The Impact of Diabetes Mellitus Structured Health Education Program on Knowledge, Attitude and Practice of Diabetes Care and Management among Nursing Students

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KEYWORDS
Diabetes mellitus, structured education program, diabetes complication, nursing student, nurses, knowledge, attitude and practice

ABSTRACT
Introduction: Diabetes mellitus is a chronic metabolic disorder which can lead to hyperglycemia and microvascular complications. Patient education given by nurses is always regarded as a vital component of diabetes therapy because the diabetes management greatly relies on the nurses who can help to unleash patient's capacity to perform self-care in their daily lives. Aim: Nursing students are the future nurses who form formidable workforce to make a difference in diabetes patients care. Hence the aim of this study was to evaluate the impact of diabetes mellitus structured education program on knowledge, attitude and practice of diabetes care and management among the nursing students in a private institution. Method: A quasi-experimental study was conducted at a private institution in Kedah, Malaysia in which a total of 93 participants were involved in the study. Pre-test was done before the intervention and subsequently pos-test was conducted immediately after intervention followed by second post-test a week after the intervention. Results: Results showed there was a significant effect of structured health education program on knowledge, attitude and practice among nursing students. Conclusion: This study underscored the significance of implementation of diabetes structured health education program as one of the preventive tools of diabetes care and management via raising patient awareness of the impending complications and can be appropriately adopted in clinical practice for their benefits.

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder which can lead to hyperglycemia and microvascular complications. It is one of the major chronic non-communicable diseases and it was estimated there will be significantly increase of cases from 171 million in 2000 to 300 million by 2025 and 366 million by 2030 (Bin Rakhis et al., 2022). World Health Organization (WHO) reported a significantly increase of about 170% in underdeveloped countries compared to industrialized nations (Tee & Yap, 2017). The rise has been seen in developing Asian countries as well. However the figures found in Southeast Asia countries showed Malaysia has a far greater prevalence of diabetes (18.3%) than its neighbors Singapore and Indonesia reported with 5.5% and 6.2% respectively (Akhtar et al., 2022), The main causes of the rapidly increasing incidence of DM in emerging nations are dietary practices and sedentary lifestyle (Sami et al., 2017). Thus, it is crucial to understand a population's knowledge of a disease prevention and management as it may affect early disease detection and diagnosis, control and reduction of complications. Further, DM and its consequences have a significant economic impact, particularly in developing nations and it seems prevention via health education is more crucial than curative measures (Konduru et al., 2017).

It is essential to identify the risk factors of diabetes and preventive aspects of its complications. A sedentary lifestyle, intake of high-calorie food, tobacco, obesity, ageing, and a family history of diabetes were identified as risk factors for the metabolic syndrome. Early diagnosis and management of DM are vital in preventing or delaying the onset of complications. DM was linked to a variety of things; some were patient-related or condition-related, while others were linked to patient attitude or the medications given. Insufficient glycemic control results in uncontrolled diabetes, which causes several

complications. These consequences, in turn, can significantly lower the patient's quality of life, shorten their life expectancy, and raise the healthcare expense of this disease (Bin Rakhis et al., 2022).

While DM cannot be cured, it could be prevented through certain lifestyle changes like diet, exercise and regular monitoring of blood glucose levels (Gazzaz, 2020). Knowledge, attitude and practice are crucial factors in effectively managing and preventing DM (Fatema et al., 2017). Adequate knowledge of the disease will promote a positive attitude towards DM which encourages the effective practice to prevent it (Fatema et al., 2017). Patient education is always regarded as a vital component of DM therapy because the management of DM greatly relies on the patient's capacity to do self-care in their daily lives. Studies had showed people with knowledge of diabetes self-care have improved long-term glucose control (Konduru et al., 2017). Understanding the risk of DM, patients are well informed and more inspired to seek out appropriate care and treatment, and this indirectly can help patients in keeping the disease under control.

Health education is crucial in resource-constrained areas where DM poses significant financial burdens and necessitates urgent participation of clinicians and health care professionals at all levels, particularly in primary care settings (Tamiru et al., 2023). Primary care health professionals can provide these patients with health education so they can adopt healthy lifestyle habits, stay motivated to regularly check their glycemic status, and be aware of diabetic consequences (Garg et al., 2019). On the other note on prevention aspects among healthy individuals, they should avail to health education and make changes to develop a positive attitude, and practices towards disease prevention and early detection and treatment (Peter et al., 2022). Studies comparing DM patient and healthy adults showed the knowledge of risk factors, symptoms, chronic complications, therapy and self-management, and monitoring measures was considerably higher in DM patients than in healthy volunteers (Yun et al., 2007). Most of studies on health education conducted focused on patients with diagnosed diabetes and the studies on healthy adults are scarce. In light of the importance of health education role can help in shaping the management landscape of diabetes mellitus. Hence, this study seeks to determine the impact of Structured Education Program-Diabetes Mellitus (SEP-DM) on knowledge, attitude and practice on diabetes care and management among the nursing students. In addition, the study hypothesized there was a significant effect of SEP-DM on knowledge, attitude and practice of diabetes care and management among nursing students.

Methods

Study design

A quasi-experimental study with pre-test and post-test design was conducted among nursing students who enrolled in a private institution in northern region of Malaysia. This cross-sectional study aimed to assess the level of knowledge, attitude and practice of diabetic care and management targeting nursing students at year 1 to year 2 who did not have prior knowledge of diabetes mellitus. The framework of study was based on Donabedian Model, which provides an approach to evaluate the outcome of health education, training or services implemented based on fundamental components of structure, process, and outcomes (Tossaint-Schoenmakers et al., 2021).

Study Setting

The study was carried out at School of Nursing, AIMST University Malaysia from December 2023 to January 2024.

Population and Sampling

The target population of this study were all students from both diploma and bachelor program enrolled at the private institution. A purposive sampling technique was employed to select from the sample frame obtained from the School of Nursing at AIMST University. This study focused on nursing students from year 1 to year 2 students who did not have the pre-requisite knowledge regarding DM.

Sample Size Calculation

The sample size was determined using Raosoft (2013) software. The calculation of sample size in this software was derived from the amount of error accommodated by the researcher, the size of uncertainty, the number of the sample, and the distribution of the given responses. Based on the population of 200, margin of error of 5%, with the confidence level of 95% in this study, the calculated sample size was 132.

Inclusion and Exclusion Criteria

Nursing students enrolled in diploma and bachelor program, who did not have prior knowledge of DM specifically year 1 and year 2 students who voluntarily agreed to participate were included. Students in year 3 and final year who had prior knowledge of DM and those who had their clinical placement or posting outside the institution were excluded.

Instrumentation

The questionnaire related to Perceived Knowledge on Diabetes Mellitus was adapted from Bukhsh, et al. (2019) and the questionnaire related to Perceived Attitude and Practice was adapted from Asmelash et al. (2019) and both questionnaires were modified accordingly to suit the study needs. There was a total of two (2) sections consisting of Section A and Section B. The total number of questions in Section I is 9 variables and Section II is 33 items and the questionnaire was delivered in English language only. Section I contained demographic variables as the baseline data of the respondents. Section II contained 19 items on Perceived Knowledge on Diabetes Mellitus, 14 items on Perceived Attitude and Practice. The knowledge component was measured with dichotomous scale. The attitude component was measured with the 5-point Likert scale (1=Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree) and the practice component was assessed with 4-point rating scale (1 = None; 2 = 1-3 Times a Week; 3 = More Than 3 Times a Week; 4 = Every Day).

Intervention

The intervention used Structured Education Program on Diabetes Mellitus (SEP-DM) that make use of empowerment, goal-setting, and problem-based learning theories, and it typically include group-based learning opportunities where participants engage in practical self-management activities to encourage health-promoting behaviour (Yorke & Atiase, 2018). The 1 hour and 40-minute SEP-DM included training for participants and facilitators on how to present and share information directly face-to-face. A thorough review of the literature and the information-motivation-behavioural skills (IMB) model served as the foundation for the researcher's development of three modules for high-quality health education sessions. The three main constructs in the IMB model that affect attitude changes are as follows: Information and understanding of the attitude, the person's drive to engage in the attitude, and the behavioural abilities required to engage in the attitude.
According to Rongkavilit et al. (2010) IMB constructs as applied to disease prevention as firstly, "information" includes relevant knowledge on DM such as the definition, types of

DM, risk factors of DM, treatment of DM and complications of DM, lifestyle modifications and dietary modifications. Secondly, personal motivation includes positive or negative attitudes toward taking action to do lifestyle modifications and diet modifications. Social motivation is the desire to conform to social norms and the impression of social support from close friends and family; and thirdly, "behavioral skills" are both the individual's objective ability to perform necessary adherence-related tasks and his/her perceived self-efficacy for these tasks. Adherence-related tasks include lifestyle modifications and diet modifications to prevent the occurrence of DM.
This session was followed by a different module that will give the participants access to pertinent information on DM through Powerpoint Presentation with the total of 22 slides. This module addressed the definition of DM, types of DM, the risk factors for developing DM, signs and symptoms of DM, the management of DM, complications of DM and preventive measures, such as lifestyle modification for DM and dietary modification of DM. (Table 1)

Table 1: Tentative Structured Educational Program-Diabetes Mellitus (SEP-DM)

Structured Educational Program - Diabetes Mellitus	
Overview of DM	10 minutes
Definition of DM	5 minutes
Types of DM	10 minutes
Signs and symptoms of DM	10 minutes
Management for DM	15 minutes
Complications of DM	20 minutes
Lifestyle Modifications for DM	10 minutes
Diet Modification for DM	10 minutes
Question and Answer Session	10 minutes
Total	1 hour 40 minutes

Data Collection Method

The data was collected from December 2023 to January 2024 for a duration of 2 months at School of Nursing, AIMST University after obtaining permission from the faculty Dean. The nature and purpose of the study was explained objectively to participants. A total of 132 participants was selected from the list of students registered in diploma and bachelor program. Informed consents were obtained from students who agreed to participate. The self-administered questionnaire was distributed to participants for them to complete within 10-15 minutes before intervention (SEP-DM) as the baseline data. Participants were assured the anonymity of their identity and confidentiality of the data. The researcher conducted SEP-DM for 1 hour and 40 minutes using PowerPoint presentation. Subsequently after intervention, the post-test questions were distributed to participants for them to complete within 10 to 15 minutes immediately after SEP-DM, and again post-test session was conducted seven (7) days after SEP-DM (Figure 1).

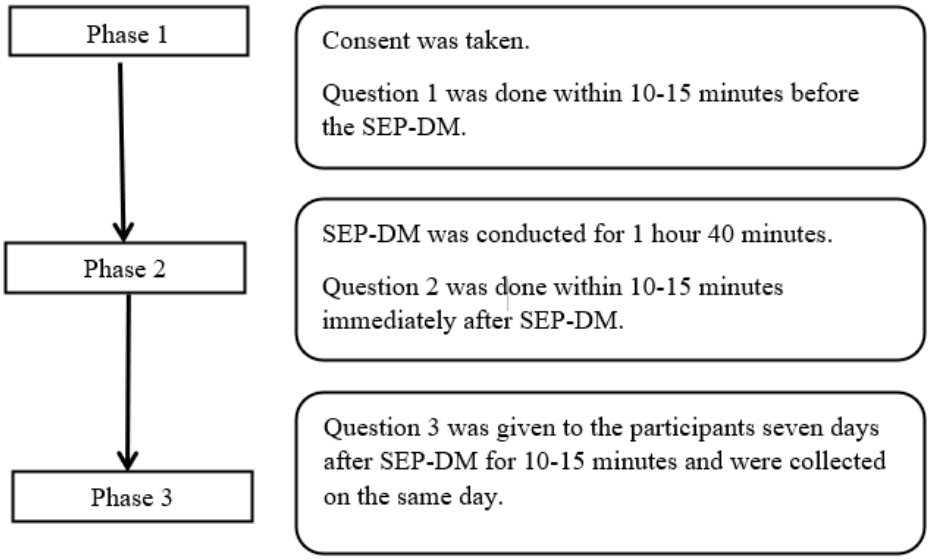

Figure 1: Flow chart of data collection

Ethical Consideration

The study protocol was approved by AIMST University Human Ethics Committee with reference no AUHEC/FAHP/06/10/2023/5 and consent to conduct study was granted by the University Research Management Centre and faculty Dean. Written informed consents were obtained from the participants before the commencement of the study.

Validity and reliability

To ensure validity of the study concept was accurately measured in a quantitative study (Heale & Twycross, 2015), a total of three (3) expert panels were consulted to review and validate the questionnaires. A reliability test was needed to confirm the consistency of a certain item. Hence, a pilot study was conducted and reliability coefficient with Cronbach's alpha test was determined for continuous data and KR21 (Kuder-Richardson 21) test was indicated for dichotomous data (Foster, 2021). A score of 0.7 and higher suggests the reliability level was at an acceptable level (Glen, 2022).

Pilot Study

A pilot test was conducted to a total of 13 nursing students to gather their feedback on questionnaire items. This preliminary study is important for improvement of the quality and efficiency of the main study (In, 2017). All suggestions for improvement were taken into consideration and amended accordingly by the researcher. Finally, the revised questionnaires were reviewed again by panel of experts to ensure all corrections had been incorporated.

Results

A total of 132 nursing students were recruited in the initial phase. However, 37 declined and 2 withdrew from the study, lastly only ninety-three (93) students participated in the study with response rate of 70.5%. The mean age of the participants was 18.23±0.42 years old. The majority of the participants were aged between 18-20 years old (76.3%, n=71) and only 16.1% (n=15) is 24 years old and above. 83.9% (n=78) are female and 57% (n=53)

are Malays. Majority of the participants 89.3% (n=83) were from Diploma in Nursing. 49.5% (n=46) were in Year 1 and 50.5% (n=47) in Year 2. Most of the participants (48.4%, n=46) had at least one comorbidity in their family and 10.8% (n=10) of the participantss had one comorbidity which is obesity as this group of them have their BMI of more than 30 (Table 1).

Table 1: Demographic data of the participants (n=93)

Characteristics			n (%)
Age	Mean±SD	18.23±0.42	71 (76.3)
18-20			
21 and above			22 (23.7)
Gender			
Female			78 (83.9)
Male			15 (16.1)
Ethnicity			
Malay			53 (57.0)
Chinese			14 (15.1)
Indian			20 (21.5)
Others			6 (6.5)
Programme of Study			
Diploma in Nursing			83 (89.3)
Bachelor's in Nursing Science			9 (9.7)
Year of Study			
Year 1			46 (49.5)
Year 2			47 (50.5)
BMI			
<19			19 (20.4)
19.1-24.9			44 (47.3)
25-29.9			20 (21.5)
Above 30			10 (10.8)
Comorbidities			
None			81 (87.1)
One comorbidity			10 (10.8)
More than one comorbidity			2 (2.1)
Family History			
None			25 (26.9)
One comorbidity			45 (48.4)
More than one comorbidity			23 (24.7)

Note: M=Mean; SD=Standard deviation; BMI: Body mass index

Normality tests were performed on data distribution of dependent variables of the study and found no violation, hence parametric test was utilized. One-way ANOVA test was used to compare the mean knowledge at three-time interval. Results revealed there was a statistically significant difference in the mean scores of knowledge on DM (p<0.05). The mean knowledge score was 33.34±2.31, 36.76±2.04 and 36.18±1.91 at time interval T_0, T_1 and T_2 respectively (Table 2).

Table 2: Comparison mean score of level of knowledge on diabetes mellitus at T_0, T_1 and T_2 (n=93)

Variables	Time	M (SD)	df	p-value
Knowledge	T_0	33.34 (2.31)	2	0.001
	T_1	36.76 (2.04)		
	T_2	36.18 (1.91)		

Note: M=Mean; SD=Standard deviation; df=Degree of freedom; Significance level at p<0.05

To determine the pairwise comparison for mean knowledge at different time interval, the GLM model with repeated measures was used. Results showed there was a statistically significant difference on the level of knowledge between T_0-T_1 (p<0.05) with the mean difference of (3.42) and 95% CI of difference (-3.951, -2.888), between T_0 -T_2 (p<0.05) with the mean difference of (2.84) and 95% CI of difference (-3.420, -2.257), between T_1-T_2 (p<0.05) with the mean difference of (0.58) and 95% CI of difference (0.115,1.047) (Table 3).

Table 3: Comparison of mean difference of knowledge on diabetes mellitus at T_0,T_1 and T_2 (n=93)

Time	Mean Difference	SEM	95% CI of Difference		p-value
			Lower Bound	Upper Bound	
T_0-T_1	3.42	0.22	-3.951	-2.888	0.001
T_1-T_2	0.58	0.19	0.115	1.047	0.009
T_0-T_2	2.84	0.20	-3.420	-2.257	0.001

Note: MD=Mean difference; SEM=Standard error of mean; CI=Confidence interval; Significance level at p<0.05

In terms of level of attitude, one-way ANOVA test was used to compare the mean attitude in three-time interval. Results depict there was a statistically significant difference on the mean scores attitude at three-time interval (p<0.05). The mean attitude scores at time interval T_0, T_1, T_2 were 11.34±1.66, 12.73±1.17 and 12.80±1.08) respectively (Table 4).

Table 4: Comparison mean score of level of attitude on diabetes mellitus at T_0, T_1 and T_2 (n=93)

Variables	Time	M (SD)	df	p-value
Attitude	T_0	11.34 (1.66)	1.850	0.001
	T_1	12.73 (1.17)		
	T_2	12.80 (1.08)		

Note: M=Mean; SD=Standard deviation; df=Degree of freedom; Significance level at p<0.05

To determine the pairwise comparison for mean attitude at different time interval, the GLM model with repeated measures was used. Results showed there was a statistically significant difference on the level of attitude between T_0-T_1 (p<0.05) with mean difference (1.39) and 95% CI of difference (-1.765, -1.009) and between T_0-T_2 (p<0.05) with the

mean difference (1.45) and 95% CI of difference (-1.824, -1.079). However, there was no statistically significant difference on the level of attitude between T_1-T_2 (p=0.667) with the mean difference (0.07) and 95% CI of difference (-0.362, 0.233) (Table 5).

Table 5: Comparison of mean difference of attitude on diabetes mellitus at T_0,T_1 and T_2 (n=93)

Time	MD	SEM	95% CI of Difference		p-value
			Lower Bound	Upper Bound	
T_0-T_1	-1.39	0.19	-1.765	-1.009	0.001
T_1-T_2	-0.07	0.15	-0.362	0.233	0.667
T_0-T_2	-1.45	0.19	-1.824	-1.079	0.001

Note: MD=Mean difference; SEM=Standard error of mean; CI=Confidence interval

In term of level of practice, one-way ANOVA test was employed to compare mean practice at three-time interval. The results demonstrated there was a statistically significant difference on the mean scores of practice (p=0.009). The mean score of practice at time interval T_0, T_1, T_2 was 2.01±1.26, 12.02±1.25 and 2.42±1.35 respectively (Table 6).

Table 6: Comparison mean score of level of practice on diabetes mellitus at T_0, T_1 and T_2 (n=93)

Variables	Time	M (SD)	df	p-value
Practice	T_0	12.01(1.26)	1.007	0.009
	T_1	12.02(1.25)		
	T_2	12.42(1.35)		

Note: M=Mean; SD=Standard deviation; df=Degree of freedom; Significance level at p<0.05

To determine the pairwise comparison for mean practice at different time interval, the GLM model with repeated measures was used. Results found there was no statistically significant difference on the level of practice between T_0 - T_1 (p=0.320) with the mean difference (0.01) and 95% CI on difference (-0.032, 0.011). However, there was a statistically significant difference on the level of practice between T_0-T_2 (p<0.05) with the mean difference (0.40) and 95% CI on difference (-0.699, -0.097) and between T_1-T_2 (p<0.05) with the mean difference (0.41) and 95% CI on difference (0.362, 0.233) (Table 7).

Table 7: Comparison of mean difference of practice on diabetes mellitus at T_0,T_1 and T_2 (n=93).

Time	Mean Difference	SEM	95% CI of Difference		p-value
			Lower Bound	Upper Bound	
T_0-T_1	-0.01	0.01	-0.032	0.011	0.320
T_1-T_2	-0.40	0.11	-0.699	-0.097	0.010
T_0-T_2	-0.41	0.15	-0.713	-0.105	0.009

Note: MD=Mean difference; SEM=Standard error of mean; CI=Confidence interval; Significance level at $p<0.05$

To determine the overall effect of SEP-DM on knowledge, attitude and practice, repeated measures ANOVA test was conducted. The results showed that there was a large statistically significant effect on knowledge ($\eta2=0.732$, $p<0.001$) at T_0-T_1 ($t= 138.91$) with 95% CI on difference (32.867, 33.821); at T_1-T_2 ($t=173.81$) with 95% CI on difference (36.343, 37.184); and at T_0-T_2 ($t=183.16$) with 95% CI on difference (35.790, 36.575).
In term of attitude, the results revealed there was a medium statistically significant effect on attitude ($\eta2=0.319$, $p<0.001$) at T_0-T_1($t=65.97$) with 95% CI on difference (11.003, 11.686); at T_1-T_2 ($t=104.794$) with 95% CI on difference (12.190, 12.972) and at T_0-T_2 ($t=114.358$) with 95% CI on difference (12.573, 13.018).
In practice side, the results demonstrated that there was a minimal statistically significant effect on practice ($\eta2=0.071$, $p=0.009$) at T_0-T_1 ($t=91.635$) with 95% CI on difference (11.750, 12.271); at T_1-T_2 ($t=92.678$) with 95% CI on difference (11.764, 12.279) and at T_0-T_2 ($t=88.460$) with 95% CI on difference (12.141, 12.698). These findings substantiated that using SEP-DM as an intervention improved knowledge, attitude and practice among the participants (Table 8).

Table 8: The effect of SEP-DM on the level of knowledge, level of attitude and level of practice on diabetes mellitus at T_0,T_1 and T_2 (n=93).
Note: CI= Confidence interval; η2=Eta squared; Significance level at $p<0.05$

Variable	Time	95% CI on Difference		η2	*p*-value	t
		Lower Bound	Upper Bound			
Knowledge	T_0-T_1	32.867	33.821	0.732	0.001	138.91
	T_1-T_2	36.343	37.184			173.81
	T_0-T_2	35.790	36.575			183.16
Attitude	T_0-T_1	11.003	11.686	0.319	0.001	65.97
	T_1-T_2	12.190	12.972			104.794
	T_0-T_2	12.573	13.018			114.358
Practice	T_0-T_1	11.750	12.271	0.071	0.009	91.635
	T_1-T_2	11.764	12.279			92.678
	T_0-T_2	12.141	12.698			88.460

Discussion

The findings demonstrated that SEP-DM was successful in enhancing knowledge, attitude, and practice on prevention and management of diabetes mellitus with a particularly notable enhancement in knowledge. Out all 93 participants involved in this research study, 21.5% were overweight and 10.8% were obese. Comparatively the figure was slightly lower (32.3%) than 54.4 per cent of Malaysian adults are overweight and obese as reported in

National Health and Morbidity Survey in 2023 (MOHM, 2023). About half of participants in this study had family history of at least one comorbidity (48.4%) and 25% had family history of more than 1 comorbidity, which was lower than found in study on a population with diabetes with 75% of people with had at least one comorbidity during their diagnosis, and 44% having at least two (Nowakowska et al., 2019).

Following a 1 hour 40-minute face-to-face intervention, there was a notable enhancement in the respondents' knowledge. SEP-DM has demonstrated its effectiveness in prevention of diabetes among nursing students. Before this intervention, respondents had a low understanding of diabetes mellitus (DM), which showed statistical improvement after participating in the health education sessions. These results align with interventional studies in comparable environments, supporting the notion that health education can positively impact individuals' knowledge and behaviors, thereby aiding in the prevention of certain diseases and infections (Akhtar, et al., 2019; Kumar, et al., 2020; Nazar, et al., 2019). The current study targeted at participants who had prior knowledge about DM had reported significant increase of knowledge on diabetes ($p<0.05$) from baseline to subsequent time interval (9-10%). This coincided with study by Nazar et al. (2021) that found a significant increase in knowledge (37%) on diabetes among diabetes patients after attending community awareness and educational program in India. The current study reported less percentage increase due to short duration of health education program as compared to prospective study with interventional program conducted in India which took longer duration of about a year.

Furthermore, existing literature has highlighted similar discoveries, emphasizing that health literacy serves as a crucial strategy for effectively preventing non-communicable diseases within communities (Pai et al., 2021; Alibrahim et al., 2021; Stenov, et al., 2019). Our study was conducted at educational institute, this aligned with previous study that support school-based interventions targeting preventable diseases have been identified as the most effective approach for educating students (Pansier & Schulz, 2015).

The respondents' attitudes underwent significant changes following 1 hour and 40 minutes of SEP-DM. This shift may be attributed to an enhanced understanding of the disease. The results concurred with Weiner (2009) study that emphasized the significance of evaluating individual readiness for change, while also advocating for the assessment of individual readiness for change. This involves the entire community demonstrating a collective commitment to the necessary changes for successfully implementing new approaches (Weiner, 2009). In addition, the present study was also in agreement with Moran et al. (2021) study that found after attending diabetic educational training, participants experienced a positive change in their attitudes toward diabetes care and management.

There were only minor changes observed in practice following SEP-DM, likely due to the fact that the follow-up questionnaire was administered just one week later. Although the available studies are limited, they do lend support to the idea that diabetes education can be cost-effective and improve outcomes. Behavior change is influenced not only by an individual's ability to control impulses but also by the broader environments we inhabit, including shared structural supports, social norms, and cultural practices. This suggests that even when observable changes in behavior occur during a transition, old habits do not disappear right away. Instead, there is a period during which new behaviors become established while old habits decline (Walker, et al., 2014).

The findings demonstrated that the SEP-DM intervention had a noteworthy and meaningful effect on knowledge, attitude, and practice throughout the duration of the study. Notably, knowledge exhibited the most substantial effect size, indicating a robust influence of the intervention on participants' knowledge levels. While attitude and practice also displayed significant improvements, their effect sizes were comparatively smaller when

contrasted with knowledge. The same results were obtained in the population where the intervention contained colour booklets, animated videos, face-to-face lectures, and practical display of eating platter (Kumar, et al., 2022). The results were similar with the study done by Kumar et.al, (2022) as health education intervention helps in managing the blood sugar and cholesterol level among the diabetic patients. Similar study has been conducted by Molly and Mercy (2016) to identify the effectiveness of health education where pre-test and post-test within the duration of a week which resulted in significant difference in practice. The current study was also in line with study by Chowla et al. (2019) that effective health education can result in improved knowledge, better attitude, and adoption of good practices which ultimately lead to better glycemic control in diabetes patients, thus help to prevent and delay progression of complications. Thus non-pharmacological intervention with effective health education form a cornerstone of diabetes management and require favorable patient knowledge, attitude, and practices.

Strengths and Limitations

This research has demonstrated its value in aiding nursing students' comprehension of the healthy lifestyle adjustments that can mitigate the risk of DM. The insights gleaned from this study could shape their daily decisions concerning dietary habits and physical activities, potentially reducing their susceptibility to DM. This quasi-experimental study gives more insight on the effectiveness of health education on knowledge, attitude and practice than a cross sectional study as they are more generalizable to more real life phenomena.

The study was hindered by limiting its applicability from Malaysian nursing students and creating inherent constraints. It was conducted within the narrow scope of focusing solely on student nurses enrolled at a private institution for junior students. Furthermore, the study faced challenges due to a scarcity of participating nursing students. Additionally, the health education was given only in one session which could not guarantee the retain of knowledge for a longer period of time.

Conclusion

The findings of this study demonstrated that SEP-DM was effective intervention on the level of knowledge, attitude and practice on diabetes care and management. This study underscored the importance and significant role of SEP-DM initiative in prevention and control of diabetes and its complications. The awareness from the intervention can enhance knowledge, improve attitudes, and the adoption of best practices, all of which contribute to better blood sugar control and the prevention of diabetes complications. Non-pharmacological interventions are fundamental in the prevention of diabetes and necessitate patients' positive knowledge, attitudes, and practices. In resource-constraint primary care settings where diabetes poses a significant financial burden, health education plays a pivotal role. Effective patient education leads to increased awareness and knowledge improved attitudes, and the adoption of healthy lifestyle practices in susceptible population, resulting in reducing the prevalence of DM among community. Thus, there is an urgent need for clinicians and healthcare providers to educate and motivate public, and more crucial to promote healthy lifestyle behaviors among diabetic patients in achieving optimal blood sugar control to reduce the morbidity and mortality of this chronic disease.

References

1.Akhtar, S., Nasir, J. A., Sarwar, A., Nasr, N., Javed, A., Majeed, R., Salam, M. A., & Billah, B. (2020). Prevalence of diabetes and pre-diabetes in Bangladesh: a systematic

review and meta-analysis. *BMJ Open*, 10(9), e036086. https://doi.org/10.1136/bmjopen-2019-036086

2.Akhtar, S., Nasir, J. A., Ali, A., Asghar, M., Majeed, R., & Sarwar, A. (2022). Prevalence of type-2 diabetes and prediabetes in Malaysia: A systematic review and meta-analysis. *PLOS ONE*, 17(1), e0263139. https://doi.org/10.1371/journal.pone.0263139

3.Alibrahim, A., AlRamadhan, D., Johny, S., Alhashemi, M., Alduwaisan, H., & Al-Hilal, M. (2021). The effect of structured diabetes self-management education on type 2 diabetes patients attending a Primary Health Center in Kuwait. *Diabetes Research and Clinical Practice*, 171, 108567. https://doi.org/10.1016/j.diabres.2020.108567

4.Asmelash, D., Abdu, N., Tefera, S., Baynes, H. W., & Derbew, C. (2019). Knowledge, Attitude, and Practice towards Glycemic Control and Its Associated Factors among Diabetes Mellitus Patients. *Journal of Diabetes Research*, 1–9. https://doi.org/10.1155/2019/2593684

5.Bin Rakhis, S., AlDuwayhis, N. M., Aleid, N., AlBarrak, A. N., & Aloraini, A. A. (2022). Glycemic control for type 2 diabetes mellitus patients: A systematic review. *Cureus*, *14*(6). https://doi.org/10.7759/cureus.26180

6.Bukhsh, A., Khan, T. M., Sarfraz Nawaz, M., Sajjad Ahmed, H., Chan, K. G., & Goh, B. H. (2019) Association of diabetes knowledge with glycemic control and self-care practices among Pakistani people with type 2 diabetes mellitus. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, Volume 12, 1409–1417. https://doi.org/10.2147/dmso.s209711

7.Chawla, S. P. S., Kaur, S., Bharti, A., Garg, R., Kaur, M., Soin, D., Ghosh, A., & Pal, R. (2019). Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus. *Journal of Family Medicine and Primary Care*, 8(1), 261–268. https://doi.org/10.4103/jfmpc.jfmpc_228_18

8.Fatema, K., Hossain, S., Natasha, K., Chowdhury, H. A., Akter, J., Khan, T., & Ali, L. (2017). Knowledge attitude and practice regarding diabetes mellitus among nondiabetic and diabetic study participants in Bangladesh. *BMC Public Health*, 17(1). https://doi.org/10.1186/s12889-017-4285-9

9.Foster R. C. (2021). KR20 and KR21 for Some Nondichotomous Data (It's Not Just Cronbach's Alpha). *Educational and psychological measurement*, *81*(6),1172–1202. https://doi.org/10.1177/0013164421992535

10.Garg, R., Chawla, S. S., Kaur, S., Bharti, A., Kaur, M., Soin, D., Ghosh, A., & Pal, R. (2019). Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus. *Journal of Family Medicine and Primary Care*, *8*(1), 261–268. https://doi.org/10.4103/jfmpc.jfmpc_228_18

11.Gazzaz, Z. J. (2020). Knowledge, Attitudes, and Practices Regarding Diabetes Mellitus Among University Students in Jeddah, Saudi Arabia. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, Volume 13, 5071–5078. https://doi.org/10.2147/dmso.s287459

12.Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence Based Nursing*, 18(3), 66–67. https://doi.org/10.1136/eb-2015-102129

13.In J. (2017). Introduction of a pilot study. *Korean journal of Anesthesiology*, 70(6), 601–605. https://doi.org/10.4097/kjae.2017.70.6.601

14.Konduru, S. S., Ranjan, A., K, K., Muddada, S., Shaik, S., & Vakkapatla, L. S. (2017). Assessment of diabetes related knowledge, attitude and practice among diabetics and non-diabetics using self prepared questionnaire for awareness of Health Promotion. *Indian Journal of Pharmacy Practice*, *10*(1), 32–38. https://doi.org/10.5530/ijopp.10.1.8

15.Kumar, R., Saha, P., Kumar, Y., Sahana, S., Dubey, A. (2020). A review on diabetes mellitus: Type 1 & Type 2. *World Journal of Pharmacy and Pharmaceutical Sciences*, 9(10), 838-850.
16.Kumar, R., Rehman, S., Baloch, G. M., Vankwani, M., Somrongthong, R., & Pongpanich, S. (2022). Effectiveness of health education intervention on diabetes mellitus among the teachers working in public sector schools of Pakistan - *BMC Endocrine Disorders. BioMed Central*. https://doi.org/10.1186/s12902-022-01110-7
17.Ministry of Health Malaysia (MOHM) (2023). *Fact sheet-National Health and Morbility Survey (NHMS) 2023: Non-communicable diseases & healthcare demand*. Institute for Public Health (IKU) National Institute of Health (NIH) MOH. Retrieved from https://iku.nih.gov.my/images/nhms2023/fact-sheet-nhms-2023.pdf
18.Molly, J., & Mercy, P. (2016). Effectiveness of a structured teaching programme on knowledge of breast cancer and skill of breast self-examination: a quasi- experimental study in rural women. *International Journal of Community Medicine and Public Health*, 2940–2943. https://doi.org/10.18203/2394-6040.ijcmph20163387
19.Moran, V., Blanchette, J., Whitley, H., Pillion, D., Albritton, A., & Israel, H. (2021). Changes in attitudes toward diabetes in nursing students at diabetes camp. *Public Health Nursing*, 38(4), 579–587. https://doi.org/10.1111/phn.12886
20.Nazar, M., Khan, S. A., Kumar, R., & Hafeez, A. (2019). Effectiveness of health literacy intervention on cardiovascular diseases among university students of Pakistan. *BMC Health Services Research*, 19(1). https://doi.org/10.1186/s12913-019-4348-y
21.Nazar, G. P., Monika, A., Vinay Kumar, G., Tina, R., Aastha, C., Surbhi, S., Prasanna, D., Anjali, B., Shailesh D. R., Unnikrishnan, A. G. (2021). The impact of project diabetes with dignity intervention on knowledge and quality of life among adults with diabetes in a rural Indian setting. *International Journal of Noncommunicable Diseases*, 6(3) 129-136. | DOI: 10.4103/jncd.jncd_31_21
22.Nowakowska, M., Zghebi, S.S., Ashcroft, D.M., Buchan, I., Chew-Graham, C., Holt, T., Mallen, C., Van Marwijk, H., Peek, N., Perera-Salazar, R., Reeves, D., Rutter, M. K., Weng, S.F., Qureshi, N., Mamas, M. A., Kontopantelis, E. (2019). The comorbidity burden of type 2 diabetes mellitus: patterns, clusters and predictions from a large English primary care cohort. *BMC Med* 17, 145. https://doi.org/10.1186/s12916-019-1373-y
23.Pai, L. W., Chiu, S. C., Liu, H. L., Chen, L. L., & Peng, T. (2021). Effects of a health education technology program on long-term glycemic control and self-management ability of adults with type 2 diabetes: A randomized controlled trial. *Diabetes Research and Clinical Practice*, 175, 108785. https://doi.org/10.1016/j.diabres.2021.108785
24.Pansier, B., & Schulz, P. J. (2015). School-Based Diabetes Interventions and Their Outcomes: A Systematic Literature Review. *Journal of Public Health Research*, 4(1), jphr.2015.467. https://doi.org/10.4081/jphr.2015.467
25.Peter, P. I., Steinberg, W. J., van Rooyen, C., & Botes, J. (2022). Type 2 diabetes mellitus patients' knowledge, attitude and practice of lifestyle modifications. *Health SA Gesondheid*, 27. https://doi.org/10.4102/hsag.v27i0.1921
26.Raosoft (2013). *Sample size calculator*. Web. http://www.raosoft.com/samplesize.html
27.Rongkavilit, C., Naar-King, S., Kaljee, L. M., Panthong, A., Koken, J. A., Bunupuradah, T., & Parsons, J. T. (2010). Applying the Information-Motivation-Behavioral Skills Model in Medication Adherence Among Thai Youth Living with HIV: A Qualitative Study. *AIDS Patient Care and STDs*, 24(12), 787–794. https://doi.org/10.1089/apc.2010.0069

28.Sami,W., Ansari, T., Butt, N. S., & Ab Hamid, M. R. (2017). Effect of diet on type 2 diabetes mellitus: A review. *PubMed Central (PMC).* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426415/
29.Stenov, V., Wind, G., Vallis, M., Reventlow, S., & Hempler, N. F. (2019). Group-based, person-centered diabetes self-management education: healthcare professionals' implementation of new approaches. *BMC Health Services Research,* 19(1). https://doi.org/10.1186/s12913-019-4183-1
30.Tamiru, S., Dugassa, M., Amsalu, B., Bidira, K., Bacha, L., & Tsegaye, D. (2023). Effects of Nurse-Led diabetes Self-Management education on Self-Care knowledge and Self-Care behavior among adult patients with type 2 diabetes mellitus attending diabetes follow up clinic: A Quasi-Experimental study design. *International Journal of Africa Nursing Sciences,* 18, 100548. https://doi.org/10.1016/j.ijans.2023.100548
31.Tee, E.-S., & Yap, R. W. (2017). Type 2 diabetes mellitus in Malaysia: Current trends and risk factors. *European Journal of Clinical Nutrition*, *71*(7), 844–849. https://doi.org/10.1038/ejcn.2017.44
32.Tossaint-Schoenmakers, R., Versluis, A., Chavannes, N., Talboom-Kamp, E., & Kasteleyn, M. (2021). The Challenge of Integrating eHealth Into Health Care: Systematic Literature Review of the Donabedian Model of Structure, Process, and Outcome. *Journal of Medical Internet Research,* 23(5), e27180. https://doi.org/10.2196/27180
33.Walker, I., Thomas, G. O., & Verplanken, B. (2014). Old Habits Die Hard. E*nvironment and Behavior*, 47(10), 1089–1106. https://doi.org/10.1177/0013916514549619
34.Weiner, B. J. (2009). A theory of organizational readiness for change. *Implementation Science,* 4(1). https://doi.org/10.1186/1748-5908-4-67
35.Yorke, E., & Atiase, Y. (2018). Impact of structured education on glucose control and hypoglycaemia in Type-2 diabetes: a systematic review of randomized controlled trials. *Ghana Medical Journal*, 52(1), 41. https://doi.org/10.4314/gmj.v52i1.8
36.Yun, L. S., Hassan, Y., Aziz, N. Abd., Awaisu, A., & Ghazali, R. (2007). A comparison of knowledge of diabetes mellitus between patients with diabetes and healthy adults: A survey from North Malaysia. *Patient Education and Counseling*, *69*(1–3), 47–54. https://doi.org/10.1016/j.pec.2007.06.017