Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.47750/jptcp.2023.30.05.059

Effects of Educational Health Literacy Development Program on Health Literacy, Health Behaviors, and Clinical Outcomes in Type 2 Diabetes Mellitus Patients in Thailand: a Mixed-Method Study

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Submitted: 18 January 2023; Accepted: 20 February 2023; Published: 25 March 2023

ABSTRACT

Diabetes mellitus has been the fifth-leading leading cause of death worldwide. This mixed-methods study aimed to investigate the impacts of an educational health literacy development program (EEHLDP) on health literacy, health behaviors, and diabetic clinical outcomes in patients with type 2 diabetes mellitus (T2DM). The quantitative sample comprised 30 control (regular monitoring and follow-ups) and 30 experimental T2DM patients who received the 5-month health literacy development program (encouragement for proactive health behaviors via home visits and telehealth). The qualitative experimental model included 17 patients. The research outcomes were health literacy, fasting blood sugar (FBS) level, and hemoglobin A1c (HbA1c). Results showed that the post-trial health literacy level in the quantitative experimental group was significantly higher than that of the control group ($p<0.01$). In addition, fasting blood sugar was significantly reduced, but the HbA1c was stable. A qualitative experimental group understood basic technical terms used in diabetes and laboratory results. Moreover, they also were able to decide to choose appropriate health behaviors. Based on findings from this study, it was concluded that the EHLDP could help reduce fasting blood sugar levels and accumulated HbA1c. Therefore, this program should be further disseminated to a larger group of T2DM patients in the community.

Keywords: *Health literacy, type 2 diabetes mellitus, health behavior, blood glucose, telehealth*

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the most common non-communicable diseases worldwide (Naserrudin et al., 2022). In persons aged 20 to 79, the prevalence of diabetes is expected to increase globally, going from 10.5% (536.6 million) in 2021 to 12.2% (783.2 million) in 2045 (Sun et al., 2022). In 2019, it was predicted that in Thailand, 4.8 million adults (45.8 million persons over 25) would develop T2DM (Apidechkul et al., 2022). This number will grow to 5.3 million by 2039, affecting the mortality rate (Apidechkul et al., 2022). T2DM is a chronic disease that causes various complications, such as diabetic retinopathy, diabetic nephropathy, diabetic foot ulcer, heart disease, stroke, and peripheral arterial diseases (Wu et al., 2022). These complications are preventable by continuous medical treatment and appropriate self-care (da Rocha et al., 2020). Consistent and adequate control of health behaviors, such as blood glucose monitoring, diet, physical exercise, medication adherence, stress management, and prevention of other comorbidities, are positive factors in improving clinical outcomes (Carpenter et al., 2019).

Health literacy is defined as "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health." (Nutbeam & Kickbusch, 1998). Poor functional health literacy presents a significant obstacle to the education of patients with chronic conditions (Nutbeam, 2000). In addition, it may result in high costs to the healthcare sector due to the improper or inappropriate use of medications and self-care (Nutbeam, 2000). Achieving health literacy goals is necessary yet difficult to attain because health literacy requires patient-provider communication and a skill development process (Rowlands et al., 2017). Recent work demonstrated that health education could enhance overall nutrition, behavioral, and psychological well-being, positively affecting the treatment's effectiveness of T2DM (Wang et al., 2022). Therefore, patients with T2DM should receive health education, as it can significantly increase medication adherence. This present study aimed to explore the impact of an educational health literacy development program (EHLDP) on health literacy, health behaviors, and diabetic clinical outcomes in patients with T2DM using mixed-methods – quasi-experimental research and qualitative research through in-depth interviews and group discussion.

MATERIAL AND METHOD

Human subjects and

The population and sample in the quantitative research consisted of T2DM patients who had received regular and ongoing treatment for at least one year. Patients admitted on a Wednesday were classified as the experimental group, and they joined an established EHLDP. Patients admitted on a Friday were ranked as the control group and joined a regular program provided by the hospital. After clarifying the details of voluntary participation in the research, simple random sampling was done using Cohen's sample size calculation. An experimental research case of large effect size (ES=0.40) was defined by 95% percent confidence intervals, with 30 samples for each group and 5 months for the experimental period. The qualitative study included ten participants admitted to the program using depth interviews.

The inclusion criteria were as follows: a participant had to 1) be a patient with T2DM who had received ongoing treatment for one year, 2) have a screening score of health literacy greater than 63, and 3) voluntarily participate in the study. The exclusion criteria were as follows: patients with T2DM who had shown dangerous complications were forbidden from participating by the doctors, as were patients who had withdrawn for any reason. The 60 participants were divided into 2 groups. Control group received regular monitoring and follow-ups whereas the experimental group received additional encouragement for their proactive health behaviors through home visits and consulting via a LINE group. Ethical rights protection was approved by the Nakhon Ratchasima Provincial Public Health Office, research project number NRPH 043, dated 18th September 2019.

J Popul Ther Clin Pharmacol Vol 30(5):e598–e606; 25 March 2023.

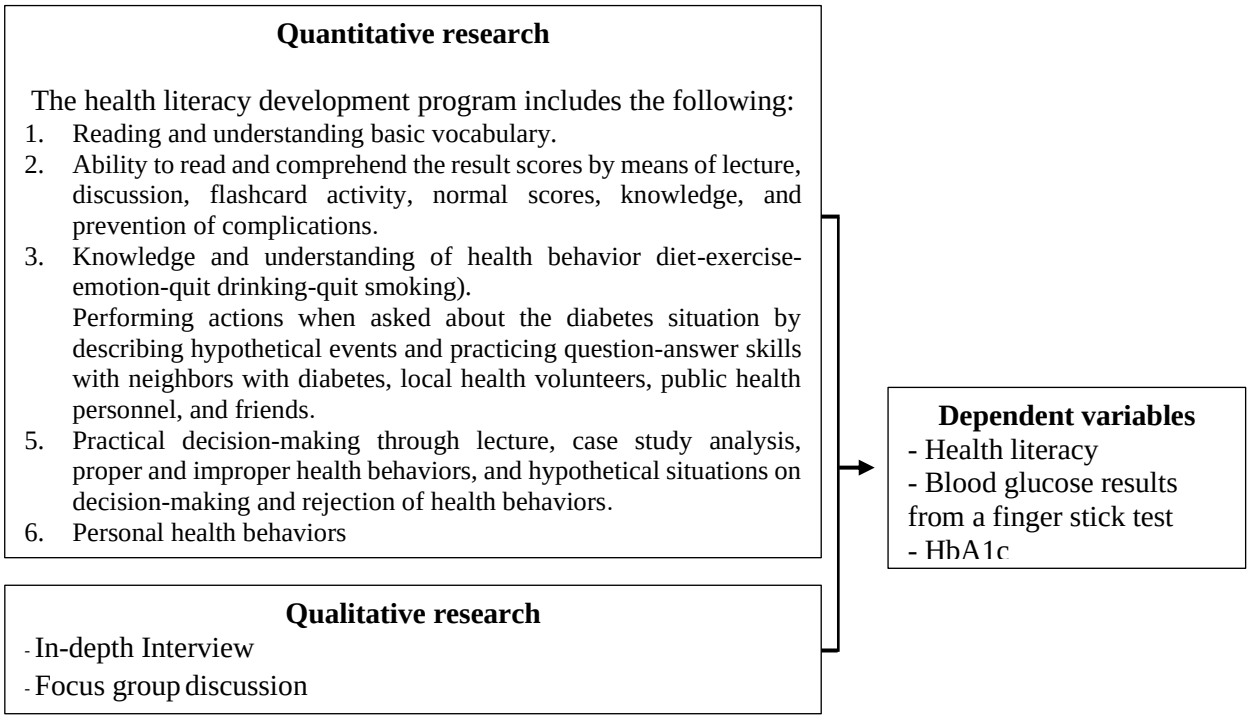

FIG. 1: Conceptual framework for research

Experimental procedures

The experimental tools were 1) an EHLDP developed using patients' problems, contexts, and needs based on in-depth interviews with seven patients, group discussions with nine stakeholders, and reviews with three experts (IOC=0.87-0.98), 2) T2DM patients' questionnaire, 3) blood sugar tests. A health literacy assessment for T2DM patients was divided into 6 sections as follows; 1. General information, seven items, 2. Assessment on health information assistance; two items were used with the following estimation scale, i.e., every time, often, occasionally, and never. The confidence value was equal to 0.81, 3. Questionnaire on essential vocabulary reading and comprehension; 10 items, reading and comprehension of numbers; eight items and health information access; five items, cognitive test on health behavior; 16 items of three-choice or four-choice questions using the following criteria: 1 point for a correct answer, 0 points for an incorrect answer; the confidence value (KR-20) was 0.98 0.82 0.74 and 0.87, 4. Assessment on performing actions when asked; 17 items and health behaviors; eight items using a five-level scale, namely, requesting relatives to answer, not answering, trying to answer, answering immediately, and answering and asking for more information, with scores from 1 point to 5 points; the confidence value was 0.97 and 0.79, 5. Assessment on right decision-making; 15 items using four-choice answers, on a four-level scale, with the criteria as 1 point for a correct answer, 0 points for an incorrect answer, and 1 point to 4 points on the four-level scale, the confidence values (KR-20) were equal to 0.49 and 0.68 after a confidence test of 0.81, and 6. Pre-trial health literacy assessments for the experimental and control groups were based on quantitative research data collection, fingertip blood sugar test and cumulative glucose test results via interviews, and activities from the EHLDP in the experimental and control groups in a standard setting for six months; and post-trial assessment of both groups based on interviews, and qualitative research conducted through in-depth interviews with individuals.

Statistical analysis

For all statistical analyses, SPSS version 22 was used. Quantitative data analysis was expressed as mean ± standard deviations (SD), frequency, mean, and percentage. Normality tests were performed using the Kolmogorov-Smirnov test. Paired t-test and independent t-test or their non-parametric counterparts were used to compare the two means. The qualitative data analysis utilized content analysis. The statistical significance level used in all analyses was 0.05.

RESULTS

Quantitative data

Demographic data showed that most patients, or 76.70 percent of the control group, were female, with a mean age of 55.59 years (max=67, min=39). Most of them attended primary school (82.00 percent), and 32.00 percent were rice farmers without unemployment. While 45.45 percent had barely enough income, 60.67 percent were without any duties in the community, and despite being physically unfit, 60.30 percent managed to perform self-care. Also, 59.25 percent had participated in health education activities by talking in person. Findings on the requirements for health assistance of the experimental and control groups indicated that 43.30 percent and 44.47 percent occasionally needed help reading health information documents from health personnel. In comparison, 33.30 percent and 37.24 percent, respectively, often required help filling out health information documents at health facilities.

Results from a fingertip fasting blood sugar (FBS) level in the pre-trial experimental group yielded a mean of 148.23 (SD=23.98) mg/dL. However, in post-trial measurement, the FBS level significantly reduced to 142.80 (SD=19.14) mg/dL ($p < 0.05$, Figure 2A). On the other hand, pre-trial results from the three-month cumulative HbAic test yielded 8.93 (SD=1.05) %, and the post-trial result was 9.13 (SD=0.97) % ($p = 0.13$, Figure 2B).

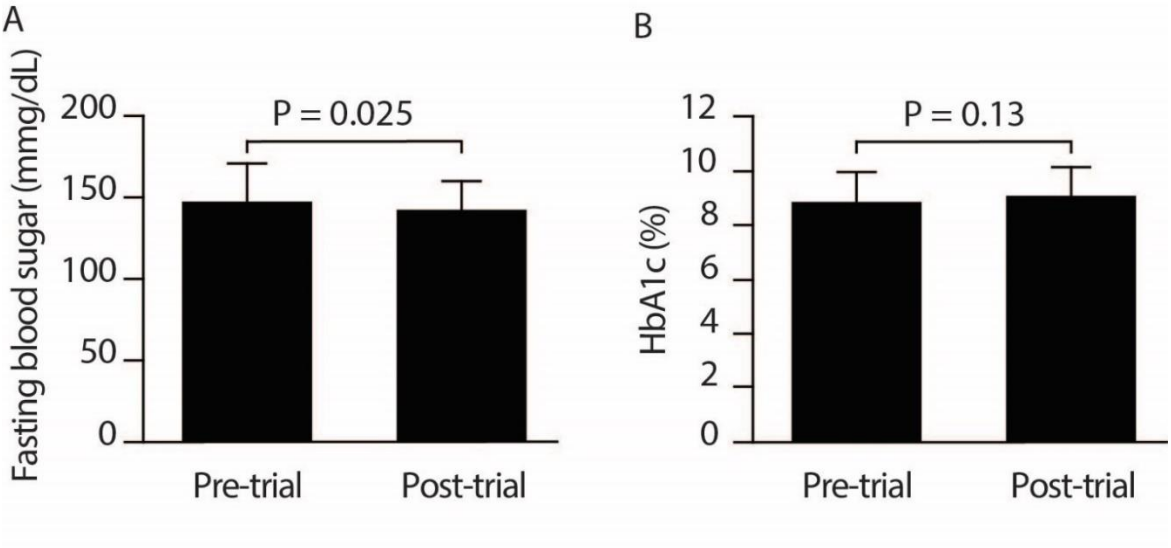

FIG. 2: Conceptual framework for research

Furthermore, results also showed that the scores of 6-item health literacy and health behavior in the post-trial of the experimental group were significantly higher than the pre-trial ($p < 0.01$). Moreover, the scores were also significantly higher than the control group ($p < 0.01$), as shown in Table 1.

TABLE 1: Comparison of scores on health literacy in T2DM patients

Variable	Sample		Percentage	SD	t	p
Reading and understanding basic vocabulary	Within groups Experimental group	Pre-trial	2.83	3.12	9.11	<0.01
		Post-trial	7.93	1.86		
	Within groups Post-trial	Experimental group	7.93	1.86	5.54	<0.01
		Control group	3.12	2.99		
Ability to read and comprehend the result scores	Within groups Experimental group	Pre-trial	2.35	2.60	8.66	<0.01
		Post-trial	6.35	1.81		
	Within groups Post-trial	Experimental group	6.35	1.81	5.57	<0.01
		Control group	2.51	2.51		
Knowledge and understanding of health behavior	Within groups Experimental group	Pre-trial	4.61	5.01	9.89	<0.01
		Post-trial	13.38	2.34		
	Within groups Post-trial	Experimental group	13.38	2.34	5.91	<0.01
		Control group	5.19	4.88		
Performing actions when asked	Within groups Experimental group	Pre-trial	6.41	4.44	8.89	<0.01
		Post-trial	13.41	3.01		
	Within groups Post-trial	Experimental group	13.41	3.01	7.36	<0.01
		Control group	6.22	4.70		
Sound and practical decision-making	Within groups Experimental group	Pre-trial	3.87	2.49	9.52	<0.01
		Post-trial	8.74	2.11		
	Within groups Post-trial	Experimental group	8.74	2.11	9.51	<0.01
		Control group	4.19	2.45		
Health behaviors	Within groups Experimental group	Pre-trial	1.42	0.60	20.28	<0.01
		Post-trial	4.58	0.57		
	Within groups Post-trial	Experimental group	4.58	0.57	14.92	<0.01
		Control group	1.52	0.56		

Note. P < .001, t = independent sample t-test

Qualitative data

The researchers classified results from qualitative research synthesis through content analysis, using in-depth interviews and group discussions into three issues. First, knowledge and understanding of Health behaviors revealed that patients actively gave feedback on the EHLDP, sharing the benefits of attending lectures, group activities, and skills training and applying knowledge in their daily life appropriate to personal circumstances, such as through menu organization, stress management, exercising, and reducing and avoiding alcohol and smoking. The first respondent explained her changes: "After the training, I began to eat less sweet food. Now, I use no MSG in my cooking. I eat on time and swing my arms while walking in the neighborhood. I quit drinking and smoking. I thought it was enough that people with diabetes just ate less sugar." The second respondent added, "People say that exercise is good. But I don't know how to exercise. I'm old, and even after a little workout, I feel tired. The doctor training us taught me to do simple exercises like walking in the morning. It isn't as difficult as I thought. Since the training day, I've kept on walking." On stress management, the third respondent said, "I didn't know that stress would make my diabetes worse. I listen to dharma or plant vegetables or trees when I have free time. I feel better than previously, a lot more comfortable." It was evident that patients could apply their knowledge in their daily lives from a health promotion perspective.

Regarding the ability to read and comprehend the result scores, this patient said that after joining the program, she could read and understand numbers related to diabetes better. The fourth respondent said, "I had attended the training before but couldn't remember anything. In this training, the doctor taught me something easy to remember. Now, I know that my blood sugar should not exceed 100. And if I want to control it within the threshold, I need to control and monitor health behavior." The fifth respondent commented, "I can't remember everything the doctor said. But I know more. I understand and apply the knowledge in many ways. In the past, I couldn't remember what cholesterol I should not exceed. If you ask me today, I can tell you it should not exceed 200. The doctor also followed up and asked via the LINE group and visited me at my home. That is why I can remember and use the knowledge in my way." The sixth respondent added, "After training, I understand a lot more. Normally, I don't know what fat in the blood is. Now, I know that it contains good fats and bad fats. Bad fats should not be more than 100." From the data, it can be demonstrated that diabetes patients could understand the numbers of measurements necessary for health care and interpret them correctly for future health monitoring and supervision. In the future sound and practical decision-making or living conditions, diabetes patients will provide post-program information similarly. The seventh respondent said, "I have been exercising all the time. I follow the best exercise courses. Usually, I exercise every day. I persist even on the days I feel faint. But after listening to the doctor at the training, I realized that if I feel faint or dizzy or palpitate during the exercises, I must stop immediately." The first respondent gave the following information: "I follow every instruction given by the doctor. Sometimes, however, it's hard to do so. When I eat something, even very little, my blood sugar rises. If I don't eat, I will be hungry. I eat a lot in the evening and even late at night if I feel hungry. The doctor suggested that if I feel hungry at night, I should delay my dinner. I used to have my dinner at 5 o'clock, but now I have changed it to 6. I go to bed at 9 o'clock. I eat less rice and more fresh vegetables." Also, the fourth respondent added, "In the past, when I went to social events, I was troubled about eating because I didn't know what food would cause my blood sugar to rise. My first thought was to eat the food and go home when full. But on second thoughts, I decided I'd better eat at home. What a pity all food looked delicious. After listening to the doctor, I learned to compare the foods I can eat." Such information explains that after participating in the program, diabetic patients could apply the knowledge to their daily lives in their circumstances. They were able to make decisions to address better various aspects of health promotion problems from cognitive health intelligence that results in lower blood sugar levels and cumulative sugar levels.

DISCUSSION

Our study suggests that the EHLDP effectively improved blood sugar levels, health literacy, and health-related behaviors in T2DM patients. This conclusion is based on the following findings. First, a fingertip blood sugar test and three-month cumulative HbA1c levels in the post-trial group were better results than the pre-trial and the control group. It is well known that a low level of health literacy is associated with a higher risk of T2DM (Tajdar et al., 2021). Moreover, poor health literacy is independently linked to lower glycemic control and higher rates of retinopathy among T2DM patients in primary care (Al Sayah et al., 2015; Schillinger et al., 2002). In contrast, proper glycemic management and adequate diabetes health literacy are closely associated – high diabetes health literacy and strong medication adherence are correlated with achieving the target glycemic control after controlling for all other factors (Tefera et al., 2020). In addition, a recent study conducted in Thailand found a substantial relationship between blood sugar control and T2DM patients' degree of health literacy, notably concerning diet and exercise habits (Singsalasang et al., 2022). However, to our knowledge, this present study is the first to investigate the effects of a health literacy development program on blood sugar levels, health literacy, and health-related behaviors in T2DM patients.

Hallmarks of the program are a comprehensive package of media on basic vocabulary related to T2DM, basic clinical result interpretation, understanding health behaviors (diet, emotion, exercise, alcohol, and smoking), taking actions when asked, practical decision-making, and health behavior modification. Moreover, adopting the telehealth (LINE) application into the program facilitated the patient's repetitive learning (Morony et al., 2018). A previous study showed that patients with T2DM who received repeated diabetes education had more positive cognitive and social parameters (Erkoc & Tan, 2017). Of note, it has been shown that the brain of T2DM patients (frontal lobe, temporal lobe, and posterior cingulate gyrus) were changed compared to healthy individuals, possibly explaining the aberrant changes in cognitive functions and behaviors in T2DM patients (Xu et al., 2019). Therefore, it is tempting to perform further studies unraveling brain structural and functional changes in response to repetitive learning in T2DM patients. Furthermore, improving the learning process might facilitate their understanding of their health status.

It has been demonstrated that the ability of nurses and patients to interpret preliminary clinical results, such as glucose, ketones, and Hb1A1c assays, could improve clinical outcomes in diabetic individuals (Jeha & Haymond, 2007). In addition, implementing the five key factors – diet, emotion, exercise, alcohol, and smoking into the program can be a candidate for success. For example, dietary practices that greatly emphasize consuming plant foods appear to improve glycemic control (Salas-Salvado et al., 2019). According to the findings of cross-sectional and longitudinal studies, T2DM risk may be elevated not only by depressive disorders but also by other forms of emotional stress and anxiety, difficulty sleeping, hostility, and anger (Pouwer et al., 2010; Tudpor et al., 2021). Exercise lessens cardiovascular risk factors, regulates body weight by lowering body fat percentage and increasing lean mass, and enhances blood glucose control in T2DM patients (Amanat et al., 2020). Alcohol consumption exacerbates T2DM by retarding muscular glucose uptake and promoting intestinal glucose absorption (Steiner et al., 2015). Lastly, it was shown that nicotine causes T2DM stimulating the mammalian target of rapamycin (mTOR) protein activity, which causes insulin resistance in skeletal muscle (Bergman et al., 2012). Altogether, following these critical practices can prevent further glycemic deliberation. Health professionals monitor and ask patients to change their behaviors when appropriate in clinical settings. A study showed that the patients who complied with their medication regimes had gainfulness glycemic and HbA1c control (Muliyil et al., 2017).

A study showed that even though it is best to have shared decision-making, most patients tended not to participate in decision-making but preferred to follow what health professionals suggested (Wang et al., 2019). In addition, behavioral modification in diet and cardiovascular fitness has been depicted to improve glycemic control in overweight patients with T2DM (Kriska et al., 2018). Health technology has become essential for improving clinical outcomes. For example, a study of elderly self-care supported by the instructors in accessing health information via the internet and learning critical health literacy skills indicated that the program augmented their information-seeking ability and self-care management (Campbell & Nolfi, 2005). Another study showed that using the internet to promote health knowledge, access to personal health information, decision-making on self-care, testing on exercise, and searching for accurate health information showed that supportive health information search enabled patients to make decisions on self-care (Chiarella & Keefe, 2008).

There are some limitations in our study. First, we had a relatively small group of participants, which might render changes in the HbA1c outcome. Secondly, 5-month length of the program might be too short to see the full effectiveness of the program. Therefore, further study is required to prolong the time of the survey. In conclusion, the health literacy and behavior change program may aid in lowering cumulative HbA1c and fasting blood sugar levels. Consequently, more T2DM patients in the

community should be brought to the attention of this initiative.

ACKNOWLEDGMENTS

The researchers would like to thank the diabetic patients, our affiliation with Nakhon Ratchasima College funds and time for this research, and all lecturers and research assistants. The authors are grateful for the research funding provided by the Nakhon Ratchasima College, Thailand.

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