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Original Article

Effectiveness of a Health Belief Model-based Educational Intervention on Treatment Adherence Among Type 2 Diabetic Patients: Insights from a Randomized Controlled Trial in Iran

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Abstract

Background: Diabetes is a significant and costly health problem worldwide, requiring effective interventions to improve adherence. The aim of this study was to increase treatment adherence in patients with type 2 diabetes using constructs from the Health Belief Model (HBM).

Methods: An educational intervention consisting of four sessions was conducted on 100 patients with type 2 diabetes referred to the Diabetes Clinic affiliated with the Social Security Organization in Mobarakeh, Isfahan province, Iran. The mean difference before and after the intervention in HBM constructs and self-efficacy activities was compared using independent *t*-tests. The association between self-care behaviors before and after the educational intervention in both groups and the expected value of a part of the HBM was examined using linear regression. The threshold for statistical significance was $P<0.05$.

Results: After the intervention, the mean difference scores for all components of the HBM and self-efficacy increased significantly in the intervention group. In linear regression analysis, perceived vulnerability was the only variable that showed a direct and significant relationship with self-care in the intervention group.

Conclusion: The results of the study suggest that patient education improved all HBM constructs related to treatment adherence. This underscores the importance and effectiveness of self-care education in controlling blood glucose levels in diabetic patients.

Keywords: Treatment adherence, Health belief model, Educational intervention, Type 2 diabetes mellitus

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Introduction

Diabetes is a significant and costly health problem that affects all age groups worldwide. The prevalence of diabetes is increasing rapidly (1). It currently affects more than 423 million people (8.5% of the world's population) and is predicted to rise to 522 million by 2030, with over 70% of cases occurring in developing countries (2,3). Lifestyle changes such as poor diet, lack of exercise, obesity, and stress associated with urbanization and industrialization are the causes of this increase (4). Diabetes is caused by a mixture of genetic and metabolic factors, ethnicity, family history, pregnancies with diabetes, aging, obesity, poor diet, lack of exercise, and smoking (3,4). Urbanization, mechanization, and industrialization also play a role in the increase in the incidence of the disease (1). Diabetes imposes a considerable economic burden on patients and healthcare systems (4,5).

Diabetes, which occurs due to insufficient insulin production or insulin resistance in the body, disrupts carbohydrate, protein, and fat metabolism and leads to serious complications such as kidney failure, amputations, cardiovascular disease, stroke, and neuropathy (1,4). Most diabetes-related deaths occur before the age of 70, which can be mitigated by a supportive environment for lifestyle changes (1,3).

In type 2 diabetes, treatment includes optimal management of blood glucose, blood lipids, and blood pressure to prevent complications. Treatment includes a controlled diet, exercise, blood glucose control, medication, and education (2,3). Failure to adhere to treatment plans for chronic diseases such as diabetes leads to deteriorating health and economic burdens. Patient's adherence to treatment is critical in type 2 diabetes (6).

Adherence to treatment for chronic diseases is a complex behavioral process that is influenced by health status, socioeconomic factors, individual characteristics, doctor-patient relationships, and the healthcare system (6,7). Understanding these factors in patients with type 2 diabetes remains a challenge (7,8). While treatment recommendations are important, barriers such as lack of awareness and the complexity of treatment hinder adherence (9).

For diabetics, education is as important as medication, exercise, and diet. Patients need to understand their disease and take proactive steps towards effective treatment. Diabetic health education should utilize a variety of models to improve awareness, skills, values, and decision-making (10). Models such as the Health Belief Model (HBM) help develop interventions that promote treatment adherence by linking beliefs to behaviors (11).

The HBM has been used extensively to understand health behaviors and provide guidance for designing interventions to improve health behaviors. HBM theory comprises six constructs: perceived susceptibility, perceived severity, perceived benefit, perceived barrier, cues to action, and self-efficacy (belief in one's own abilities). The constructs' perceived susceptibility and perceived severity are basically an assessment of the threat associated with susceptibility to a disease and the potential severity or seriousness of the disease due to maintaining certain behaviors. Perceived benefit refers to an assessment of the benefits that are useful in preventing the consequences. Perceived barriers can be interpreted to mean that the perception of obstacles to changing behavior can hinder the implementation of actions to change. The cues to action are triggers that prompt individuals to take action. Self-efficacy is the confidence that one is able to perform certain actions (11,12).

Research on treatment adherence in diabetics is critical because diabetes is a silent but deadly disease (2). Non-compliance with medication can lead to elevated blood glucose levels, causing complications such as damage to blood vessels and nerves, affecting quality of life, and increasing mortality (3). This study examined the impact of an educational intervention based on the HBM on treatment adherence.

Materials and Methods

Study Design

The present study was a randomized controlled clinical trial conducted from September 2019 to June 2020 among patients with type 2 diabetes who were referred to the Diabetic Clinic in Mobarakeh County, Isfahan province, Iran.

Participants

The participants were selected using a systematic random sampling approach. In order to ensure a representative sample, the following procedure was followed. The sampling frame was created by compiling a list of all type 2 diabetes patients referred to the Diabetes Clinic in Mobarakeh county, Isfahan province, Iran. To determine the sampling interval, the total number of patients on the list was divided by the desired sample size. A random starting point was selected by choosing a random number between one and the sampling interval. This starting point served as the first participant included in the sample. After the random start, every nth patient on the list is included in the sample, where "n" is the predetermined sampling interval. This systematic approach ensured that the sample was drawn evenly across the entire list, thereby reducing potential bias. Once the participants were selected, they were randomly assigned to either the intervention or control group through a random allocation process. This ensured that each group had a similar distribution of characteristics and potential confounding factors. A systematic random sampling method was employed to increase the likelihood that the selected participants were representative of a larger population of patients with type 2 diabetes referred to the clinic. Finally, a total of 86 patients participated in the study and were randomly divided into two intervention groups (46 people) and a control group (42 people). This approach aimed to enhance the generalizability of the study findings and minimize selection bias.

Inclusion Criteria

The inclusion criteria were being 25–70 years old, being diagnosed with type 2 diabetes, receiving treatment in a diabetes clinic, having the ability to participate in educational sessions, having mental capacity, giving informed and voluntary consent to participate in the study, duration of diabetes of at least 6 months, not having diabetes complications or physical activity limitations, and availability for follow-up.

Exclusion Criteria

Patients diagnosed with type 1 diabetes who had missed two or more sessions of the education program, were cognitively impaired, had severe medical problems, were unable to attend the sessions, were pregnant, experienced emotional stress during the intervention (e.g., death of loved ones), and participated in other interventions were excluded from the study.

Data Collection

The research instrument included four sections to collect demographic data (age, sex, stage of disease, duration of disease, education level, marital status, employment status, economic status, etc), as well as measurements of weight, height, waist circumference, blood pressure, and metabolic parameters, and a valid and reliable researcher-designed questionnaire based on the HBM, Morisky Medication Adherence Scale, and Summary of Diabetes Self-Care Activities (SDSCA).

The 8-question Morisky Medication Adherence Scale was designed and developed to measure medication adherence. This questionnaire consisted of eight questions and was based on a Likert scale (never = 0, rarely = 1, sometimes = 2, often = 3, and always = 4). A person who received a score of 6 or above indicated that they were adherent to treatment. In the study by Dianti et al, its validity and reliability were confirmed using Cronbach's alpha coefficient (7).

The SDSCA developed by Tobert et al was used to assess patient self-care. This scale is a 15-question self-assessment questionnaire that examines patients' self-care over the last seven days and covers various aspects of diabetes management. Questions 1 to 5 are on general diet and specific diabetes diet, questions 6 and 7 on physical activity, questions 8 and 9 on blood glucose monitoring, question 10 on insulin injection or antidiabetic tablets, questions 11 to 14 on foot care, and question 15 on smoking. On this scale, except for smoking behavior, which is scored from 0 to 1, each behavior is given a score from zero to seven, and the total adherence score is calculated by adding the scores of the individual questions. The total score on the scale ranged from 0 to 99. In the study by Hamadzadeh et al, the reliability of the questionnaire was examined using Cronbach's alpha coefficient, which yielded a value of 0.78 (13).

A researcher-designed questionnaire was used to measure the HBM constructs. The model included 10 questions on the knowledge domain, 14 questions on perceived susceptibility, 5 questions on perceived severity, 6 questions on perceived benefits, 14 questions on perceived barriers, and 7 questions on cues to action.

The answers to the questions were "strongly agree", "agree", "have no opinion", "disagree", and "strongly disagree". The evaluation was conducted on a scale of 1 to 5. The minimum and maximum scores on the question section of the HBM constructs were different. The total score was calculated to be 100 points. The validity of the questionnaire was confirmed by a panel of experts consisting of one endocrinologist, three general practitioners, one nutritionist, and one epidemiologist. The reliability of the questions was confirmed with a Cronbach's alpha coefficient of 0.71 (CVR: 0.78, CVI: 0.76).

Educational Intervention

A multidisciplinary team comprising a researcher, a doctor from the diabetes clinic, a dietitian, and a patient with effectively controlled diabetes collaborated to design and conduct the educational intervention. The intervention aimed to empower participants with essential knowledge and skills for effective type 2 diabetes management.

The intervention spanned four one-hour sessions conducted once a week over the course of a month. Each session was meticulously structured to address key aspects of diabetes self-care.

Blood glucose management: The inaugural session guided the participants on proper blood glucose testing techniques and underscored the criticality of consistent blood glucose monitoring.

Medication adherence: The second session delved into the correct use of medications, potential complications, and strategies to overcome barriers hindering drug adherence.

Dietary compliance: In the third session, participants explored the benefits and challenges of dietary compliance, along with practical guidance on making informed dietary choices.

Physical activity: The final session centered on the repercussions of inadequate physical activity and elucidated the recommended types and amounts of exercise.

The intervention sessions employed an array of interactive teaching techniques to foster participants' engagement and understanding. Attendees actively participated in lectures, engaged in insightful question-and-answer sessions, collaboratively discussed challenges and solutions in group interactions, and benefited from visual aids, such as slideshows, films, and whiteboards. Importantly, the involvement of a patient with firsthand experience of effectively managing diabetes provided a valuable perspective to the intervention.

The comprehensive intervention approach aimed to equip participants with actionable insights and skills, empowering them to confidently navigate the intricacies of type 2 diabetes management.

Statistical Analysis

The collected data were examined for eligibility, and a statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 26.0 to examine the effects of the educational intervention and correlations between key variables.

Methods included comparing mean variances before and after the intervention using t-tests, comparing serological indices between the intervention and control groups, and assessing relationships using linear regression. Statistical significance was set at $P < 0.05$.

Results

This study aimed to investigate the effects of a training intervention based on the HBM on treatment adherence and self-care behavior of patients with diabetes. Table 1 presents the demographic characteristics. Accordingly, patients in both the control and intervention groups were between 37 and 70 years of age, and over 80% of them were married. The prevalence of cigarette smoking among the participants was approximately 14%, and 80% had underlying diseases. A considerable proportion of participants had low literacy levels and belonged to the low-income category.

Table 1 shows the demographic characteristics of the control and intervention groups before the intervention. The data showed a comparable distribution of various demographic variables between the two groups. No significant differences were found between the intervention and control groups with regard to

Table 1. Demographic Characteristics Between the Control and Intervention Groups before the Educational Intervention

Variable	Intervention group (n=44)	Control group (n=42)	*P* Value
	No. (%)	No. (%)	
Gender			
Male	20 (45.5)	19 (45.2)	0.98
Female	24 (54.5)	23 (54.8)	
Marital status			
Married	39 (88.6)	35 (83.3)	0.48
Single	3 (6.8)	3 (7.1)	
Widowed	2 (4.6)	4 (9.6)	
Cigarette smoking			
Yes	6 (13.6)	6 (14.3)	0.93
No	38 (86.4)	36 (85.7)	
Job			
Employee	3 (6.8)	9 (21.4)	0.12
Self-employment	11 (25.0)	7 (16.7)	
Housewife	22 (50.0)	21 (50.0)	
Retired	8 (18.2)	5 (11.9)	
Education			
Illiterate	18 (40.9)	18 (42.9)	0.94
Elementary	13 (29.5)	14 (33.3)	
Middle school and high school	9 (20.5)	7 (16.7)	
Collegiate	4 (9.1)	3 (7.1)	
Income			
Low	21 (47.7)	17 (40.5)	0.44
Medium	18 (40.9)	16 (38.1)	
Good	5 (11.4)	9 (21.4)	
Living status			
With family	42 (95.5)	38 (90.5)	0.43
Alone	2 (4.5)	4 (9.5)	
Number of children			
3 children or fewer	17 (38.6)	18 (42.8)	0.69
More than 3 children	27 (61.4)	24 (57.2)	
Underlying disease			
No	7 (15.8)	8 (19.0)	0.32
Hypertension	15 (34.1)	10 (23.8)	
Dyslipidemia	9 (20.5)	4 (9.5)	
Hypertension and dyslipidemia	9 (20.5)	12 (28.6)	
Other diseases	4 (9.1)	8 (19.1)	
	Mean ± SD	Mean ± SD	
Age	57.9 ± 8.7	57.2 ± 10.2	0.75
Duration of diabetes	7.8 ± 5.0	10.0 ± 6.9	0.09
Body Mass Index	25.6 ± 3.0	27.1 ± 3.9	0.06
Systolic blood pressure	12.6 ± 1.2	12.4 ± 1.1	0.47
Diastolic blood pressure	8.0 ± 1.0	7.8 ± 1.0	0.27
Fasting blood sugar	144.5 ± 51.8	141.6 ± 33.6	0.76
Glycosylated hemoglobin	7.3 ± 1.9	7.1 ± 1.0	0.63
Total cholesterol	157.9 ± 33.7	161.0 ± 32.4	0.66
Triglycerides	177.6 ± 47.1	177.2 ± 40.9	0.96
Low-density lipoprotein	156.6 ± 33.9	162.3 ± 26.6	0.40
High-density lipoprotein	44.5 ± 13.2	44.7 ± 12.3	0.95

demographic variables such as gender, marital status, cigarette consumption, occupation, education level, income level, housing situation, number of children, and underlying diseases ($P > 0.05$).

Table 2 compares the changes in the mean values of the constructs of the HBM and self-efficacy between the pre- and post-intervention phases in the control and intervention groups. After the intervention, the intervention group showed significant increases in scores for all constructs and self-efficacy measures, whereas the control group showed minimal increases or even decreases in some aspects. These differences in the changes between the intervention and control groups were statistically significant for all dimensions ($P < 0.05$), indicating the effectiveness of the educational intervention in strengthening participants' health beliefs and self-efficacy.

The effect sizes (Cohen's d) further illustrate the practical significance of the observed changes, with moderate-to-large effect sizes observed for the various constructs. This suggests that the educational intervention had a significant impact on participants' perceptions and self-efficacy in relation to diabetes management.

Table 3 shows the results of the linear regression analysis examining the predictive value of the HBM constructs for self-care behavior prior to the educational intervention in both the intervention and control groups.

Before the intervention, the analysis revealed no significant relationships between any of the HBM constructs and self-care behaviors in either group ($P > 0.05$). However, in the post-intervention phase, perceived susceptibility emerged as the only significant predictor of self-care behavior in the intervention group (B = 2.21, CI = 0.4-21.21, $P = 0.03$).

In the intervention group, the R^2 value was 0.15 with a *P* value of 0.369, indicating that the HBM constructs together explained 15% of the variance in self-care behavior after the intervention. In contrast, the R^2 value in the control group was 0.32 with a *P* value of 0.027, indicating that the HBM constructs explained 32% of the variance in self-nurturing behavior after the intervention.

Table 4 shows the results of the linear regression analysis examining the predictive value of the HBM constructs for self-care behavior after the educational intervention in both the intervention and control groups. In the intervention group, the analysis revealed a significant relationship between perceived sensitivity and post-intervention self-care behavior (B = 2.21, CI = 0.21-4.21, $P = 0.031$). The R^2 value for the intervention group was 0.56 with a *P* value of 0.023, indicating that the HBM constructs together explained 56% of the variance in post-intervention self-care behavior. In contrast, none of the HBM constructs showed a significant relationship with self-care behavior in the control group. The R^2 value for the control group was 0.33 with a *P* value of 0.645, indicating that the HBM constructs in this group did not explain a significant proportion of the variance in post-

Table 2. Comparison of Changes in the Scores of HBM Constructs and Self-efficacy Activities Before and After the Intervention between Study Groups

	Intervention Group	Control Group	*P* Value	Cohen's d
	Mean Difference (SD)	Mean Difference (SD)		
Knowledge	22.4 (7.0)	-0.3 (3.6)	<0.001	3.20
Perceived susceptibility	45.8 (12.7)	6.9 (18.7)	<0.001	3.61
Perceived severity	12.3 (5.4)	5.9 (6.2)	<0.001	2.23
Perceived benefits	19.6 (8.4)	1.0 (7.6)	<0.001	2.33
Perceived barriers	40.9 (14.4)	-0.1 (25.1)	<0.001	2.84
Cues to action	16.7 (7.9)	4.0 (6.7)	<0.001	2.11
Self-efficacy	12.1 (19.1)	-6.3 (20.5)	<0.001	.63

Table 3. The Results of a Linear Regression Model to Determine Predictive Value of HBM Constructs for Self-care Behaviors before Educational Intervention

Health Belief Model Constructs	Intervention group			Control group		
	Regression Coefficient	95% CI	*P* Value	Regression Coefficient	95% CI	*P* Value
Knowledge	-0.28	(-0.82-.27)	0.310	0.37	(-0.53-1.26)	0.410
Perceived susceptibility	-0.42	(-1.12-.28)	0.2311	0.10	(-0.5-0.71)	0.726
Perceived severity	1.12	(-.47-2.71)	0.161	-1.09	(-2.45-0.26)	0.110
Perceived benefits	0.73	(-0.56-2.02)	0.260	0.71	(-0.56-1.97)	0.265
Perceived barriers	-0.53	(-1.37-0.31)	0.211	-0.31	(-0.64-0.03)	0.074
Cues to action	-0.04	(-1.08-0.01)	0.940	-0.12	(-1.03-0.79)	0.789

In the intervention group, R2 = 0.15 and *P* value = 0.369. In the control group, R2 = 0.32 and *P* value = 0.027 .

Table 4. The Results of a Linear Regression Model to Determine Predictive Value of HBM Constructs for Self-care Behaviors after Educational Intervention

HBM Constructs	Intervention group			Control group		
	Regression Coefficient	95% CI	*P* Value	Regression Coefficient	95% CI	*P* Value
Knowledge	0.57	(-2.49-3.64)	0.707	0.72	(-1.16-2.61)	0.439
Perceived susceptibility	2.21	(0.21-4.21)	0.031	0.29	(-0.20-0.79)	0.232
Perceived severity	1.55	(-2.38-5.49)	0.429	-0.83	(-5.61-3.94)	0.726
Perceived benefits	-0.37	(-3.24-2.50)	0.796	-0.04	(-1.05-0.96)	0.928
Perceived barriers	0.35	(-1.99-2.71)	0.761	-0.16	(-1.32-0.99)	0.774
Cues to action	0.57	(-2.25-3.40)	0.683	0.15	(-3.01-3.39)	0.926

In the intervention group, R2 = 0.56 and *P* value = 0.023. In the control group, R2 = 0.33 and *P* value = 0.645.

intervention self-care behavior.

These results indicate that the educational intervention based on HBM constructs was effective in improving self-care behavior and adherence to treatment among diabetic patients in the intervention group. In particular, the perception of susceptibility to the disease plays a crucial role in motivating positive self-care behavior. In contrast, there were no significant improvements in self-care behavior in the control group, and none of the HBM constructs were predictive of behavioral changes in this group.

Discussion

Diabetes is a chronic disease that affects all aspects of a person's life, and its control requires fundamental changes in the patient's lifestyle. Considering the high prevalence of diabetes in Iran and the role of education in improving patients' lifestyle to control the disease and reduce its significant complications, as well as its positive impact on economic capital and human resources, the present study aimed to determine the effect of an educational intervention based on HBM on treatment compliance in patients with type 2 diabetes. The results showed that patient education improved the scores on all components of the HBM and self-efficacy in treatment adherence, indicating the positive effects of education.

The results showed that both groups had an average level of knowledge about diabetes before the educational intervention, which is consistent with previous studies indicating an average level of knowledge among diabetes patients. Interestingly, the control group initially had a significantly higher level of knowledge than the intervention group. However, after the educational intervention, the score of the control group stagnated, whereas the score of the intervention group increased significantly and surpassed that of the control group. This underlines the effectiveness of educational measures in improving patients' level of knowledge.

The significant difference observed between the groups after the intervention in terms of knowledge level is consistent with the results of the studies by Ahmed (14), Sharifirad et al (15), and Fani et al (16). This consistency between the results of different studies reinforces the idea that targeted educational interventions can have a positive impact on patients' knowledge. In contrast, Sadeghi et al (17) reported contrasting results, showing a significant increase in awareness levels in both groups after a 3-month intervention. These different results require further investigation and could possibly be due to differences in intervention strategies, duration, or patient demographics in the different studies. In interpreting these differences and similarities, it is important to examine the theoretical underpinnings of health education and behavior change. By drawing on established theories, such as the HBM or Social Cognitive Theory, we can gain deeper insights into the mechanisms by which educational interventions influence patient knowledge and behavior. These theoretical frameworks provide a solid foundation for understanding the complexity of health education interventions and can inform the design and implementation of future interventions tailored to specific patient groups.

The analysis of the data from the pre-test phase showed that in the intervention group, the values for the patients' perceived susceptibility to treatment adherence were below the average value and thus significantly lower compared to the control group. A plausible explanation for this result could be the random differences between the groups, possibly amplified by a higher infection rate in the control group. In the post-test phase, the scores increased in both groups, but the increase was significantly greater in the intervention group than in the control group. Consequently, in the post-test phase, the scores of patients in the intervention group were significantly higher than those in the control group. These results are consistent with the findings of studies by Daniel and Maser in Colombia (18), Shamsi et al in Isfahan (19), Asadzandi et al in Tehran (20), Sharifirad et al in Kermanshah (15), Farsi et al (21), and Tavafian et al in Bandar Abbas (22). These studies reported an increase in perceived susceptibility scores in patients with type 2 diabetes after education, reflecting our findings. Interpreting these results in the context of a theoretical framework, such as the HBM, may deepen our understanding of the observed patterns. According to this model, perception of individual susceptibility to a disease plays a crucial role in the adoption of preventive measures. Therefore, the significant increase in perceived susceptibility scores among patients in the intervention group suggests that the educational intervention was effective in influencing their perception of the risks associated with diabetes and motivating them to take proactive measures to manage their condition. In addition, consideration of the sociocultural factors that influence health beliefs and behaviors can provide further insights. By addressing cultural beliefs and norms through culturally tailored interventions, healthcare providers can improve the effectiveness of educational programs and promote positive health outcomes in diverse patient populations.

The results of the data analysis showed that the score of the construct of perceived severity in the pre-test phase was similar in both the intervention and control groups, which was below the average score. After the educational intervention, the scores increased in both groups, with a significantly greater increase in the intervention group than in the control group. This significant increase in the perceived severity score suggests that patients in the intervention group developed a deeper understanding of the risks associated with the disease and the severity of its complications in various dimensions, including physical, psychological, social, and economic. Perception of the severity of the disease influences the motivation of the individual to adopt health-promoting behaviors. The significant increase in perceived severity scores among patients in the intervention group indicated that the educational intervention effectively raised their awareness of the severity of diabetes and its potential consequences. This increased awareness likely contributed to their willingness to take preventative measures and adhere to treatment plans, ultimately leading to improved health outcomes.

Furthermore, the consistency of these findings with previous research by Fani et al (16), Farahani Dastjani et al (23), and Daniel and Maser in Colombia (18) underscores the robustness of our results. These studies also reported an increase in perceived severity scores following diabetes education interventions, further supporting the effectiveness of educational interventions in improving patients' perceptions of disease severity.

The results of our study showed that before the intervention, the control group had a higher score on the construct of perceived benefit of treatment adherence than the intervention group, and this difference was statistically significant. However, after the intervention, the score in the control group remained unchanged, whereas the score in the intervention group increased significantly. This difference in perceived benefits emphasizes the importance of understanding the benefits of following treatment recommendations as this influences an individual's willingness to take preventative measures or treat their disease effectively. Additionally, patients in the intervention group received greater benefits from following the recommendations, leading to a healthier lifestyle and a more positive attitude towards disease management. People are more willing to engage in health-promoting behaviors if they believe that they will benefit from them. Therefore, the observed increase in perceived benefit among patients in the intervention group indicates the effectiveness of the educational intervention in improving patients' understanding of the benefits of adhering to treatment regimens.

Furthermore, the consistency of our results with previous studies by Sharifirad et al (15), Seddiq et al (24), Farahani Dastjani et al (23), and Shamsi et al (19) supports the robustness of our results. These studies also reported significant increases in the perceived benefit scores following educational interventions targeting different health conditions. However, it is worth noting that the results of the study by Farsi et al (21) are not consistent with our results, as they found no significant difference in perceived benefit scores between the intervention and control groups. This discrepancy could be due to differences in the provision of educational material during the interventions or variations in the administration of the questionnaire. In addition, differences in the characteristics of the study populations, such as the severity of illness, could also have contributed to these divergent results. For example, while Farsi et al studied inpatients, our study focused on individuals who regularly visit diabetes centers, where disease severity may influence perceptions of treatment benefits.

The results of our study showed that the perceived barriers to treatment adherence were very different between the intervention and control groups before the educational intervention was implemented, with the control group having significantly higher levels. However, after the educational intervention, the perceived barrier score increased significantly in the intervention group, while it remained unchanged in the control group. People are less likely to participate in the recommended health interventions if they perceive significant obstacles or barriers. Therefore, the observed increase in perceived barrier scores among patients in the intervention group suggests that the educational intervention may have increased patients' awareness of potential barriers to treatment adherence. In contrast to our findings, previous studies have reported a decrease in perceived barriers following similar educational interventions (15,16,21). This discrepancy could be due to the different methods of data collection, particularly self-report and questionnaire completion. In addition, differences in the characteristics of the patient populations studied could also have contributed to these contradictory results. Furthermore, it is important to consider the theoretical underpinnings of health behavior models when interpreting these results. The HBM assumes that perceived barriers play a critical role in determining health behaviors, underscoring the importance of addressing and reducing these barriers in interventions to promote health-related behaviors. The increase in perceived barrier scores in the intervention group following the educational intervention highlights the need for tailored interventions that effectively address patients' concerns and barriers to adherence to treatment.

The results of our study indicate that the scores of cues to action for treatment adherence were higher in the control group than in the intervention group before the intervention. However, after the intervention, there was a notable increase in cues to action scores in both groups, with a more pronounced increase in the intervention group. This difference in values between the two groups was significant both before and after the intervention. The cues to action construct reflects the perception of external cues and support that facilitate the adoption of health behaviors. Therefore, the observed increase in cues to action scores in the intervention group could be an indication of the effectiveness of the educational intervention, as it improves patients' perceptions of external support for treatment adherence. Additionally, the fact that both groups had relatively high cues to action scores at baseline suggests that individuals in both groups had access to appropriate guidance and external incentives to engage in disease prevention. This finding is consistent with previous studies (19,25,26), which also emphasized the importance of external support and guidance in promoting health-related behaviors.

The results of our study showed that self-efficacy scores related to treatment adherence were significantly higher in the control group than in the intervention group before the educational intervention. However, after the educational intervention, self-efficacy scores increased significantly in the intervention group, resulting in a remarkable difference between the two groups, which is consistent with the results of previous studies (27-29). Self-efficacy, defined as a person's belief in their ability to successfully perform a certain behavior, is a crucial factor in behavior change and adherence to treatment regimens, especially in the management of chronic diseases, such as type 2 diabetes. The observed increase in self-efficacy scores in the intervention group suggests that the educational intervention was effective in boosting patients' confidence in their ability to adhere to treatment recommendations and to take care of themselves.

In addition, self-efficacy is a critical factor in lifestyle change and self-care, which are essential for managing chronic diseases, such as type 2 diabetes. By giving them confidence in their ability to perform tasks such as blood glucose monitoring, insulin administration, and medication adherence, they are better able to effectively manage their disease and improve health outcomes.

Strengths and Limitations

The strength of this study lies in the precise application of the HBM as a theoretical framework, offering a comprehensive understanding of the factors affecting treatment adherence in patients with diabetes. Employing a well-established theoretical model enhances the validity and reliability of the findings of this study.

Furthermore, the longitudinal design of study, incorporating pre- and post-test assessments, enabled the evaluation of the effectiveness of educational intervention over time. This design bolsters the internal validity of the study by reducing intervening variables and revealing the temporal relationships between the intervention and outcomes.

Moreover, the study used standard criteria and valid questionnaires to assess various constructs related to treatment adherence, ensuring the reliability and comparability of the results. By employing valid tools, this study enhances the validity of its findings and facilitates comparisons with other studies in the field.

Additionally, focusing on a specific population of patients with diabetes attending diabetes centers enhances the relevance and applicability of the findings to similar patient groups. This targeted approach allows for the development of interventions tailored to the specific needs and challenges faced by patients with diabetes in clinical settings.

As with other studies, the study also had some limitations, including the lack of participation of patients in all educational sessions, the problem of access to patients for attending educational sessions and illiteracy, low level of literacy among patients, and difficulty in completing questionnaires. Another limitation of the study was the limited sample size, and the implementation of a single-center study, the use of volunteer samples, and self-reporting by patients affected the generalizability of the results, which should be done with caution. In addition, personality differences in the acceptance of educational content beyond the control of the researcher may have affected the results of the study.

Conclusion

Educational interventions based on HBM can significantly improve various constructs related to treatment adherence in patients with diabetes. The intervention led to improvements in knowledge, awareness, perceived sensitivity and severity, perceived benefit, and cues to action among the participants in the intervention group.

These results underscore the importance of diabetes in actively participating in educational programs that address their beliefs and attitudes about treatment adherence. By participating in these interventions, patients can gain a deeper understanding of their condition and the benefits of adhering to treatment regimens, ultimately leading to improved self-care behaviors and glycemic control.

Healthcare providers should consider incorporating HBM-based education into their practice to help patients with diabetes adopt healthier lifestyles and adhere to their treatment plans. Through tailored education and guidance, healthcare providers can empower patients to take control of their health and effectively manage their disease.

Policymakers should recognize the value of investing in educational programs to promote diabetes management and prevention. By providing funding for initiatives that focus on patient education and empowerment, policymakers can help reduce the burden of diabetes and its associated complications for both individuals and the healthcare system.

The results of this study demonstrate the importance of targeted educational interventions based on HBM to improve diabetes outcomes and enhance the quality of life of people with diabetes. It is important that all stakeholders, including patients, health care providers, and policymakers, work together to implement and support such interventions to effectively address the challenges posed by diabetes.

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Competing Interests

The authors declare that they have no competing interests.

Ethical Approval

This study was based on a research plan approved by the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.SCHEANUT.REC.1397.700). Ethical standards, such as obtaining informed consent, ensuring privacy, and maintaining confidentiality, were followed. Informed consent was obtained from all participants.

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