensive education and information can bolster an individual's commitment to prevention, while the level of social support received can also impact this commitment. The implications of the results of this research for nurses suggest that they can use the Health Promotion Model (HPM)-based flipped classroom model as an effort to increase the knowledge and skills of patients with diabetes mellitus and other diseases within community.

Limitation of this research is that it employs an observational research design, which can only assess associations rather than establish causality. Consequently, uncontrolled confounding variables—such as individual motivation, baseline knowledge, socioeconomic status, family support, and prior exposure to similar educational experiences—may influence the outcomes.

CONCLUSION AND RECOMMENDATION

The flipped classroom approach in foot care education significantly increases diabetic foot wound prevention behaviors. The implementation of the flipped classroom, which includes both online and face-to-face evaluation stages, proves to be more effective than traditional educational methods. Training and development of the flipped classroom approach can be conducted to further improve its effectiveness in the context of preventing diabetic foot wounds. Further research should aim to expand the sample size and study area, as well as conduct long-term monitoring of participants to assess the sustainability of the behavioural changes that have occurred. This will also helpimprove the effectiveness of this approach in preventing of diabetic complications.

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