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Effect of Diabetes Self-Management Education on Knowledge and HbA1c Levels among Patients with Type 2 Diabetes Mellitus in Occupational Health Care

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Abstract

Background: Diabetes Self-Management Education (DSME) is a structured self-care program for managing type 2 diabetes mellitus (T2DM), including treatment adherence and complications prevention. This study aimed to evaluate the effect of DSME on diabetes-related knowledge and hemoglobin A1c (HbA1C) levels among patients with T2DM.

Methods: A quasi-experimental pretest-posttest non-equivalent control group design was conducted from August 2023 to January 2024, involving 65 patients with T2DM in occupational health care in Cikarang and Tangerang, Indonesia. The DSME program included five key components: (1) diabetes mellitus education, (2) medical nutrition therapy, (3) physical exercise, (4) pharmacological intervention; and (5) blood glucose self-monitoring. The intervention group received DSME in six sessions over three weeks (45–60 minutes each), while the control group only reviewed 40 educational slides for 30 minutes. Knowledge was assessed using the Diabetes Knowledge Questionnaire (DKQ-24), and HbA1c levels were measured twice, six months apart. Data were analyzed using independent t-tests, dependent t-tests, and ANOVA.

Results: The intervention group (n=26) and control group (n=39) had similar baseline characteristics. A significant improvement in diabetes knowledge was observed in both groups. Interestingly, only the intervention group showed a notable reduction in HbA1c levels (−1.9%), from 8.5% to 6.6%. Post-intervention HbA1c levels differed significantly between groups ($p<0.05$), with the control group remaining at 8.2%.

Conclusion: The DSME program effectively improves knowledge and reduces HbA1c levels in patients with T2DM. It is recommended for integration into occupational health care settings to promote healthy lifestyles and enhance diabetes management.

Keywords: Diabetes mellitus, DSME, HbA1C, knowledge, type 2 diabetes mellitus

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Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disease that requires lifelong management to prevent complication. The progression of chronic diseases may cause limitations in physical, psychological, and cognitive function, affecting daily activity. Previous studies have shown that better blood glucose control, as expressed by glycohemoglobine A1C (HbA1C) levels, is associated with improved quality of life in patients with T2DM.[1,2]

The increasing prevalence of diabetes mellitus (DM) is related to an unhealthy lifestyle. Data from the 2018 National Basic Health Research in Indonesia reported the prevalence of overweight (13.6%),

pre-obesity (21.8%) and obesity (31%).[3] Smoking is another contributing factor, with high prevalence among males (62.9%) and adolescents aged 10–18 years (23.91%).[3] The 2023 National Health Survey reported a diabetes prevalence of 2.2% based on physician diagnosis in individuals aged ≥15 years. Interestingly, the prevalence based on blood glucose testing was substantially higher at 11.7%. Moreover, the proportion of patients receiving diabetes treatment education was 81.4%, and treatment adherence reached 89.5%. However, non-adherence was primarily due to feeling healthy (44.7%), using traditional medicine (21.2%), and boredom, laziness, or forgetfulness (19%). Routine check-ups at health facilities were reported by only 59.2% of patients.[4]

Despite advancements in care, many patients with T2DM continue to have suboptimal glycemic control. A multicenter, cross-sectional study conducted across nine Latin American countries found that 56.8% of patients with T2DM had poor glycemic control (HbA1c ≥7%).[5] Similarly, a survey in USA conducted between 1998 and 2002 revealed that only 42.3% of adults achieved HbA1c level < 7%, while 14% had HbA1C level >10%.[5] Poor glycemic control contributes significantly to mortality, with diabetes accounting for 13.6% of deaths, coronary heart disease (CHD) for 17.9%), and stroke for 2.7%.[6]

Lifestyle modifications are essential for diabetes management, as well as health education.[7] According to the American Association of Diabetes Educators (AADE), diabetes self-management education (DSME) is a key educational strategy for T2DM patients.[8] DSME, when combined with pharmacological treatment,empower patients to manage their condition effectively.[9,10] It is recognized as a standard of care and is recommended for improving glycemic control and overall health outcomes.[11,12] DSME aims to equip patients with the knowledge, skills, and confidence necessary for effective diabetes self-care.

Several studies have shown that DSME programs focusing on counseling, therapy adherence, awareness of potential side effects, and patient empowerment are associated with better glycemic control, improved quality of life, and reduced healthcare costs.[13,14] A systematic review also confirmed that group-based DSME interventions significantly reduce HbA1c levels compared to usual care.[15] Furthermore, psychological and psychosocial interventions have also been shown to contribute to better diabetes management.[16,17] This study aimed to evaluate the effect of DSME on diabetes-related knowledge and HbA1C levels in patients with T2DM receiving care in occupational health setting.

Methods

This study employed a quasi-experimental pretest-posttest non-equivalent control group design. Both the intervention and control group completed the same questionnaire as a pre-test and post-test to assess changes in

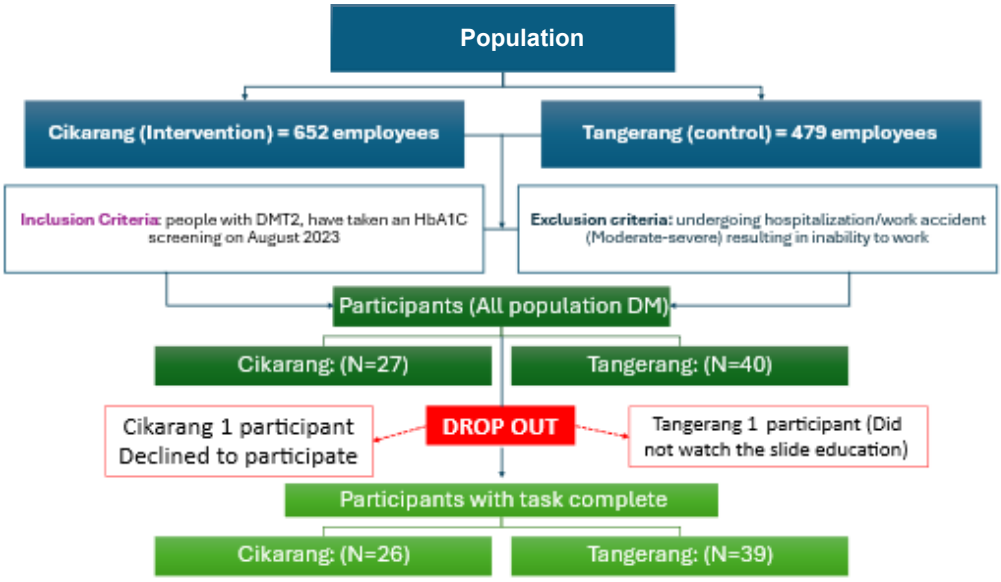

Figure 1 Flowchart of Participant Inclusion

Table 1 DSME knowledge Questionaire

No.	Statement	Answer
Meeting 1 (10 statement items): Pathogenesis of diabetes mellitus (definition, causes, signs and symptoms, classification)		
1.	Consuming too much sugar and other sugary foods causes diabetes	Wrong
2.	A common cause of diabetes is a lack of effective insulin in the body	Right
3.	Diabetes is caused by kidney failure to keep sugar out of the urine.	Wrong
4.	The kidneys produce insulin.	Wrong
5.	In untreated diabetes, blood sugar levels are usually elevated.	Right
6.	If I have diabetes, my child is more likely to develop diabetes	Right
7.	Diabetes can be cured	Wrong
8.	A fasting blood sugar level of 210 mg/dL is too high	Right
9.	The best way to check my diabetes is to test my urine	Wrong
10.	There are two main types of diabetes: Type 1 (insulin-dependent) and Type 2 (insulin-independent)	Right
Meeting 2 (5 statement items): Management of therapy with non-pharmacological and pharmacological interventions		
11.	Regular exercise increase the need for insulin or other diabetes medications.	Wrong
12.	Insulin reacts due to too much food.	Wrong
13.	Treatment is more important than diet and exercise to control my diabetes.	Wrong
14.	The way I prepare food is just as important as the food I eat	Right
15.	The diet of diabetics consists mostly of special foods	Wrong
Meeting 3 (5 Statement items): How to monitor blood glucose and understand blood glucose results		
16.	Wounds and blisters in diabetes heal more slowly	Right
17.	Diabetics must be extra careful when cutting their toenails	Right
18.	Diabetics should clean wound with iodine and alcohol	Wrong
19.	Frequent urination and thirst are signs of low blood sugar.	Wrong
20.	Tight-fitting stockings or socks are not bad for diabetics.	Wrong
Meeting 4 (4 statement items): prevention or minimization of acute and chronic complications		
21.	Diabetes always leads to poor blood circulation	Right
22.	Diabetes always damages my kidneys	Right
23.	Diabetes can cause loss of sensation in my hands, fingers and toes	Right
24.	Shaking and sweating are signs of high blood sugar.	Wrong

Note : DKQ 24 One point is given for each correct answer, while incorrect answers score 0

knowledge after the DSME intervention. The intervention group received DSME through interactive education involving discussion with health workers and dietary monitoring. Whereas the control group received the same DSME material in the form of brochure and 55-slide presentation without any explanation from facilitators, tutors, or researchers.

Ethical approval for this study was obtained from the Health Research Ethics Committee of Universitas Padjajaran (No 1386/UN8. KEP/EC/2023). All participants provided written informed consent prior to participation.

The study population consisted of employees with T2DM enrolled in occupational health care services. In 2023, there were 466 employees in Tangerang and 528 in Cikarang, Indonesia. Results from the routine medical check-up in June 2023 identified 40 workers in Tangerang and 27 in Cikarang with elevated blood glucose levels, who were subsequently confirmed through HbA1C testing. Using purposive sampling, these workers were selected as study participants.

Exclusion criteria included individuals who withdrew from occupational health care before completing the program, had anemia, hemoglobinopathy, or received blood transfusions within the last 2–3 months, as well as those with conditions that affecting erythrocytes lifespan, impaired kidney function, recent hospitalization, or moderate-to-severe work-related injuries that prevented them from working.

The Diabetes Knowledge Questionnaire (DKQ-24) from the Starr County Diabetes Education Study was translated into Indonesian for this study. The questionnaire consisted of 24 items including 17 positively worded and 7 negatively words statements (Table 1). The DKQ was distributed to the participants as a pre-test on the first day, followed by the DSME

intervention in stage 1 to 6, and the post-test was conducted the day after completing the intervention in both groups.

The questionnaire included 4 domains, covering knowledge about the pathogenesis of diabetes mellitus, management of diabetes, blood glucose monitoring, and complication prevention. The domain of pathogenesis included question about the definition, causes, signs and symptoms, and classification of diabetes. The management domain focused on pharmacological and non-pharmacological therapies. The blood glucose monitoring domain assessed participants' knowledge of how to monitor blood glucose and understand the results. The complication prevention domain focused on strategies to prevent or minimize both acute and chronic complications.

The original DKQ demonstrated a

Table 2 Sociodemographic Characteristics of Respondents (n=65)

Variable	Group		Total n (%)	P-value
	Intervention (n=26) n (%)	Control (n=39) n (%)		
Age (years)				
Mean± SD	41.1±5.9	45.9 ±6.3	-	0.256
Range	28–54	36–57		
Gender				
Male	26 (100)	36 (92.3)	62 (95.4)	0.269*
Female	0 (0)	3 (7.7)	3 (4.6)	
Education				
Undergraduate	4 (15.4)	13 (33.3)	17 (26.1)	0.185
High School	22 (84.6)	26 (66.7)	48 (73.9)	
Marital Status				
Single	2 (7.7)	1 (2.6)	3 (4.6)	0.717
Married	24 (92.3)	38 (97.4)	62 (95.4)	
Duration of DM (years)				
Mean±SD	1.6±0.9	2.7±3.3		
Range	0.3–3	1–16		0.367
<3 years	22 (84.6)	28 (71.8)	50 (76.9)	
≥3 years	4 (15.4)	11 (28.2)	15 (23.1)	
Working time				
Non-Shift	15 (57.7)	22 (56.4)	37 (56.9)	1
Shift	11 (42.3)	17 (43.6)	28 (43.1)	
Type of therapy				
Insulin and medicine	1 (3.8)	1 (2.6)	2 (3.1)	0.017**
Medicine	6 (23.1)	23 (59)	29 (44.6)	
Diet control	19 (73.1)	15 (38.5)	34 (52.3)	
Body mass index (BMI)				
Mean± SD	29.1±4.9	28 ±4.6		
Range	19.5–41	19.5–40.9		0.147**
Normal	3 (11.5)	2 (5.1)	5 (7.7)	
Overweight	2 (7.7)	10 (25.6)	12 (18.5)	
Obese	21 (80.8)	27 (69.2)	48 (73.8)	
Abdominal circumference (AC)				
Mean±SD	107.4±2	99.6±12.7		
Range	71–145	79–138		0.723
Normal	14 (53.8)	18 (46.1)	32 (49.2)	
Dilated	12 (46.1)	21 (53.8)	33 (50.8)	

Note: * Fisher's exact test, ** Pearson Chi-Square ; SD=Standar Deviation.

Cronbach's alpha of 0.78. The Indonesian version of the DKQ-24 test yielded a Cronbach's alpha of 0.723, indicating acceptable reliability and validity for use in the Indonesian population.[18–20]

The intervention group participated in a DSME training program delivered over 3 weeks, consisting of 6 session lasting 45 minutes each. Meanwhile, the control group received the DSME material passively through 40 slides presented in leaflet format over 30 minutes, without any verbal explanation. HbA1C levels were assessed approximately 6 months after the initial examination and 6 weeks following any pharmacological adjustments made as part of the DSME program. The DSME program comprised comprehensive education about diabetes mellitus, medical nutrition therapy, physical exercise, pharmacological management, and self-monitoring of blood glucose. The primary outcome was diabetes-related knowledge, measured using the DKQ-24.

Data analysis was carried out using SPSS, with a significance level set at $p<0.05$. An independent samples t-test was used to compare knowledge between the intervention and control group. Paired t-tests were applied to assess changes in knowledge within each group before and after intervention. Differences in HbA1C levels between the intervention and control group were analyzed using the ANOVA test.

Results

A total of 67 workers were initially included, comprising 27 participants in the intervention group and 40 participants in the control group. However, one subject from each group was excluded due to incomplete participation in the training program. Thus, data from 65 respondents were analyzed. The majority were male (95.4%), married (95.4%), and high school graduates (73.9%). Most participants had been diagnosed with T2DM for less than 3 years (76.9%). Notably, a substantial proportion managed their diabetes primarily through diet control (52.3%) (Table 2).

There were no significant differences in baseline characteristics between the groups ($p>0.05$), indicating that both groups were comparable in terms of age, gender, marital status, working patterns, duration of diabetes, BMI, and abdominal circumference. The only variation was in the type of therapy used, where a higher proportion in the control group relied on medication compared to the intervention group, which predominantly used dietary control (Table 2).

At baseline, both groups had similar knowledge scores ($p=0.525$) and HbA1c levels ($p=0.804$) (Table 3). Following the three-week DSME program, the intervention group demonstrated a significant improvement in HbA1c levels. The intervention group improved from 14.65±2.37 to 15.38±2.16 ($p=0.010$), while the control group improved

Table 3 Knowledge Scores and HbA1c Levels Before and After the Intervention

Parameter	Group	Pre-Intervention		Post-Intervention	
		Mean ± SD	P-value	Mean ± SD	P-value
Knowledge	Intervention	19.85 ± 2.78	0.525	21.81 ± 2.70	0.909
	Control	19.28 ± 3.88		21.90 ± 3.29	
HbA1C (%)	Intervention	8.5 ± 2.43	0.804	6.6 ± 2.33	0.012*
	Control	8.7 ± 2.10		8.2 ± 2.45	

Note: *Analysis used independent sample t-test and Kolmogorov-Smirnov test. $p<0.05$ indicates significance.

Table 4 Mean Changes in Knowledge and HbA1C After Intervention

Parameter	Group	Pre-Intervention	Post-Intervention	Mean Change (Δ)	P-value
		Mean ± SD	Mean ± SD		
Knowledge	Intervention	14.65 ± 2.37	15.38 ± 2.16	+0.73	0.010*
	Control	14.15 ± 2.55	15.49 ± 2.22	+1.34	<0.0001*
HbA1C (%)	Intervention	8.5 ± 2.43	6.6 ± 2.33	−1.9	<0.0001*
	Control	8.7 ± 2.10	8.2 ± 2.45	−0.5	0.297

Note: *Data are presented as Mean ± Standard Deviation (SD). Δ = Mean difference (Post − Pre). Analysis used paired t-test. $p<0.05$ indicates significance

from 14.15±2.55 to 15.49±2.22 (p<0.001) (Table 4). However, there was no statistically significant difference in post-intervention knowledge scores between the groups (p=0.909) as shown in Table 3.

A significant reduction in HbA1c was observed in the intervention group, decreasing from 8.5±2.43% to 6.6±2.33% (Δ−1.9%, p<0.001). In contrast, the control group showed a non-significant reduction from 8.7±2.10% to 8.2±2.45% (Δ −0.5%, p=0.297) (Table 4). Post-intervention HbA1c levels were significantly lower in the intervention group compared to the control group (p=0.012) (Table 3).

Furthermore, the intervention group (n=26) showed a significant increase in knowledge scores from 14.3±3.1 to 19.8±2.6 (p<0.001), while the control group (n=39) showed a smaller increase from 14.6±3.2 to 16.1±3.0 (p=0.04). The mean reduction in HbA1c in the intervention group was −1.9% (from 8.5% to 6.6%, p<0.001), compared to a non-significant change in the control group (8.3% to 8.2%, p = 0.23). Post-intervention HbA1c levels differed significantly between groups (p<0.01).

These results indicate that the DSME program significantly improved glycemic control in the intervention group but did not result in a statistically significant difference in knowledge improvement when compared to the control group, despite within-group improvements.

Discussion

This study observed a positive change in the attitudes of participants in the intervention group, shifting from an initial reluctance to use pharmacological treatments to a willingness to adhere to them. This change was accompanied by a significant reduction in HbA1c levels. Respondents in the intervention group received direct consultations, which contributed to this positive behavioral change, whereas the control group did not receive such consultations beyond educational materials. DSME serves as an educational tool to improve knowledge, foster self-care behaviors, and enhance self-efficacy among individuals with diabetes.[21]

DSME interventions can yield short-term, medium-term, and long-term outcomes. Short-term outcomes include improved glycemic control and healthier lifestyles, such as reduced smoking, improved diet, and increased physical activity. Medium-term outcomes encompass enhanced knowledge, medication adherence, self-monitoring skills, problem-solving abilities, psychological well-being, and better utilization of health facilities. Long-term outcomes focus on preventing microvascular and macrovascular complications, reducing mortality, and improving quality of life. The significant reduction in HbA1c in the intervention group compared to the control group measured one month after completing the DSME program, reflects the positive impact of this intervention.[22–24]

The DSME program utilized various educational strategies, including lectures with question-and-answer sessions, small interactive focus group discussions (problem-based learning), and role-playing. Lectures provided foundational knowledge about diabetes and its management. Problem-based discussions enabled participants to strengthen communication skills, share experiences, and develop problem-solving capabilities. Role-playing helped participants simulate real-life scenarios, fostering readiness to take action. These methods work synergistically to enhance information reception, active engagement, and decision-making, ultimately promoting behavior change.[25]

In this study, knowledge assessments using the DKQ-24 questionnaire were conducted in each session for the intervention group over three weeks. In contrast, the control group completed a post-test after 30 minutes of reviewing 55 educational slides. Despite these efforts, there was no statistically significant increase in knowledge in either group. This finding contrasts with previous studies that reported significant knowledge improvements when DSME was delivered through structured curricula using visual media such as leaflets and slides.[26–28]

Considering the short duration of the intervention, it is important to note that knowledge acquisition follows a cognitive process that progresses through stages: knowing, understanding, applying, analyzing, synthesizing, and evaluating before translating into behavior change.[29] Most respondents in this study had received prior health education, which may have influenced the outcome. The lack of a significant increase in knowledge highlights the importance of a comprehensive educational process rather than one-time exposure.[30]

The relatively small sample size is a limitation of this study. However, the findings provide valuable insight into the prevalence of previously undiagnosed T2DM among employees in the two participating companies.

In conclusion, improving knowledge about diabetes through DSME or printed educational materials like leaflets is essential. Nevertheless, treatment adherence challenges arise not only from knowledge gaps but also from the lack of self-care skills. Providing comprehensive information through the five pillars of the DSME program, combined with clear guidance on therapy choices, can significantly transform knowledge into effective self-management behaviors for individuals with T2DM.

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