Received: 12 April 2021 | Revised: 10 October 2021 | Accepted: 16 November 2021

DOI: 10.1002/nop2.1140

RESEARCH ARTICLE

NursingOpen Open Access WILEY

Use of health locus of control on self-management and HbA1c in patients with type 2 diabetes

Lingxiao Zhu[1] | Qifang Shi[1] | Yue Zeng[1] | Tong Ma[2] | Haomiao Li[3] | Dilihumaer Kuerban[1] | Sarita Hamal[1] | Meng Li[4]

[1]Faculty of Nursing, Health Science Center, Xi'an Jiaotong University, Xi'an, Shaanxi, China

[2]The First People's Hospital of Lianyungang, Lianyungang, China

[3]Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, Victoria, Australia

[4]Department of Endocrinology and Metabolism, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, Shaanxi, China

Correspondence
Qifang Shi, Faculty of Nursing, Health Science Center, Xi'an Jiaotong University, 76 N. Yanta West Road, Xi'an, 710061 Shaanxi, China.
Email: qifangshi@xjtu.edu.cn

Abstract

Aim: To assess the effects of health locus of control-based education programme (HLCEP) on self-management, health locus of control and glycated haemoglobin (HbA1c) among type 2 diabetes mellitus (T2DM).

Design: Quasi-experimental study.

Methods: The study recruited 120 T2DM participants from May–September 2020. The control group received one-week in-hospital care and 12-week follow-up. The intervention group received additional HLCEP. The self-management and the health locus of control were measured by using the Summary of Diabetes Self-care Activities and the Multidimensional Health Locus of Control at baseline and the 4th and 12th week after discharge. The HbA1c was collected at baseline and the 12th week after discharge. The generalized estimating equation analysis was performed to assess the intervention effects.

Results: The intervention group has statistically significantly higher scores on the overall level of self-management, dietary management, foot care, medication management and internal health locus of control, while a lower HbA1c level than the control group.

KEYWORDS

clinical trial, glycaemic control, locus of control, self-management, type 2 diabetes

1 | INTRODUCTION

Diabetes mellitus is a long-term disease that can be caused by both external factors and internal factors. Recent statistics showed that the diabetes had a high prevalence, and it threatened people's health worldwide (International Diabetes Federation 2017, 2019). Self-management is the key to stabilizing diabetes control, due to the lifelong characteristics of it (Aga et al., 2020). However, poor self-management and glycaemic control are the prominent problems of people with type 2 diabetes mellitus (T2DM) (Eh et al., 2016; Lin et al., 2017). Health education is an important non-pharmacological method to promote self-management and stabilize glycaemic control in people with diabetes (Mohamed et al., 2019). Psychosocial factors have progressively played an essential role in diabetes education and management (Klinovszky et al., 2019). Notably, current education often neglects the psychosocial factors in disease management. Health locus of control (HLC) as a psychosocial variable that could predict self-management behaviours of T2DM, and the education,

which takes the health locus of control into account, should be valued. However, the current studies on health locus of control have focused on cross-sectional surveys, and few interventional studies, especially for patients with type 2 diabetes, have been conducted. One HLC-based intervention study on the effect of self-management of type 2 diabetes was retrieved (Ebadi Fardaza et al., 2017), but it did not present a detailed intervention programme based on HLC for the reference of Chinese patients and did not explore the effect on HbA1c. The intervention in our study added personalized interview communication compared to previous interventions, which not only stimulated patients' awareness of internal control, but also made the subsequent intervention protocols more personalized and tailored to patients' needs. At the same time, our study explored the effect of the HLC-based education programme (HLCEP) on glycaemic control in patients with type 2 diabetes. It is expected that the findings of this study could promote the application of health locus of control in health education and provide new ideas for personalized care of type 2 diabetes in clinical practice.

2 | BACKGROUND

Prevention and management of diabetes have received global attention. Simultaneously, recent statistics revealed that the prevalence of diabetes is at a constant high level. Diabetes management and glycaemic control were not satisfied. Thus, effective prevention and management were needed (International Diabetes Federation 2017, 2019; Laxy et al., 2014). According to the statistics of the International Diabetes Federation (IDF), 9.3% of adults (20–79 years old) worldwide were diagnosed with diabetes, which means one in eleven adults were diagnosed (IDF 2019). Furthermore, T2DM is the most common type of diabetes, accounting for around 90% of all diabetes worldwide (IDF 2019). A systematic review (Mannucci et al., 2014) indicated that approximately two-thirds of people with T2DM had not achieved the treatment target [glycated haemoglobin (HbA1c) <7.0%)]. A cross-sectional study demonstrated that the proportion of HbA1c <7.0% was only 30.1% (Aschner et al., 2020). If the HbA1c targets could not be achieved in a long term, it would increase the number of long-term complications, readmission rates, economic burden and even premature mortality (Zhou et al., 2020). As reported in the World Health Statistics 2020 report (WHO 2020), approximately three-quarters of deaths in 2016 were caused by non-communicable diseases (NCDs). While other NCDs had a decreasing trend, the premature mortality of diabetes increased by 5% from 2000–2016.

The management of diabetes is a systematic and comprehensive process. The long-term and progressive characteristics of diabetes could cause unsuccessful diabetes management in a short period of hospitalization. As people with diabetes are primary managers of their health, self-management plays an important role in the management of diabetes (Yao et al., 2019). Diabetes education is an essential method to improve patients' self-management and reduce HbA1c. The theoretical basis and forms of diabetes education have been greatly enriched, and the diabetes self-management education and support (DSMES) was regarded as an effective way to enhance self-management and reduce HbA1c (Powers et al., 2020). However, current studies suggested that participation in self-management and HbA1c control remained suboptimal among people with T2DM (Aschner et al., 2020; Eh et al., 2016; Laxy et al., 2014). Research has shown that diabetes education often neglects the impact of psychosocial factors on educational effects, and people with different psychosocial characteristics may derive different benefits from education (Li 2018). Certain educational methods and contents might not be suitable for the patients and may led to unsatisfactory educational outcomes. The role of psychosocial factors is increasingly significant in diabetes management (Li et al., 2019). Compared with some factors that are difficult to change, such as biological factors, the changeable characteristics of psychosocial factors provide a personalized direction for interventions. Therefore, there is a call for personalized intervention programmes that take into account people's psychosocial characteristics to improve self-management behaviours and achieve HbA1c targets.

Health locus of control (HLC) is a psychosocial variable to predict people's behaviours in health care, which includes three types: internal health locus of control (IHLC), powerful others health locus of control (PHLC) and chance health locus of control (CHLC) (Wallston et al., 1978). According to the HLC theory, people with IHLC believe that they are responsible for their behaviours and health through their own efforts. Those with PHLC believe that health relies on the guidance and care of powerful others (e.g. medical professionals). Moreover, those with CHLC often have negative or false perceptions and cope with disease management passively (Nugent et al., 2015). A series of studies (Alyami et al., 2019; Klinovszky et al., 2019; O'Hea et al., 2005) showed that HLC was related to self-management and HbA1c in people with T2DM, and those with a higher IHLC, especially both with a lower CHLC, might frequently engage in self-management and have a safe level of HbA1c. However, few numbers of research are on the application of HLC to self-management interventions for people with T2DM. A study showed that the education based on HLC could stimulate the IHLC perception and improve self-management behaviours among people with T2DM (Ebadi Fardaza et al., 2017). However, their study lacked a systematic and specific education programme based on HLC. In addition, it did not explore the effect on HbA1c, which is one of the best physiological indicators to assess glycaemic control in diabetes. There are some other differences between our study and Ebadi Fardaza's study. In terms of the duration and dosage of intervention, Ebadi Fardaza's study only mentioned three 60-min educational sessions in the form of short lectures, question and answer, and group discussions. However, it did not specify a specific timetable for the intervention. Our study included one-week in-hospital education and 11-week intensive follow-up education. A detailed schedule and additional personalized communications based on HLC helped stimulate the patient's sense of internal control and motivation. In addition, Ebadi Fardaza's study population was from the Babol Diabetes Association and the effectiveness of this intervention in the Chinese population remained to be explored.

The study aimed to explore the effects of HLCEP on self-management, HLC and HbA1c in type 2 diabetes by applying the quasi-experimental study. It was hypothesized that the HLCEP might increase the level of self-management and IHLC and reduce HbA1c at the end of the intervention.

3 | THEORETICAL BASIS

The HLC theory and the Thorndike's Law of Learning were the theoretical basis of HLCEP. The HLC is a crucial variable to predict individuals' health behaviours (Wallston et al., 1978). The increase of the people's IHLC would facilitate the self-management behaviours. Thorndike's Law of Learning, including the law of readiness, the law of exercise and the law of effect, could strengthen the IHLC perception and educational effect. A study indicated that (Cheng et al., 2019) applying the Law of Learning to Chronic Obstructive Pulmonary Disease patients could improve their IHLC. Therefore, we incorporated it into this study to enhance the IHLC perception of people with T2DM.

4 | METHODS

4.1 | Research design

A quasi-experimental design was used to evaluate the effects of the HLCEP, that is the research method allowing to conduct experiments in a more natural and realistic setting. Therefore, this design is appropriate and more feasible to our population.

4.2 | Participants and recruitment

Participants who were familiar with social media (Zoom, QQ or Wechat) and were hospitalized in the department of endocrinology of a tertiary hospital in Xi'an, China, from May–September 2020 were consecutively selected. Inclusion criteria were as follows: (a) WHO (1999) diagnosis for T2DM; (b) ages 18–70 years; (c) diabetes duration ≥3 months; (d) can use e-platform (Zoom, QQ or Wechat); and (e) volunteer to participate. Exclusion criteria were as follows: (a) people with malignant tumours; (b) people with severe complications and/or comorbidities; (c) people with cognitive impairment; and (d) participating in other clinical trials at the same time.

Researchers of our team screened qualified participants through reviewing the electronic medical records. Researchers informed the purpose and process of the study, and volunteers were selected. The baseline assessments were completed independently by the participants after they signed informed consent. The endocrinology department has two wards, Ward A and Ward B, where participants' basic conditions and treatment plans were homogeneous. By convenience sampling, the Ward A participants were assigned to the experimental group and the Ward B participants were assigned to the control group. Ward A and Ward B are independent, while the intervention was conducted in the diabetes education room in Ward A to prevent contamination as much as possible. Once eligible patients were enrolled, the researchers would select the application that was used more frequently based on patients' habits and train them uniformly on Zoom, QQ or WeChat to ensure that all participants were able to use these applications correctly during the follow-up. Besides, the outcome evaluator was blinded to the allocation of participants.

4.3 | Sample size

The sample size was calculated according to the formula of repeated-measures analysis of variance (Lui & Cumberland, 1992): $n=\frac{2}{\delta^2}\left[\sigma_\mu^2+\frac{1+(K-1)\rho_c}{K}\sigma_e^2\right]\left(\mu_{\alpha/2}+\mu_\beta\right)^2$ based on the primary outcome self-management. Referring to the previous literature (Peng et al., 2019), in this study $\alpha=0.05$, $\beta=0.10$, $\delta=11.25$, $\rho_c=0.5$, $K=3$, $\sigma_\mu^2=99.62$, and $\sigma_e^2=199.23$. Considering an attrition rate of 20%, the participants of per group were 47. Finally, a total of 120 participants were collected depending on the actual conditions.

4.4 | Description of the intervention

4.4.1 | Control group

The control group received the routine care provided by endocrine nurses during hospitalization. It included admission education, routine nursing care, discharge guidance and follow-up. The unstructured online follow-up was implemented at the 4th and 12th week after discharge, with each follow-up lasted 20–25 min. The main purpose of the follow-up was to gain information about the blood glucose levels and to answer questions, and attention bias could be balanced through follow-up.

4.4.2 | Experimental group

The intervention group received the routine care and HLCEP provided by endocrine nurses and study group members who had received uniform training. The HLCEP included hospital education and intensive follow-up education. The hospital education consisted of 2 personalized communications (20–25 min/session) and 3 group educations (40–45 min/session) attended by 6–8 participants each and encouraged caregivers to participate in the whole process. Specifically, the first personalized communication was held on the first or second day of hospitalization, and the second communication was held on the fourth day. Three group educations were conducted on days 3, 5 and 6 of hospitalization respectively. Themes of personalized communications were "Ice breaking, HLC identifying" and "Self-directed goals setting," and the group educations themed

"Hello diabetes," "Scientific dietary and exercise" and "SMBG and medication as prescribed." Unlike traditional education, HLCEP requires an assessment of the patient's HLC before the implementation of the education. Then, according to the outline, personalized communications were conducted for participants of different HLC, aiming to guide them to rational attribution, focus on their strengths and stimulate IHLC perception in diabetes self-management. Details of hospital education are shown in Table 1. Researchers conducted intensive follow-up education through sending messages about diabetes-related knowledge and answering questions to participants via e-platform (e.g. Zoom, QQ or WeChat). Thus, we could learn about their daily self-management and supervise the review of the hospital courses to strengthen the educational effects. Additionally, participants could interact and communicate with each other without time and geographic restrictions. After discharge, the follow-up was biweekly for 20–25 min and was flexibly adjusted according to participants' actual status.

4.5 | Outcome measures and data collection

Sociodemographic information, disease-related status and outcomes of interest were collected. The primary outcome was self-management, while the secondary outcomes were HLC and HbA1c.

The Summary of Diabetes Self-Care Activities (SDSCA) of Toobert (Toobert et al., 2000) was used extensively to assess the level of self-management for people with diabetes. It contains 12 entries with five dimensions: exercise management, dietary management, medication management, foot care and self-monitoring of blood glucose (SMBG). Each entry was scored according to the number of days that participants engaged in self-management behaviours in the past seven days. The score of 0 represents never completed, and 7 represents daily completion; the mean scores were calculated for each dimension, and higher scores indicated better self-management behaviours. In China, Hua and Zhu (2014) translated the SDSCA from English to Chinese, and the results showed that the instrument had good reliability and validity. The reliability of the Chinese version had been validated (Cheng et al., 2018). In the pilot study, the Cronbach's α of the overall instrument was 0.820, and the range of Cronbach's α for each dimension was 0.707–0.937. The HLC was assessed by Multidimensional Health Locus of Control (MHLC), which was widely used in the medical field to assess people's attitudes, beliefs and coping strategies of people in the face of health-related problems (Wang et al., 1999). It contains 18 entries and three subscales: IHLC subscale, PHLC subscale and CHLC subscale. Each subscale adopts a 6-point scoring method, ranging from "strongly disagree" to "strongly agree," and each of them is scored separately. Higher scores that were obtained from a subscale indicated that the individual was more likely to the corresponding tendency of HLC. The Multidimensional Health Locus of Control (Chinese version) had been translated from English to Chinese, and the validity and reliability of it had been confirmed in Chinese communities (Wang et al., 1999). The Cronbach's α of the subscales in the pilot study was 0.725, 0.726 and 0.745. HbA1c was measured by the high-performance liquid chromatography, using the Japanese Tosoh-G8 automatic glycated haemoglobin analyzer.

At baseline, the data were obtained from the participants and the electronic medical records. At the 4th and 12th week after discharge, primary and secondary outcomes were collected again. We collected these data using wjx, an online questionnaire collection programme (https://www.wjx.cn/). Notably, HbA1c was only collected at the 12th week and was checked at a convenient hospital by themselves.

4.6 | Data analysis

Epidata 3.1 was used to establish the database, and SPSS 26.0 was used for statistical analysis. The study chose appropriate descriptive indicators (mean, standard deviation [*SD*], frequency and percentage) and statistical methods based on the data characteristics and the normality test results. The generalized estimating equation analysis was used to assess the main effects of group and time, and the interaction effects of the group by time for interest outcomes. The statistically significant level was set at $\alpha = 0.05$, and the Bonferroni corrected $\alpha' = 0.00167$ was used to compare simple effects between groups.

4.7 | Ethical considerations

Research Ethics Committee approval was obtained by the Biomedical Ethics Committee of the Medical Department of Xi'an Jiaotong University (Approval number: 2020-1187) and registered in the Chinese Clinical Trial Registry (Identifier: ChiCTR2000032160). All participants signed informed consents, and the research process complied with the Declaration of Helsinki.

5 | RESULTS

5.1 | Recruitment and attrition

Recruitment started from May–September 2020. As shown in Figure 1, 109 of 120 eligible participants provided complete data, 54 in the control group and 55 in the intervention group. The attrition rate between the two groups was not statistically significant (10.0% vs. 8.3%, $p = .752$).

5.2 | Baseline characteristics

The majority of the participants were males (55.8%), and the mean age of them was 49.83 ± 11.66 years. The duration of diabetes

TABLE 1 Outline of the hospital education programme among type 2 diabetes based on HLC

Time	Form	Theme	Main content
Day 1 ~ 2	Personalized communication (law of readiness)	Ice breaking and HLC identifying	1. Establishing trust relationship and active listening. (*10 min*) 2. Identifying the HLC and guiding rational attribution. (*10 min*) • IHLC: praising responsibility consciousness and healthy behaviors, assessing whether their ability match with the high internal control perception. • PHLC: Affirming compliance with clinicians, guiding them to focus on strengths of themselves in diabetes self-management and stimulating internal control perception. • CHLC: Neutral, non-judgemental communication and receptive listening, recognizing irrational cognition and imparting hope. 3. Introducing education theme and assessing relevant needs. (5 min)
Day 3	Group education (law of readiness)	Hello diabetes	1. Introducing story to stimulate awareness of internal control perception "the transatlantic experiment." (*5 min*) 2. The management of diabetes and complications, and the content of self-management. (*40 min*)
	Interaction (law of exercise, law of effect)		1. "Brainstorming": the benefits of self-management. (*5 min*) 2. Treatment of hypoglycaemia (*5min*) 3. Positive feedback and reinforcement. (*5min*)
Day 4	Personalized communication (law of readiness)	Self-directed goals setting	1. Strengthening self-management benefits. (*5 min*) 2. Clarify self-directed goals. (*10 min*) • IHLC: Self-evaluation and goals setting, educator supplement. • PHLC: Strengthening the perception of internal control, encouraging self-analysis of problem and setting goals. • CHLC: Improving irrational cognition and strengthening internal awareness, analysing their problem together, setting goals, compensation education (if needed). 3. Introducing next education theme and assessing relevant needs. (*5 min*)
Day 5	Group education (law of readiness)	Scientific dietary and exercise	1. Course review. (*5 min*) 2. Significance, principles, skills and precautions of scientific dietary and regular exercise. (*40 min*)
	Interaction (law of exercise, law of effect)		1. "Let's find the difference"—Case Study. (*5 min*) 2. Assessing whether goals of dietary and exercise were completed. (*5 min*) 3. Participant interaction. (*5 min*)
Day 6	Group education (law of readiness)	SMBG and medication as prescribed	1. Course review. (*5 min*) 2. Significance, scheme and precautions of SMBG; Introduction of common hypoglycaemic agents and insulin. (*40 min*)
	Interaction and Follow-up guidance (law of exercise, law of effect)	Participating follow-up actively	1. Participants demonstrating SMBG or insulin injection. (*5 min*) 2. Assessing whether goals of SMBG and medication were completed. (*5 min*) 3. Experience sharing among participants with high levels of self-management and internal perception. (*5 min*) 4. Informing participants of follow-up arrangements and distributing educational materials. (*5 min*)

Abbreviations: CHLC, participants with chance health locus of control; HLC, health locus of control; IHLC, participants with internal health locus of control; PHLC, participants with powerful others health locus of control; SMBG, self-monitoring of blood glucose.

<5 years accounted for 44.2%. Only 11.9% of participants were from rural. Other characteristics of sociodemographic, medical status and outcomes of interest are shown in Table 2. Chi-square test, *t*-test and Fisher exact test were used to test the comparability of the two groups, and the two groups were comparable at baseline ($p > .05$).

5.3 | Effect on self-management

Generalized estimating equation analysis was used to identify the effects of the intervention on participants' self-management over time. The results showed that the group by time interaction effects were statistically significant on the overall level of self-management (Wald $\chi^2 = 28.910$, $p < .001$), dietary management (Wald $\chi^2 = 17.600$, $p < .001$), foot care (Wald $\chi^2 = 61.709$, $p < .001$) and medication management (Wald $\chi^2 = 6.690$, $p = .025$). Consequently, the simple effect analyses were conducted for the above variables, and the results are detailed in Table 3.

5.4 | Effect on health locus of control

Generalized estimating equation analysis was implemented to test the effects of intervention over time on the HLC. Statistical difference was only found on the interaction effect of IHLC (Wald $\chi^2 = 9.226$, $p < .001$), implying that changes in the IHLC scores of participants over time varied depending on the intervention. The simple effect analyses presented that by the 12th week, the IHLC scores of the control group decreased from the baseline, while the intervention group increased. At both 4th week and 12th week, the IHLC scores of the intervention group were higher than those of the control group (see Table 3).

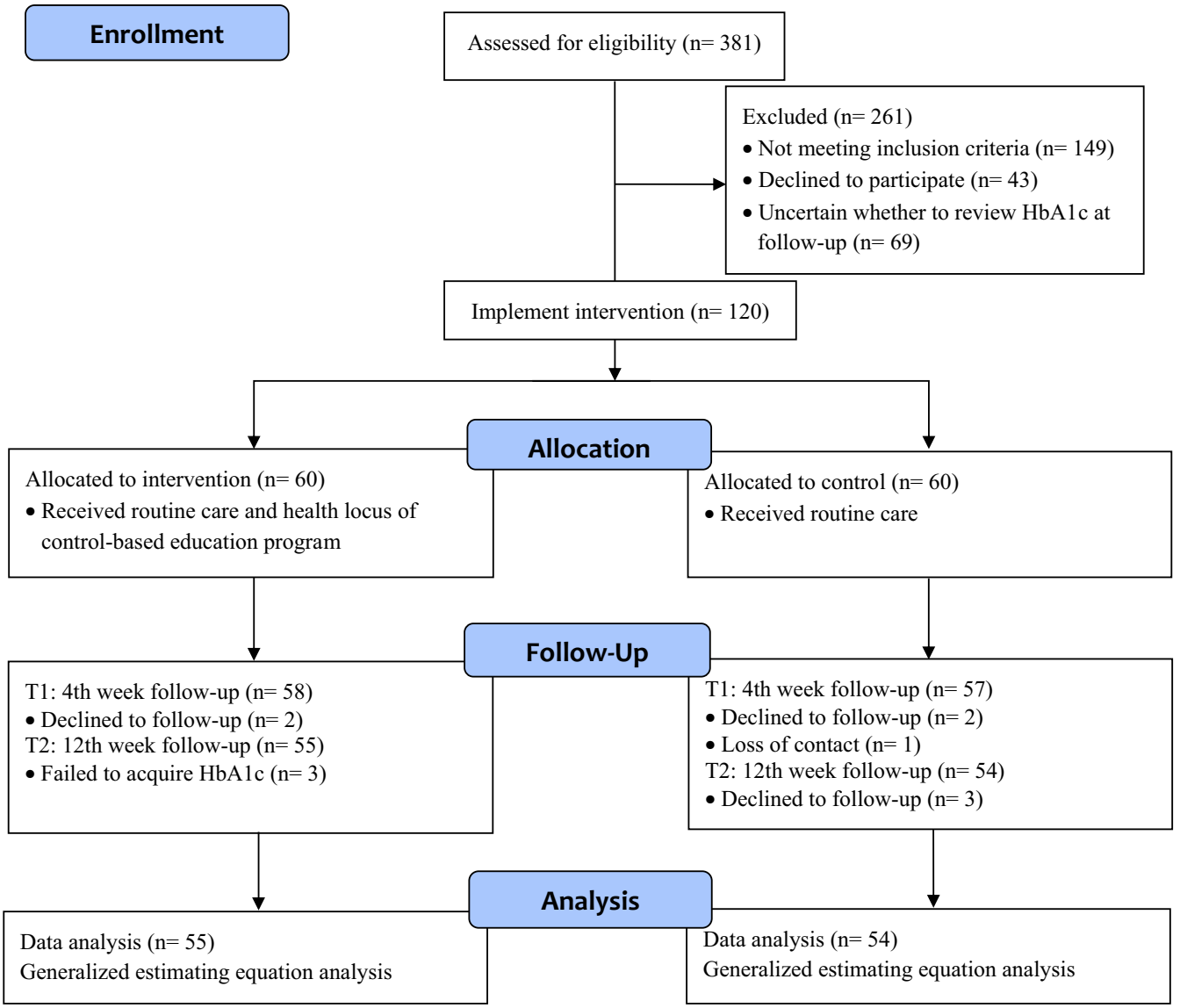

FIGURE 1 The flow diagram of the study selection process

TABLE 2 Baseline characteristics of participants between the two groups (N = 109)

Variables	Control group (n = 54)		Intervention group (n = 55)		t/χ^2	p
	n (%)	Mean (SD)	n (%)	Mean (SD)		
Gender						
Male	31 (57.4)		31 (56.4)		0.012	.912
Female	23 (42.6)		24 (43.6)			
Age (y)		51.15 (10.18)		46.93 (12.68)	1.918	.058
≤44	12 (22.2)		24 (43.6)		5.663	.059
45 ~ 59	29 (53.7)		21 (38.2)			
≥60	13 (24.1)		10 (18.2)			
Marital status (%)						
Married	46 (85.2)		47 (85.5)		0.002	.968
Others	8 (14.8)		8 (14.5)			
Employment (%)						
Employed	22 (40.7)		22 (40.0)		0.136	.934
Retired	15 (27.8)		14 (25.5)			
Others	17 (31.5)		19 (34.5)			
Educational level (%)						
Junior high school and below	12 (22.2)		9 (16.4)		0.604	.739
High school or secondary school	13 (24.1)		14 (25.5)			
College or above	29 (53.7)		32 (58.2)			
Residence (%)						
City	49 (90.7)		47 (85.5)		0.725	.395
Rural	5 (9.3)		8 (14.5)			
Monthly income (%)						
≤1,000 (CNY)	5 (9.3)		4 (7.3)		4.846	.185
1,001 ~ 3,000 (CNY)	19 (35.2)		18 (32.7)			
3,001 ~ 5,000 (CNY)	24 (44.4)		18 (32.7)			
≥5,001 (CNY)	6 (11.1)		15 (27.3)			
T2DM family history (%)						
No	39 (72.2)		30 (54.5)		3.665	.056
Yes	15 (27.8)		25 (45.5)			
Treatment (%)						
Hypoglycaemic drugs	23 (42.6)		19 (34.5)		2.889	.236
Insulin	10 (18.5)		18 (32.7)			
Hypoglycaemic drugs combined with insulin	21 (38.9)		18 (32.7)			
Complications (%)						
No	20 (37.0)		30 (54.5)		3.364	.067
Yes	34 (63.0)		25 (45.5)			
Diabetes duration (%)		8.09 (6.29)		6.47 (6.29)	1.344	.182
<5 (y)	20 (37.0)		27 (49.1)		1.614	.446
5 ~ 10 (y)	17 (31.5)		14 (25.5)			
>10 (y)	17 (31.5)		14 (25.5)			

(Continues)

TABLE 2 (Continued)

Variables	Control group ($n = 54$)		Intervention group ($n = 55$)		t/χ^2	p
	n (%)	Mean (*SD*)	n (%)	Mean (*SD*)		
BMI (%)						
Normal	23 (42.6)		28 (50.9)		0.757	.384
Abnormal	31 (57.4)		27 (49.1)			
HbA1c (%)		9.11 (1.85)		8.93 (2.03)	0.490	.625
HbA1c (mmol/mol)		76		74	–	–
SDSCA		17.76 (3.61)		17.04 (3.22)	1.097	.275
Diet management		3.95 (0.77)		3.74 (0.86)	1.371	.173
Exercise management		4.30 (1.63)		4.04 (1.63)	0.833	.407
Blood glucose self-monitoring		1.78 (1.51)		1.83 (1.49)	−0.172	.864
Foot care		1.11 (1.10)		1.33 (0.91)	−1.116	.267
Medication management		6.20 (0.96)		6.20 (1.16)	0.018	.986
MHLC						
IHLC		24.33 (3.10)		23.78 (3.07)	0.934	.353
PHLC		24.69 (3.96)		24.89 (3.40)	−0.291	.771
CHLC		11.48 (3.37)		14.84 (3.07)	−0.575	.567

Abbreviations: BMI, body mass index; CHLC, chance health locus of control; CNY, Chinese Yuan; HbA1c, glycated haemoglobin; IHLC, internal health locus of control; MHLC, Multidimensional Health Locus of Control; PHLC, powerful others health locus of control; SDSCA, the Summary of Diabetes Self-care Activities; T2DM, type 2 diabetes mellitus.

5.5 | Effect on HbA1c

As highlighted in Table 4, HbA1c decreased significantly in both groups after the intervention compared to baseline ($p < .001$). Moreover, the average HbA1c of the intervention group was lower than that of the control group in the 12th week.

6 | DISCUSSION

This study was designed to assess the effects of HLCEP on self-management, HLC and HbA1c among people with T2DM. The results indicated that the HLCEP could improve the overall level of self-management as well as dietary management, foot care and medication management. Meanwhile, it also increased IHLC scores and reduce HbA1c levels. Research showed that diabetes care and education is moving towards greater personalization (Dickinson et al., 2017). Currently, no systematic and specific HLC-based intervention programme for patients with T2DM has been developed for reference, and the impact on HbA1c needs to be explored. Therefore, this study developed the HLCEP to focus on the crucial role of perception in diabetes management and to enrich the personalized approach to diabetes education.

Compared with the control group, statistically significant improvements were observed in the intervention group on self-management, especially on the dietary management, foot care and medication management, suggesting that HLCEP could facilitate the involvement of self-management behaviours, which were similar but better to previous studies on diabetes education (Cheng et al., 2018; Ebadi Fardaza et al., 2017; Nejhaddadgar et al., 2019). The study further enriched the evidence that personalized diabetes education could improve self-management. Diabetes education is a process to promote the knowledge and ability that are necessary for self-management. Multiple studies have found that (Eh et al., 2016; Ghisi et al., 2020; McElfish et al., 2020) diabetes self-management education was practical to improve physical and psychosocial outcomes and health behaviours. In this study, we used the Law of Learning to reinforce the educational content, which would help to reduce the loss of intervention effects after a short intervention period. However, in terms of exercise management and SMBG, both groups improved compared with the baseline, but the intergroup comparisons did not show statistical differences. Given that the baseline scores of the exercise management were already at a relatively high level, it left very little room for further improvements. Besides, both the hospital and the community are continually reinforcing the benefits of exercise for disease management, enhancing people's awareness of exercise. Compared with other dimensions, SMBG remained at a low level. Possibly that participants in the study did not have the time or forgot to measure their blood glucose, or that cost considerations prevented them from measuring blood glucose strictly as required. Consequently, researchers and clinicians may need to further explore the corresponding measures, for instance, inviting their families to assist in supervising and designing blood glucose monitoring check-in applets as reminders. In addition, the government could consider policies for glucose strips reimbursements.

TABLE 3 Comparisons of self-management behaviors and health locus of control by groups ($N = 109$)

Variables	Baseline Mean (*SD*)	4th week Mean (*SD*)	12th week Mean (*SD*)	Group main effect Wald χ^2 (*p*)	Time main effect Wald χ^2 (*p*)	Interaction effect Time × Group Wald χ^2 (*p*)
SDSCA						
Control	17.76 (3.61)	20.78 (3.37)[a]	18.64 (3.47)[b]	24.443 (<.001**)	104.060 (<.001**)	28.910 (<.001**)
Intervention	17.04 (3.22)	23.72 (3.77)[a]	23.12 (3.95)[a]			
t	1.097	−4.304	−6.293			
p	.275	<.001**	<.001**			
Dietary management						
Control	3.95 (0.77)	4.75 (0.90)[a]	4.36 (1.03)[a,b]	1.458 (.227)	127.444 (<.001**)	17.600 (<.001**)
Intervention	3.74 (0.86)	4.96 (1.08)[a]	4.89 (0.96)[a]			
t	1.371	−1.112	−2.809			
p	.173	.269	.006**			
Exercise management						
Control	4.30 (1.63)	4.81 (1.68)[a]	4.42 (1.61)[b]	0.079 (.779)	14.644 (.001**)	1.310 (.519)
Intervention	4.04 (1.63)	4.74 (1.68)[a]	4.53 (1.81)			
t	0.833	0.215	−0.336			
p	.407	.830	.737			
SMBG						
Control	1.78 (1.51)	2.59 (1.77)[a]	2.02 (1.54)[b]	3.579 (.059)	26.623 (<.001**)	2.812 (.245)
Intervention	1.83 (1.49)	3.16 (1.82)[a]	2.69 (1.70)[a,b]			
t	−0.172	−1.660	−2.161			
p	.864	.100	.033*			
Foot care						
Control	1.11 (1.10)	2.04 (1.44)[a]	1.47 (0.96)[a,b]	55.395 (<.001**)	139.994 (<.001**)	61.709 (<.001**)
Intervention	1.33 (0.91)	4.14 (2.23)[a]	4.21 (2.12)[a]			
t	−1.116	−5.825	−8.647			
p	.267	<.001**	<.001**			
Medication management						
Control	6.20 (0.96)	6.59 (0.63)[a]	6.37 (0.92)	2.554 (.110)	21.876 (<.001**)	6. 690 (.035*)
Intervention	6.20 (1.16)	6.73 (0.59)[a]	6.80 (0.52)[a]			
t	0.018	−1.151	−3.010			
p	.986	.252	.003**			
IHLC						
Control	24.33 (3.10)	23.54 (3.11)	22.50 (3.79)[a,b]	2.952 (.086)	9.226 (.010*)	21.824 (<.001**)
Intervention	23.78 (3.07)	25.11 (4.05)[a]	24.51 (4.02)			
t	0.934	−2.270	−2.684			
p	.353	.025*	.008**			
PHLC						
Control	24.69 (3.96)	23.31 (4.35)[a]	22.91 (3.99)[a]	0.441 (.506)	54.608 (<.001**)	3.185 (.203)
Intervention	24.89 (3.40)	22.84 (3.29)[a]	21.98 (3.17)[a,b]			
t	−0.291	0.649	1.344			
p	.771	.518	.182			
CHLC						
Control	14.48 (3.37)	14.46 (3.82)	14.33 (3.70)	0.303 (.582)	5.685 (.058)	3.809 (.149)
Intervention	14.84 (3.07)	13.85 (4.31)[a]	13.56 (3.94)[a]			
t	−0.575	0.779	1.052			
p	.567	.437	.295			

Abbreviations: CHLC, chance health locus of control; IHLC, internal health locus of control; PHLC, powerful others health locus of control; SDSCA, the Summary of Diabetes Self-care Activities; SMBG, self-monitoring of blood glucose.

*$p < .05$.

**$p < .01$.

[a]Compared with baseline, $p < .05$.

[b]Compared with 4th week, $p < .05$.

TABLE 4 Comparisons of HbA1c by groups ($N = 109$)

	Baseline Mean (*SD*)	12th week Mean (*SD*)	t	*p*
Control	9.11 (1.85)	7.74 (1.84)	4.825	<.001**
Intervention	8.93 (2.03)	6.83 (0.79)	7.398	<.001**
t	0.490	3.354		
p	.625	.001**		

Abbreviation: HbA1c, glycated haemoglobin.
**$p < .01$.

The results showed that the IHLC scores of the intervention group increased compared to baseline, while the control group had an opposite trend. The scores of PHLC in the two groups decreased significantly, whereas the difference between the two groups was not statistically significant. As for CHLC scores, the intervention group decreased over time, while the control group did not change significantly. The results were similar to Ebadi Fardaza's (Ebadi Fardaza et al., 2017), indicating that education based on HLC could increase the IHLC perception while reducing the CHLC perception in people with T2DM. HLC is an individual's perception of responsibility for behavioural outcomes. People who believe that health behaviours or results are determined by their abilities and efforts belong to IHLC. Those who choose to rely on authorities when facing health-related problems belong to PHLC. However, people with CHLC often attribute the behavioural consequences to chance and random events. They are more likely to believe in the role of fate rather than their efficacy or others' help (Rotter, 1966). The relationship between the HLC and the self-management among people with diabetes is attracting more attention (Ferrari et al., 2017; Reach et al., 2018; Zhu et al., 2020), and those with high IHLC tend to take proactive actions that are beneficial to health (Zhu et al., 2020). Given that, this study developed the HLCEP to identify the HLC perception of participants before education implementation and encouraged people to identify their strengths in diabetes management. Simultaneously, strengths-based languages were used during the whole education could let people focus on their strengths and stimulate their IHLC perception. Thus, a virtuous circle was formed between self-management and IHLC.

Our results found that this programme significantly reduced the HbA1c, similar to several systematic reviews related to diabetes education (Chrvalaa et al., 2016; Mohamed et al., 2019). Previous studies proved that the glycaemic control was closely associated with the effective self-management (D'Souza et al., 2017; Lin et al., 2017). This study adopted the education to enable participants to grasp diabetes-related knowledge, laid the foundation for the engagements of self-management and promote HbA1c at a safe level. However, several studies found that self-management education programme did not significantly reduce HbA1c (Cheng et al., 2018; Gamboa Moreno et al., 2019). In this study, the statistically significant reduction of HbA1c may be due to a virtuous cycle created by the personalized education based on HLC. The HLCEP focused on improving participants' confidence in diabetes management and providing positive feedback on stable glycaemic control. In addition, participants had elevated HbA1c at baseline, around 75 mmol/mol (9.0%); however, Gamboa Moreno et al. was about 53 mmol/mol (7.0%) (Gamboa Moreno et al., 2019), possibly leading to a more significant room for improvements. Additionally, participants in this study were hospitalized, most of whom were admitted due to elevated HbA1c. After experiencing the discomfort caused by hyperglycaemia and the professionals' guidance during hospitalization, they would attach more importance on glycaemic stability in a shorter period after discharge, therefore inducing a statistically significant reduction in HbA1c among the two groups.

The innovation of HLCEP was mainly reflected as follows. Firstly, the HLCEP integrated the strengths of the HLC theory and the Thorndike's Law of learning to maximize the educational effects. Secondly, during the personalized communication, we applied targeted instructions according to people's HLC characteristics to help people identify their strengths in diabetes management, stimulate or stabilize their perception of IHLC that also embodied the law of readiness. Thirdly, the group education consisted of three topics covering essential aspects of diabetes self-management, providing participants with knowledge and skills for self-management practice. Finally, the law of exercise and the law of effect served to deepen the participants' memory through continuous repetition of knowledge and positive feedback.

6.1 | Limitations

It should be noted that the following limitations on the interpretation of the results. Due to the single-centre, quasi-experimental study, the representation of samples and the conclusions' extrapolation would be limited. The effects might be exaggerated since self-reported instruments were used. Furthermore, the SDSCA was used to assess self-management activities in the past seven days, which would be influenced by memory bias. Ultimately, considering that the participants would have their HbA1c rechecked at 12th week after discharge. Thus, the follow-up lasted only 12 weeks. The long-term effects of the intervention need to be explored.

6.2 | Suggestions

In the future, qualitative methods can be considered into the personalized communication to explore more deeply the inner feelings of type 2 diabetes patients with different HLC. Moreover, more biomarkers (e.g. blood lipids and blood pressure) can be considered to be included to verify the effects of the intervention.

7 | CONCLUSION

The HLCEP improved self-management and IHLC of people with T2DM, and further reduced HbA1c. This programme can provide an empirical basis for innovating personalized education for T2DM and

for broadening the application of the theory of HLC and Thorndike's Law of Learning in clinical practice. However, the representation of subjects and the conclusions' extrapolation would be limited due to the single-centre study. The intervention's effects could be further verified through considering using multi-centre and multiple biomarkers in the future.

ACKNOWLEDGMENTS

The authors would like to thank all participants in this study for their friendly cooperation, and all staffs in the hospital for their assistance.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

AUTHOR CONTRIBUTIONS

LZ involved in conceptualization, data curation, formal analysis, methodology, software, validation, visualization and writing—original draft. QS involved in conceptualization, methodology, resources, supervision and writing—review and editing. YZ performed data curation, investigation, visualization and writing—review and editing. TM performed conceptualization, investigation, software and writing—review and editing. HL involved in validation, visualization and writing—review and editing. DK involved in investigation and writing—review and editing. SH validated, reviewed and edited. ML supervised, reviewed and edited.

ETHICAL APPROVAL

Research Ethics Committee approval was obtained by the Biomedical Ethics Committee of the Medical Department of Xi'an Jiaotong University (Approval number: 2020–1187) and registered in the Chinese Clinical Trial Registry (Identifier: ChiCTR2000032160). All participants signed informed consents, and the research process complied with the Declaration of Helsinki.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Lingxiao Zhu https://orcid.org/0000-0003-4148-4307

REFERENCES

Aga, F., Dunbar, S. B., Kebede, T., Higgins, M. K., & Gary, R. (2020). Relationships of diabetes self-care behaviours to glycaemic control in adults with type 2 diabetes and comorbid heart failure. *Nursing Open*, *7*(5), 1453–1467. https://doi.org/10.1002/nop2.517

Alyami, M., Serlachius, A., Mokhtar, I., & Broadbent, E. (2019). Illness perceptions, HbA1c, and adherence in type 2 diabetes in Saudi Arabia. *Patient Preference and Adherence*, *13*, 1839–1850. https://doi.org/10.2147/PPA.S228670

Aschner, P., Gagliardino, J. J., Ilkova, H., Lavalle, F., Ramachandran, A., Mbanya, J. C., Shestakova, M., Chantelot, J. M., & Chan, J. C. N. (2020). Persistent poor glycaemic control in individuals with type 2 diabetes in developing countries: 12 years of real-world evidence of the International Diabetes Management Practices Study (IDMPS). *Diabetologia*, *63*(4), 711–721. https://doi.org/10.1007/s00125-019-05078-3

Cheng, H., Yang, Y., & Yu, Q. (2019). Influence of PTP incentive mechanism based on Thorndike′s learning law on health psychological control source of COPD patients. *Journal of Qilu Nursing*, *25*(15), 33–36. https://doi.org/10.3969/j.issn.1006-7256.2019.15.010

Cheng, L., Sit, J. W. H., Choi, K. C., Chair, S. Y., Li, X., Wu, Y., Long, J., & Tao, M. (2018). Effectiveness of a patient-centred, empowerment-based intervention programme among patients with poorly controlled type 2 diabetes: A randomised controlled trial. *International Journal of Nursing Studies*, *79*, 43–51. https://doi.org/10.1016/j.ijnurstu.2017.10.021

Chrvalaa, C. A., Sherrb, D., & Lipmanb, R. D. (2016). Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. *Patient Education and Counseling*, *99*(6), 926–943. https://doi.org/10.1016/j.pec.2015.11.003

Dickinson, J. K., Guzman, S. J., Maryniuk, M. D., O'Brian, C. A., Kadohiro, J. K., Jackson, R. A., D'Hondt, N., Montgomery, B., Close, K. L., & Funnell, M. M. (2017). The use of language in diabetes care and education. *Diabetes Care*, *40*(12), 1790–1799. https://doi.org/10.2337/dci17-0041

D'Souza, M. S., Karkada, S. N., Parahoo, K., Venkatesaperumal, R., Achora, S., & Cayaban, A. R. R. (2017). Self-efficacy and self-care behaviours among adults with type 2 diabetes. *Applied Nursing Research*, *36*, 25–32. https://doi.org/10.1016/j.apnr.2017.05.004

Ebadi Fardaza, F., Heidari, H., & Solhi, M. (2017). Effect of educational intervention based on locus of control structure of attribution theory on self-care behavior of patients with type II diabetes. *Medical Journal of the Islamic Republic of Iran*, *31*, 116–121. https://doi.org/10.14196/mjiri.31.116

Eh, K., McGill, M., Wong, J., & Krass, I. (2016). Cultural issues and other factors that affect self-management of Type 2 Diabetes Mellitus (T2D) by Chinese immigrants in Australia. *Diabetes Research and Clinical Practice*, *119*, 97–105. https://doi.org/10.1016/j.diabres.2016.07.006

Ferrari, M., Dal Cin, M., & Steele, M. (2017). Self-compassion is associated with optimum self-care behaviour, medical outcomes and psychological well-being in a cross-sectional sample of adults with diabetes. *Diabetic Medicine*, *34*(11), 1546–1553. https://doi.org/10.1111/dme.13451

Gamboa Moreno, E., Mateo-Abad, M., Ochoa de Retana García, L., Vrotsou, K., del Campo Pena, E., Sánchez Perez, Á., Martínez Carazo, C., Arbonies Ortiz, J. C., Rúa Portu, M. Á., Piñera Elorriaga, K., Zenarutzabeitia Pikatza, A., Urquiza Bengoa, M. N., Méndez Sanpedro, T., Oses Portu, A., Aguirre Sorondo, M. B., & Rotaeche del Campo, R.; Osakidetza Active Patient Research Group (2019). Efficacy of a self-management education programme on patients with type 2 diabetes in primary care: A randomised controlled trial. *Primary Care Diabetes*, *13*(2), 122–133. https://doi.org/10.1016/j.pcd.2018.10.001

Ghisi, G. L. M., Aultman, C., Konidis, R., Foster, E., Tahsinul, A., Sandison, N., Sarin, M., & Oh, P. (2020). Effectiveness of an education intervention associated with an exercise program in improving disease-related knowledge and health behaviours among diabetes patients. *Patient Education and Counseling*, *103*(9), 1790–1797. https://doi.org/10.1016/j.pec.2020.04.007

Hua, L., & Zhu, W. (2014). Verification of the reliability and validity of Chinese version of diabetes self-management activities questionnaire. *Nursing Journal of Chinese People's Liberation Army*, *31*(16), 5–8. https://doi.org/10.3969/j.issn.1008-9993.2014.16.002

International Diabetes Federation (2017). *IDF diabetes atlas* (8th ed). Retrieved from: https://www.diabetesatlas.org/upload/resources/previous/files/8/IDF_DA_8e-ZH-final.pdf Accessed December 15, 2020.

International Diabetes Federation (2019). *IDF diabetes atlas* (9th ed). Retrieved from: https://www.diabetesatlas.org/upload/resources/

material/20200302_133351_IDFATLAS9e-final-web.pdf Accessed December 15, 2020

Klinovszky, A., Kiss, I. M., Papp-Zipernovszky, O., Lengyel, C., & Buzas, N. (2019). Associations of different adherences in patients with type 2 diabetes mellitus. *Patient Preference and Adherence*, *13*, 395–407. https://doi.org/10.2147/PPA.S187080

Laxy, M., Mielck, A., Hunger, M., Schunk, M., Meisinger, C., Ruckert, I. M., Rathmann, W., & Holle, R. (2014). The association between patient-reported self-management behavior, intermediate clinical outcomes, and mortality in patients with type 2 diabetes: Results from the KORA-A study. *Diabetes Care*, *37*(6), 1604–1612. https://doi.org/10.2337/dc13-2533

Li, H., Ji, M., Scott, P., & Dunbar-Jacob, J. M. (2019). The effect of symptom clusters on quality of life among patients with type 2 diabetes. *The Diabetes Educator*, *45*(3), 287–294. https://doi.org/10.1177/0145721719837902

Li, L. (2018). *Intervention effect of self-management behavior on different personality traits in patients with type 2 diabetes mellitus*. Shanxi Medical University.

Lin, K., Park, C., Li, M., Wang, X., Li, X., Li, W., & Quinn, L. (2017). Effects of depression, diabetes distress, diabetes self-efficacy, and diabetes self-management on glycemic control among Chinese population with type 2 diabetes mellitus. *Diabetes Research and Clinical Practice*, *131*, 179–186. https://doi.org/10.1016/j.diabres.2017.03.013

Lui, K. J., & Cumberland, W. G. (1992). Sample size requirement for repeated measurements in continuous data. *Statistics in Medicine*, *11*, 633–641. https://doi.org/10.1002/sim.4780110508

Mannucci, E., Monami, M., Dicembrini, I., Piselli, A., & Porta, M. (2014). Achieving HbA1c targets in clinical trials and in the real world: A systematic review and meta-analysis. *Journal of Endocrinological Investigation*, *37*(5), 477–495. https://doi.org/10.1007/s40618-014-0069-6

McElfish, P. A., Long, C. R., Bursac, Z., Scott, A. J., Felix, H. C., Schulz, T. K., Worley, M. A., & Rowland, B. (2020). Diabetes self-management education exposure and glycated haemoglobin levels among Marshallese participants in a randomized controlled study. *Diabetic Medicine*, *37*(2), 319–325. https://doi.org/10.1111/dme.14189

Mohamed, A., Staite, E., Ismail, K., & Winkley, K. (2019). A systematic review of diabetes self-management education interventions for people with type 2 diabetes mellitus in the Asian Western Pacific (AWP) region. *Nursing Open*, *6*(4), 1424–1437. https://doi.org/10.1002/nop2.340

Nejhaddadgar, N., Darabi, F., Rohban, A., Solhi, M., & Kheire, M. (2019). The effectiveness of self-management program for people with type 2 diabetes mellitus based on PRECEDE-PROCEDE model. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *13*(1), 440–443. https://doi.org/10.1016/j.dsx.2018.08.016

Nugent, L. E., Carson, M., Zammitt, N. N., Smith, G. D., & Wallston, K. A. (2015). Health value & perceived control over health: Behavioural constructs to support Type 2 diabetes self-management in clinical practice. *Journal of Clinical Nursing*, *24*(15–16), 2201–2210. https://doi.org/10.1111/jocn.12878

O'Hea, E. L., Grothe, K. B., Bodenlos, J. S., Boudreaux, E. D., White, M. A., & Brantley, P. J. (2005). Predicting medical regimen adherence: The interactions of health locus of control beliefs. *Journal of Health Psychology*, *10*(5), 705–717. https://doi.org/10.1177/1359105305055330

Peng, W., Zhang, C., Luo, H., & Zeng, Y. (2019). Effect of self-management plan based on the empowerment education model on diabetic patients with poor glycemic control. *Nursing Journal of Chinese People's Liberation Army*, *36*, 25–28. https://doi.org/10.3969/j.issn.1008-9993.2019.04.006

Powers, M. A., Bardsley, J. K., Cypress, M., Funnell, M. M., Harms, D., Hess-Fischl, A., Hooks, B., Isaacs, D., Mandel, E. D., Maryniuk, M. D., Norton, A., Rinker, J., Siminerio, L. M., & Uelmen, S. (2020). Diabetes self-management education and support in adults with type 2 diabetes: A Consensus Report of the American Diabetes Association, the Association of Diabetes Care & Education Specialists, the Academy of Nutrition and Dietetics, the American Academy of Family Physicians, the American Academy of PAs, the American Association of Nurse Practitioners, and the American Pharmacists Association. *Diabetes Care*, *43*, 1636–1649. https://doi.org/10.1177/0145721720930959

Reach, G., Pellan, M., Crine, A., Touboul, C., Ciocca, A., & Djoudi, Y. (2018). Holistic psychosocial determinants of adherence to medication in people with type 2 diabetes. *Diabetes & Metabolism*, *44*(6), 500–507. https://doi.org/10.1016/j.diabet.2018.06.001

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied*, *80*(1), 1–28. https://doi.org/10.1037/h0092976

Toobert, D. J., Hampson, S. E., & Glasgow, R. E. (2000). The summary of diabetes self-care activities measure. *Diabetes Care*, *23*(7), 943–950. https://doi.org/10.2337/diacare.23.7.943

Wallston, K. A., Wallston, B. S., & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) scales. *Health Education Monographs*, *6*(1), 160–170. https://doi.org/10.1177/109019817800600107

Wang, X., Wang, X., & Ma, H. (1999). Manual of mental health rating scale (Supplement). *Chinese Mental Health Journal*, *12*, 329–332.

WHO (2020). *World Health Statistics 2020: Monitoring health for the SDGs*. Retrieved from: ; https://www.diabetesatlas.org/upload/resources/previous/files/8/IDF_DA_8e-ZH-final.pdfhttps://www.who.int/gho/publications/world_health¬_statistics/2020/en/ Accessed December 15, 2020

Yao, J., Wang, H., Yin, X., Yin, J., Guo, X., & Sun, Q. (2019). The association between self-efficacy and self-management behaviors among Chinese patients with type 2 diabetes. *PLoS One*, *14*(11), e0224869. https://doi.org/10.1371/journal.pone.0224869

Zhou, X., Shrestha, S. S., Shao, H., & Zhang, P. (2020). Factors contributing to the rising national cost of glucose-lowering medicines for diabetes during 2005–2007 and 2015–2017. *Diabetes Care*, *43*(10), 2396–2402. https://doi.org/10.2337/dc19-2273

Zhu, L., Shi, Q., & Ma, T. (2020). Research progress on self-management and locus of control in patients with type 2 diabetes mellitus. *Chinese Nursing Research*, *34*(2), 283–287. https://doi.org/10.12102/j.issn.1009-6493.2020.02.020

How to cite this article: Zhu, L., Shi, Q., Zeng, Y., Ma, T., Li, H., Kuerban, D., Hamal, S., & Li, M. (2022). Use of health locus of control on self-management and HbA1c in patients with type 2 diabetes. *Nursing Open*, 9, 1028–1039. https://doi.org/10.1002/nop2.1140