# Determinants of carbohydrate consumption in patients with type 2 diabetes based on the health belief model

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## Abstract

**Background**: Diabetes is a chronic condition in which serious complications can only be avoided by managing blood sugar levels. Carbohydrates are the most crucial macronutrients that greatly influence blood glucose levels, and tracking carbohydrate intake is a vital strategy for managing diabetes-related glycaemic control. This study aimed to explore the predictors of carbohydrate consumption in diabetic patients using the health belief model (HBM).

**Methods**: This cross-sectional study was conducted on 202 people with type 2 diabetes (T2DM) from health service centers in Arak City from 2019 to 2020, selected using a systematic random sampling method. Data were gathered using a researcher-designed questionnaire covering knowledge, HBM constructs and patients' carbohydrate consumption behaviours, with linear regression employed to assess the predictive model of these constructs.

**Results**: A significant positive association was found between perceived severity (r = 0.271, p < 0.001), perceived benefits (r =0.422, p < 0.001), self-efficacy (r = 0.390, p < 0.001), knowledge (r = 0.401, p < 0.001), and carbohydrate consumption behaviour. Conversely, carbohydrate consumption behaviour and perceived susceptibility (r = -0.172, p = 0.014) were negatively correlated. The following factors were associated with carbohydrate consumption behaviour: awareness (β = 0.278, p < 0.001), perceived barriers (β = -0.241, p < 0.001), perceived benefits (β = 0.335, p < 0.001), and self-efficacy (β = 0.177, p < 0.001), with an explanatory power of 32.7% (p<0.001). Regarding fasting blood sugar (FBS) and glycosylated haemoglobin ($HbA_{1c}$), knowledge was the strongest predictor.

**Conclusion**: Our findings demonstrated the efficiency of the health belief model in prediction of carbohydrate intake in people with T2DM.


*Br J Diabetes* 2025;**25**(1):8-13
https://doi.org/10.15277/bjd.2025.477

**Key words:** diet, diabetes, health belief model, health education

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## Introduction

Diabetes is a non-communicable disease referred to as a "latent epidemic" by the World Health Organization. In 2021, an estimated 485 million adults aged 20 to 79 years were diagnosed with diabetes, with a range of 456 to 517 million.[1] Type 2 diabetes(T2DM) accounted for 96.0% of all diabetes cases in 2021. Global diabetes prevalence increased by 90.5% from 1990 to 2021, with some regions, such as North Africa and the Middle East, experiencing over a rise of more than 100%.[1] In 2023, Hazar *et al*. reported that the prevalence of diabetes among Iranians over 25 years old was 10.80%.[2] In 2019, diabetes directly caused 1.5 million deaths, with 48% occurring before the age of 70. Additionally, diabetes contributed to 460,000 kidney disease deaths, and elevated blood glucose accounted for approximately 20% of cardiovascular deaths.[3] Individuals with diabetes face at least double the risk of death compared to those without the condition. Uncontrolled blood sugar can lead to serious consequences, including vision loss, nephropathy, peripheral neuropathy, cardiovascular diseases, lipid disorders and kidney failure.[4]

The World Health Organization finds that adhering to basic healthy lifestyle standards effectively prevents or delays T2DM.[4] The International Diabetes Association asserts that diabetes-related diseases can be prevented through proper education.[5] Research indicates that educational interventions, along with ongoing patient support, can enhance glycaemic control, improve quality of life, heighten treatment satisfaction, and increase knowledge and awareness.[6] The health belief model (HBM) is an effective framework in health education, viewing

behaviour as influenced by a person's knowledge and attitude. It posits that awareness of a health threat shapes individuals' health-related behaviours.[7] According to the HBM, a person is motivated to adopt healthy behaviours when he perceives himself as susceptible to a disease (perceived susceptibility), recognizes the seriousness of the disease's consequences (perceived severity), and believes in the effectiveness of recommended actions to reduce risk (perceived benefits). He also considers obstacles to these behaviours, such as costs (perceived barriers), assesses his ability to engage in the behaviour (perceived self-efficacy), and responds to both internal and external cues (guidelines for action), ultimately leading to healthier choices.[8] Patients' adherence to medical advice and involvement in self-care behaviours can be influenced by their health beliefs.[9] Previous research findings have illustrated the successful implementation of the HBM in both the explanation and prediction of health behaviours in patients with diabetes.[10-12]

Given the significance of blood sugar control in preventing diabetes complications, managing post-meal blood sugar through lifestyle adjustments and proper nutrition — particularly by limiting carbohydrates and consuming high-fibre foods — is crucial for controlling this disease. The reduction of carbohydrate intake is an effective strategy for improving glycaemic control in patients suffering from diabetes.[13-15] Therefore, identifying the factors that affect behaviour with regard to carbohydrate consumption can help to control this behaviour and ultimately control diabetes. The aim of this study was to determine factors influencing the carbohydrate intake of people with T2DM based on the HBM.

## Materials and methods

### Study population

The present cross-sectional study was conducted on 202 people with T2DM in Arak from November 2019 to July 2020. Systematic random sampling was used for this study. The sample size was assessed based on the following formula:

$$n = \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{d}\right)^2$$

where n = sample size, Z = critical value for α = [0.05] and d = [9].[16] The minimum required sample size was calculated as 184. Accounting for a dropout rate of 10%, the sample size was adjusted to 202 patients. The study's inclusion criteria encompassed individuals aged 30 to 60 years diagnosed with T2DM who were permanent residents of the town. Participants were required to have a minimum one-year history of T2DM, be currently utilizing oral anti-diabetic medications, and to possess the ability to read and write. The exclusion criteria involved individuals who were receiving insulin therapy, adhering to any specific dietary regimens, or who had a medical history of intestinal, pulmonary, hepatic, renal, cardiac or infectious diseases. Those with thyroid disorders, pregnant or breastfeeding women, and individuals who had experienced any alterations in diet, lifestyle or dosage of diabetic medications in the past six months were also excluded. The study was conducted on T2DM patients who had been referred to comprehensive health service centres of Arak. They were divided into four strata, according to the opinion of the health department staff, based on their socio-economic status. These centres with a covered a population of almost good, medium, low-medium and poor economic status. A total of eight centres was determined and 25 people were selected from each centre. Patients from each centre were selected and contacted in accordance with the inclusion criteria. If they were satisfied and interested, they were included in the study.

### Data collection tool

The data collection tool included a researcher-made questionnaire that was completed by self-reporting and semi-structured interviews (see Appendix 1 online at www.bjd-abcd.com). This questionnaire was set up in two parts. The first part contained 22 questions about the demographic information of people with T2DM and the second part contained 9 questions about knowledge, 2 questions for perceived susceptibility, 5 questions for perceived severity, 8 questions for perceived benefits, 7 questions for perceived barriers, 8 questions for self-efficacy, 6 questions for behaviour, 5 questions for internal cues for action, and 6 questions for external cues for action. To score the questionnaire in the knowledge part, one point was given for each correct answer and zero score was considered for the answer "I don't know". The knowledge items included in the questionnaire evaluated individuals with T2DM on their awareness of the disease, food groups (food pyramid), carbohydrate containing foods (simple and complex), colour-coded food labeling, cooking methods and blood sugar monitoring tests.

In the constructs section (perceived sensitivity, perceived severity, perceived benefits, perceived barriers, self-efficacy, performance and internal action guidelines and external action guidelines) a five-point Likert scale from "completely disagree" to "completely agree" was used: the range of points for each question varied from 1 to 5, so that the answers were given 1 point, 2 points, 3 points, 4 points or 5 points. In the self-efficacy section, the score of each question varied between 1 and 10, so that the answer "I am not sure at all" was given a score of 1 and "I am absolutely sure" was given a score of 10. The score of each question related to behaviour varied between 0 and 3: the answer of "never" was given 0 points, 1 point to "some extent", 2 points to "most of the time" and 3 points for "always". In the cues for action section (both internal and external), questions were in the form of yes and no. If the answer was "yes", the score was between 1 and 4 points, "always" was given 4 points, "often" 3 points, "somewhat" 2 points and "rarely" 1 point. If the answer was "no", zero points were assigned to it.

The questions related to severity and sensitivity addressed issues related to diabetes and its complications. The section related to perceived benefits and barriers addressed the effect of choosing healthy carbohydrates on disease control and the existing barriers to selecting healthy carbohydrates. Eight questions assessed patients' self-efficacy (e.g. I can reduce consumption of sweets). Cues to action items (10 questions)

were elements that could encourage patients to choose healthy carbohydrates (e.g. "Consumption of healthy carbohydrates boosts my feeling of being healthy"). The behavioural assessment item consisted of six questions designed to evaluate the patient's behaviour regarding food groups, colour-coded food labels, self-monitoring blood sugar and self-monitoring body weight.

In order to measure the validity of the questionnaire, the content validity method was used in such a way that it was reviewed by 10 experts (five professionals in health education, three nutritionists and two epidemiologists) and their opinions were applied in the questionnaire. At this stage, three questions were removed due to the low content validity ratio and finally validity of the questionnaire was confirmed. The reliability of the questionnaire was also measured through Cronbach's alpha test method on 20 people with T2DM who were similar to the study population in terms of demographic characteristics. The results were similar. Internal validity using Cronbach's alpha coefficients showed that all coefficients were favourable and satisfactory and confirmed, with values above 0.7.

After correcting the questions, the final questionnaire was compiled. Patients were advised to keep a food diary for three days (two weekdays and one day of the weekend). To ensure that there were no potential changes in carbohydrate intake, these notes were reviewed by a nutritionist. Before the patients entered the study, the necessary explanations about the purpose of the research were given to them and informed written consent was obtained. This study was performed according to the principles of the Declaration of Helsinki and approved by the Ethics Committee of Arak University of Medical Sciences (ID IR.ARAKMU.REC.1398.079).

### Statistical analysis

The statistical analyses were conducted utilizing SPSS software (Version 23, IBM Corporation, Armonk, NY, USA). The Spearman/Pearson correlation coefficient was used to examine the associations between the HBM constructs and carbohydrate intake behaviours. In order to determine the predictive power of the structures, the linear regression test was used with the backward method. $P < 0.05$ was considered to be a statistically significant level.

## Results

Of the 202 participants, 70.8% were female and 84.2% were married, with a mean age of 54.7 years (SD=9.3). Of the participants, 34.6% had completed high school or education beyond this level. The average fasting blood sugar was 156.9±50.3 mg/dL (8.7±2.8 mmol/L) and the average $HbA_{1c}$ was 7.1±1.3% (54 mmol/L) (Table 1).

Table 2 presents the range, means and standard deviations of the Health Belief Model (HBM) constructs related to carbohydrate intake behaviour and knowledge. Patients scored highest in self-efficacy and perceived severity, while behaviour received the lowest score.

Table 3 shows bivariate associations between the HBM variables and carbohydrate consumption behaviour. Significant

**Table 1.** Baseline characteristics of the people with T2DM in the study

| Variables | |
|---|---|
| **Age (y)** | 54.7±9.3 |
| **Gender, n (%)** | |
| Female | 143 (70.8) |
| Male | 59 (29.2) |
| **Education level, n (%)** | |
| Below diploma level | 147 (72.8) |
| Diploma or bachelor degree | 55 (27.2) |
| **Employment, n (%)** | |
| Housewife | 132 (65.3) |
| Employed | 29 (14.4) |
| Unemployed | 7 (3.5) |
| Retired | 34 (16.8) |
| **Marital status, n (%)** | |
| Single | 32 (15.9) |
| Married | 170 (84.2) |
| **Diabetes management method, n (%)** | |
| Oral medications | 58 (28.7) |
| Diet therapy | 5 (2.5) |
| Oral medications + diet therapy | 138 (68.3) |
| **Family income, n (%)** | |
| Very low | 39 (19.3) |
| Low | 129 (63.9) |
| Medium | 33 (16.3) |
| High | 1 (0.5) |
| **FBS, mg/dL (mmol/L)** | 156.9±50.3 (8.7±2.8) |
| **$HbA_{1c}$, % (mmol/mol)** | 7.1±1.3 (54) |

* Quantitative data are presented as mean ± SD;
Key: FBS=fasting blood sugar; $HbA_{1c}$= glycosylated hemoglobin

**Table 2.** Ranges, means and SDs of HBM constructs and carbohydrate intake behaviour and knowledge in people with T2DM (n=202)

| HBM construct | Possible score range | Observed range | Mean (SD) |
|---|---|---|---|
| Perceived susceptibility | 2-10 | 1-5 | 3.02 (1.009) |
| Perceived severity | 5-25 | 2.6-5 | 4.29 (0.58) |
| Perceived benefits | 0-40 | 1.75-5 | 3.98 (0.66) |
| Perceived barriers | 0-35 | 1.71-5 | 3.30 (0.58) |
| Self-efficacy | 8-80 | 1.88-10 | 5.6 (1.69) |
| Cues for action (internal) | 0-40 | 0-4 | 2.13 (1.38) |
| Cues for action (external) | 0-35 | 0-4 | 1.81 (0.79) |
| Knowledge | 0-9 | 0-8 | 3.82 (1.74) |
| Behaviour | 0-9 | 0.67-3 | 1.68 (0.43) |

Key: HBM= health belief model; SD= standard deviation

**Table 3.** Associations between the HBM variables and carbohydrate consumption behaviour

| HBM construct | Carbohydrate behaviour | |
|---|---|---|
| | Pearson correlation coefficient | P value |
| Perceived susceptibility | - 0.172 | 0.014 |
| Perceived severity | 0.271 | <0.001 |
| Perceived benefits | 0.422 | <0.001 |
| Perceived barriers | - 0.73 | 0.301 |
| Self-efficacy | 0.390 | <0.001 |
| Cues for action (internal) | 0.084 | 0.237 |
| Cues for action (external) | - 0.172 | 0.14 |
| Knowledge | 0.401 | <0.001 |

Key: HBM= health belief model

**Table 4.** Predicting carbohydrate intake behaviour and blood sugar with HBM variables

| | Variables | B | Beta | t | P value |
|---|---|---|---|---|---|
| Carbohydrate intake behaviour | Knowledge | 0.69 | 0.278 | 4.346 | <0.001 |
| | Perceived benefits | 0.2019 | 0.335 | 4.827 | <0.001 |
| | Perceived barriers | - 0.18 | - 0.241 | - 3.912 | <0.001 |
| | Self-efficacy | 0.045 | 0.177 | 2.872 | <0.001 |
| FBS | Knowledge | - 4.551 | - 1.63 | - 2.233 | 0.027 |
| $HbA_{1c}$ | Knowledge | - 0.152 | - 0.214 | - 2.333 | 0.021 |

Key: FBS=fasting blood sugar; $HbA_{1c}$=glycosylated hemoglobin

positive associations were found between the four constructs perceived severity, perceived benefits, self-efficacy and knowledge and carbohydrate consumption behaviour. Conversely, carbohydrate consumption behaviour and perceived susceptibility were negatively correlated.

To examine the predictive ability of the HBM constructs on carbohydrate consumption behaviour in T2DM patients, a backward regression model was conducted so that carbohydrate behaviour was defined as a dependent variable and all other constructs of the HBM and baseline characteristics were defined as independent variables. HBM constructs, including knowledge, perceived barriers, perceived benefits and self-efficacy, predicted 32.7% of the variance in carbohydrate consumption behaviour (Table 4). For both FBS and $HbA_{1c}$, knowledge was the strongest predictor.

## Discussion

The HBM constructs in this study accounted for 32.7% of the variance in carbohydrate consumption behaviours among T2DM patients, highlighting knowledge, perceived barriers, perceived benefits and self-efficacy as predictors. The results showed that as knowledge, perceived benefits and self-efficacy scores increased, behaviour scores also rose significantly. Conversely, a reduction in perceived barriers correlated with improved behaviour scores.

A study in Saudi Arabia found that adults with T2DM lacked dietary knowledge, especially about carbohydrates.[17] Another study by Vasconcelos *et al*. showed that middle-aged and elderly patients suffering from T2DM possess troubling inadequacies in their nutritional knowledge.[18] We found knowledge to be an important determinant of carbohydrate consumption behaviour and blood glucose control. Consistent with our results, it has been shown that there is a significant link between nutritional knowledge, dietary control, dietary practice and blood glucose levels in people with T2DM.[19] Primanda *et al*. reported a significant positive relationship between knowledge regarding diabetic diet and the total dietary behaviour scores (r = .36, p< 0.01).[20] This relationship emphasizes the importance of nutritional education in promoting healthy eating behaviour and controlling blood glucose levels in people with T2DM.[21]

Transitioning to a healthier diet for diabetes care can be challenging.[22] It involves establishing routine meal times, adjusting food choices, sacrificing spontaneity and modifying social habits. Cost and time for meal preparation are also common obstacles.[23] The present study revealed that the perceived benefits and barriers have a decisive role in carbohydrate consumption behaviour. Previous findings have indicated a significant negative association between the perceived barriers faced by people with T2DM and their self-care behaviours.[24,25] Melkamu *et al*. also reported that perceived severity, perceived benefit, perceived barriers and self-efficacy were factors significantly associated with self-care practices of people with T2DM.[26] Aris *et al.* also demonstrated that, in the context of HBM constructs, perceived benefits have been consistently identified as significant predictors of both dietary self-care and insulin intake behaviours over a six-month period.[27] A previous meta-analysis suggested that the perceived benefits aspect of the HBM is the most significant factor associated with health-related behaviours.[28]

In the present study, self-efficacy was one of the most important predictors of carbohydrate intake behaviour. Similar to our finding, other studies have reported that patients with high self-efficacy were more likely to perform self-care practice.[29,30] The study by Nouwen *et al*. revealed that dietary self-efficacy, perceived outcomes and the efficacy of treatment independently and directly affected both the self-care related to diet and the distress experienced by individuals with diabetes.[31] Potential explanations for this observation include that patients with elevated self-efficacy are more likely to engage in acquiring nutritional knowledge and to reach out for support from healthcare providers and family members. This proactive approach is crucial for them in maintaining their self-management behaviours successfully. Furthermore, earlier studies established a correlation between self-efficacy and improved quality of life, reduced levels of depression and lower $HbA_{1c}$ among individuals with diabetes.[32] Consequently, it is essential to implement self-efficacy interventions within clinical environments.

Several limitations of this research should be highlighted. First, the cross-sectional nature of the study restricts the capacity to infer causal relationships

### Key messages

- In patients with type 2 diabetes, as scores of awareness, perceived benefits, and self-efficacy increase, behavior scores also increase significantly.
- A decrease in perceived barriers score is associated with an improvement in behavior scores.
- For both fasting blood sugar and $HbA_{1c}$, knowledge was the strongest predictor.

among the variables. Second, while a significant positive correlation was identified between perceived severity, perceived benefits, self-efficacy and knowledge regarding carbohydrate consumption behaviour, none reached an r value of 0.7 or higher. Other factors that were not examined in this analysis may also be influencing carbohydrate consumption behaviour. Furthermore, the evaluation of carbohydrate intake behaviours was based on a self-reported questionnaire, which could have introduced misclassification due to the absence of established criteria, despite the application of stringent quality control during the interview process.

## Conclusions

This study identifies perceived benefits, perceived barriers, self-efficacy and knowledge as key predictors of carbohydrate consumption behavior in people with T2DM. Moreover, increasing the awareness of people with T2DM about diabetes, the benefits of choosing (e.g. improving blood sugar control and quality of life, as well as reducing diabetes complications) and barriers to choosing healthy carbohydrates (e.g. limited knowledge about healthy carbohydrates and colour-coded food labels, disinterest in and high price of healthy carbohydrate-containing foods), and blood sugar monitoring all play a crucial role in managing blood sugar within this group.



**Conflict of interest** The authors declare they have no conflict of interest.

**Funding** This work was supported by the Arak University of Medical Sciences (grant number: 5901).

**Ethics approval and consent to participate** This study was performed according to the principles of the Declaration of Helsinki and approved by the Ethics Committee of Arak University of Medical Sciences (ID IR.ARAKMU.REC.1398.079). Before the patients entered the study, the necessary explanations about the purpose of the research were given to them and informed written consent was obtained.

**Availability of data and materials** The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Authors' contributions** As a team, all authors contributed to the conception and design of the study. M KH, FAS, M SH and RM conceived and developed the idea for the study and, under the supervision of M KH, revised the manuscript. This study is being conducted by FM as part of her MSc thesis (5901). Final approval of the manuscript was obtained from all authors.

**Acknowledgements** We want to express our gratitude to everyone who took part in the study.

### References

1. Ong KL, Stafford LK, McLaughlin SA, *et al*. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet* 2023;**402**(10397):203-34. https://doi.org/10.1016/S0140-6736(23)01301-6
2. Hazar N, Jokar M, Namavari N, Hosseini S, Rahmanian V. An updated systematic review and meta-analysis of the prevalence of type 2 diabetes in Iran, 1996–2023. *Front Public Health* 2024; **12**:1322072. https://doi.org/10.3389/fpubh.2024.1322072
3. Evaluation IfHMa. Global burden of disease collaborative network. Global burden of disease study 2019. Results. 2020 [Available from: https://vizhub.healthdata.org/gbd-results/).
4. Roglic G. WHO Global report on diabetes: a summary. *Internat J Noncommunicable Diseases* 2016;**1**(1):3-8. https://doi.org/10.4103/2468-8827.184853
5. Walker K, O'Dea K, Gomez M, Girgis S, Colagiuri R. Diet and exercise in the prevention of diabetes. *J Human Nutr Dietetics* 2010; **23**(4):344-52. https://doi.org/10.1111/j.1365-277X.2010.01061.x
6. Shiferaw WS, Akalu TY, Desta M, Kassie AM, Petrucka PM, Aynalem YA. Effect of educational interventions on knowledge of the disease and glycaemic control in patients with type 2 diabetes mellitus: a systematic review and meta-analysis of randomised controlled trials. *BMJ Open* 2021;**11**(12):e049806. https://doi.org/10.1136/bmjopen-2021-049806
7. Skinner CS, Tiro J, Champion VL. Background on the health belief model. *Health Behavior: Theory Res Pract* 2015;**75**:1-34.
8. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Commun* 2015;**30**(6):566-76. https://doi.org/10.1080/10410236.2013.873363
9. Harvey J, Lawson V. The importance of health belief models in determining self-care behaviour in diabetes. *Diabetic Medicine* 2009;**26**(1):5-13. https://doi.org/10.1111/j.1464-5491.2008.02628.x
10. Dehghani-Tafti A, Mahmoodabad SSM, Morowatisharifabad MA, Ardakani MA, Rezaeipandari H, Lotfi MH. Determinants of self-care in diabetic patients based on health belief model. *Global J Health Sci* 2015;**7**(5):33-42. https://doi.org/10.5359/gjhs.v7n5p33
11. Karimy M, Araban M, Zareban I, Taher M, Abedi A. Determinants of adherence to self-care behavior among women with type 2 diabetes: an explanation based on health belief model. *Med Journal Islamic Republic Iran* 2016;**30**:368. eCollection2016. PMCID:PMC4972051
12. Hu Y, Liu H, Wu J, Fang G. Factors influencing self-care behaviours of patients with type 2 diabetes in China based on the health belief model: a cross-sectional study. *BMJ Open* 2022;**12**(8):e044369. https://doi.org/10.1136/bmjopen-2020-044369
13. Kirkpatrick CF, Bolick JP, Kris-Etherton PM, *et al.* Review of current evidence and clinical recommendations on the effects of low-carbohydrate and very-low-carbohydrate (including ketogenic) diets for the management of body weight and other cardiometabolic risk factors: a scientific statement from the National Lipid Association Nutrition and Lifestyle Task Force. *J Clin Lipidol* 2019;**13**(5):689-711. e1. https://doi.org/10.1016/j.jacl.2019.08.003
14. Schwingshackl L, Chaimani A, Hoffmann G, Schwedhelm C, Boeing H. A network meta-analysis on the comparative efficacy of different dietary approaches on glycaemic control in patients with type 2 diabetes mellitus. *Eur J Epidemiol* 2018;**33**:157-70. https://doi.org/10.1007/s10654-017-0352-x

15. Meng Y, Bai H, Wang S, Li Z, Wang Q, Chen L. Efficacy of low carbohydrate diet for type 2 diabetes mellitus management: a systematic review and meta-analysis of randomized controlled trials. *Diabetes Res Clinl Pract* 2017;**131**:124-31. https://doi.org/10.1016/j.diabres.2017.07.006
16. Fani N, Mohebbi B, Sadeghi R, Tol A, Shamshiri AR. Assessing the effect of educational intervention on promoting nutrition adherence among patients with type 2 diabetes referred to South Health Center of Tehran University of Medical Sciences: application of health belief model. *Iran J Dia Met* 2017;**17**(1).
17. Sami W, Alabdulwahhab KM, Ab Hamid MR, Alasbali TA, Alwadani FA, Ahmad MS. Dietary knowledge among adults with type 2 diabetes-Kingdom of Saudi Arabia. *Int J Environ Res Public Health* 2020;**17**(3). https://doi.org/10.3390/ijerph17030858
18. Vasconcelos C, Almeida A, Sá C, *et al*. Nutrition-related knowledge and its determinants in middle-aged and older patients with type 2 diabetes. *Prim Care Diabetes* 2020;**14**(2):119-25. https://doi.org/10.1016/j.pcd.2019.06.007
19. Ahmed S, Ripon MSH, Islam MF, *et al*. Association of dietary intake and nutrition knowledge with diabetes self-management behavior among Bangladeshi type 2 diabetes mellitus adults: a multi-center cross-sectional study. *Endocrine Metabolic Sci* 2024;**14**:100156. https://doi.org/10.1016/j.endmts.2023.100156
20. Primanda Y, Kritpracha C, Thaniwattananon P. Dietary behaviors among patients with type 2 diabetes mellitus in Yogyakarta, Indonesia. *Nurse Media Journal Nursing* 2011;**1**(2):211-23. https://doi.org/10.14710/nmjn.v1i2.975
21. Sanaeinasab H, Saffari M, Yazdanparast D, *et al*. Effects of a health education program to promote healthy lifestyle and glycemic control in patients with type 2 diabetes: a randomized controlled trial. *Prim Care Diabetes* 2021;**15**(2):275-82. https://doi.org/10.1016/j.pcd.2020.09.007
22. Breland JY, McAndrew LM, Gross RL, Leventhal H, Horowitz CR. Challenges to healthy eating for people with diabetes in a low-income, minority neighborhood. *Diabetes Care* 2013;**36**(10): 2895-901. https://doi.org/10.2337/dc12-1632
23. Nagelkerk J, Reick K, Meengs L. Perceived barriers and effective strategies to diabetes self-management. *J Adv Nurs* 2006; **54**(2):151-8. https://doi.org/10.1111/j.1365-2648.2006.03799.x
24. Glasgow RE, Toobert DJ, Gillette CD. Psychosocial barriers to diabetes self-management and quality of life. *Diabetes Spectr* 2001;**14**(1):33-41. https://doi.org/10.2337/diaspect.14.1.33
25. Aljasem LI, Peyrot M, Wissow L, Rubin RR. The impact of barriers and self-efficacy on self-care behaviors in type 2 diabetes. *Diabetes Educ* 2001;**27**(3):393-404. https://doi.org/10.1177/014572170102700309
26. Melkamu L, Berhe R, Handebo S. Does patients' perception affect self-care practices? The perspective of health belief model. *Diabetes, Metabolic Syndr Obes* 2021;**14**:2145-54. https://doi.org/10.2147/DMSO.S306752
27. Aris A, Blake H, Adams G. Health beliefs predict self-care practices and glycaemic control in Malaysian patients with insulin-treated diabetes: a longitudinal study. *Malaysian Journal Public Health Med* 2017;**17**(2):80-9.
28. Carpenter CJ. A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health Communication* 2010;**25**(8):661-9. https://doi.org/10.1080/10410236.2010.521906
29. Gurmu Y, Gela D, Aga F. Factors associated with self-care practice among adult diabetes patients in West Shoa Zone, Oromia Regional State, Ethiopia. *BMC Health Serv Res* 2018;**18**:732. https://doi.org/10.1186/s12913-018-3448-4
30. Gopichandran V, Lyndon S, Angel M, *et al*. Diabetes self-care activities: a community-based survey in urban southern India. *Nat Med J India* 2012;**25**(1):14-17. PMID:22680314
31. Nouwen A, Urquhart Law G, Hussain S, McGovern S, Napier H. Comparison of the role of self-efficacy and illness representations in relation to dietary self-care and diabetes distress in adolescents with type 1 diabetes. *Psychology Health* 2009;**24**(9):1071-84. https://doi.org/10.1080/08870440802254597
32. Mishali M, Omer H, Heymann A. The importance of measuring self-efficacy in patients with diabetes. *Family Practice* 2011;**28**(1):82-7. https://doi.org/10.1093/fampra/cmq086

## Appendix

**In the Name of God**

**The patient's file No. .....**
**Code No. .....Questionnaire.....**

**Demographic queries**

| Code | Items |
|---|---|
| | **Age** (year) .....Weight.. |
| | **Sex :** Male □ Female□ |
| | **Education** □ **:**Elementary (Up to 5th grade) □ Middle school (Up to 8th grade) □ Under diploma (8th to 11th grade) □ Diploma (completing 12th grade) □ Academic (Associate degree□ Bachelor's degree □ Masters or higher) |
| | **Job :** Government employee □ Self-employed or employee of non-governmental organizations □ Housewife□ |
| | **Marital status** :Married□ Divorced □ Widowed □ Single (never married)□ |
| | **How many years do you struggle with diabetes? .....Year** |
| | **Type of treatment:**<br>Oral medication □ Dietary regimen □ Oral medication plus dietary regimen□ |
| | Do you have previous experience of participation in diabetes training programs?<br>□Yes □ No If yes, please note the type of training. |
| | Monthly household income (tomans)□ :<1 million□ 1-3 million□ 3-5 million □ >5 million |
| | Number of family members (mother, father, children):<br>1-2 □ 3-4 □ 5-6 □ >6 □ |
| | Health insurance: I have health insurance□I have no health insurance □ |
| | Do any of your family members suffer from diabetes? Yes □ No □ |
| | If your response to the above item is positive, which one of the following fits?<br>Mother □ Father □ Sister □ Brother□ |
| | How was your diabetes diagnosed for the first time?<br>▪ Clinical presentations (e.g. becoming thirsty, hungry, frequent urination)<br>▪ Clinical complications (e.g., numbing of feet, visual problems, renal problems)<br>▪ During pregnancy<br>▪ Undergoing testing for another reason (e.g. for a disease)<br>▪ Unhealing wounds<br>▪ Others (Please specify) |
| | **In which manner do you prefer to receive training for diabetes?**<br>Movies and educational CDs/DVDs □Lectures □Face-to-face training □ Group discussion □Pamphlet □ Text messages□ |
| | The patient's results for the following test:<br>Fasting blood sugar (FBS):<br>Glycosylated hemoglobin (HbA1c): |

**Appendix** (continued)

How many visits do you pay to the following items? Please specify by marking in the table below.

| I pay no visits at all | Once in more than a year | Once a year | Once every six months | Once every three months | Once a month | Once a week | Specialty |
|---|---|---|---|---|---|---|---|
| | | | | | | | Specialized doctor |
| | | | | | | | General physician |
| | | | | | | | Nutritionist |
| | | | | | | | Health centres |

| Code | **Awareness about diabetes and carbohydrates** |
|---|---|
| | Which of the following food groups contain carbohydrates?<br>A) Bread and cereals B) Dairy<br>C) Fruits and vegetables D) All items E) I don't know |
| | Which of the following foods contain more carbohydrates and boost blood sugar the most ?<br>A) Apple B) Potato C) Fish D) Sweets E) Don't know F) All items |
| | Which of the following food groups increases blood sugar the most ?<br>A) Simple carbohydrates B) Complex carbohydrates<br>C) Fat D) Proteins…..E) Don't know…..F) All groups do the same |
| | Which of the following raises blood sugar faster?<br>A) Carrot B) Chocolate…..C) Bread D) Don't know …..E) All do the same |
| | The colour-coded nutritional information on food products refer to which of the following?<br>A) Carbohydrates (Sugar) B) Fat C) Salt D) Fatty acids E) All items F) Don't know |
| | What does the green marker in the colour-coded nutritional information signify?<br>A) These products should be prioritized when shopping.<br>B) The consumption of these products should be restricted<br>C) These products are safe most often<br>D) Don't know |
| | What is the normal range of fasting blood sugar? ( mg/dl)<br>A) <60 B) 70-100 C) 100-150 D (> 150 E) Don't know |
| | Which of the following tests show your blood sugar status during the last 2-3 months?<br>A) Glycosylated haemoglobin (HbA1c) B) -Fasting blood sugar ( FBS) C) Cell blood count D) Don't know |
| | Does the cooking method (boiling, barbecuing, frying) influence the sugar content of food? A) Much B) Somehow C) No effect D) Don't know |

**Appendix** (continued)

| Perceived susceptibility construct | | | | | |
|---|---|---|---|---|---|
| | Totally disagree | Disagree | No opinion | Agree | Totally agree |
| Because of my healthy diet, I am not worried about diabetes complications | | | | | |
| I am in a good health condition, and see it very unlikely for myself to become affected by diabetes complications | | | | | |

| Perceived severity construct | | | | | |
|---|---|---|---|---|---|
| | Totally disagree | Disagree | No opinion | Agree | Totally agree |
| In my opinion, diabetes should be taken seriously | | | | | |
| If patients with diabetes do not consume healthy carbohydrates (such as whole grain bread and cereals, vegetables, fruits, nuts, and low-fat dairy products), their blood sugar levels can increase | | | | | |
| Ignorance in consuming healthy carbohydrates poses me at the risk of diabetes complications, such as diabetic foot, cardiac disease and renal problems | | | | | |
| In my opinion, taking unhealthy carbohydrates increases diabetes-related mortality | | | | | |
| If I include starches and simple carbohydrates in my diet (gel, ice cream, soft drinks, fruit juice, sweets), it will be difficult for me to control my blood sugar | | | | | |

**Appendix** (continued)

| **Perceived benefits construct** | | | | | |
|---|---|---|---|---|---|
| | Totally disagree | Disagree | No opinion | Agree | Totally agree |
| Regular consumption of fruits can help me control my blood sugar | | | | | |
| Regular consumption of vegetables can help me control my blood sugar | | | | | |
| Picking healthy carbohydrates can help me improve my quality of life despite diabetes | | | | | |
| Consumption of whole grain bread and cereals can greatly help me control my blood sugar | | | | | |
| When shopping, the presence of the nutrition facts on food packages can help me pick healthier items | | | | | |
| In my opinion, being prudent about taking healthy carbohydrates reduces the likelihood of diabetes complications (such as eye, renal, neuronal and cardiac problems) | | | | | |
| Adherence to a healthy carbohydrate diet can save me extra therapeutic costs | | | | | |
| As a person with diabetes, I must stick to consuming healthy carbohydrates | | | | | |

| **Perceived barriers construct** | | | | | |
|---|---|---|---|---|---|
| | Totally disagree | Disagree | No opinion | Agree | Totally agree |
| I struggle to choose the right foods for myself as a patient with diabetes due to insufficient knowledge about healthy carbohydrates | | | | | |

**Appendix** (continued)

| | | | | | |
|---|---|---|---|---|---|
| I do not like the taste of whole grain (black) bread. | | | | | |
| I know no bakery making whole grain bread around me | | | | | |
| It is hard for me to purchase fruits and vegetables due to their cost | | | | | |
| I enjoy eating sweets | | | | | |
| As I am not familiar with the meanings of colour-coded nutritional information on food, it is difficult for me to recognize healthy products | | | | | |
| Due to the illegibility of the descriptions of the colour-coded nutritional information on food (they are small and tiny), I cannot use them effectively when shopping | | | | | |

| **Action guide (internal) construct** | | | | | |
|---|---|---|---|---|---|
| | Never | Rarely | Sometimes | Often | Always |
| Eating healthy carbohydrates brings me inner peace | | | | | |
| Eating healthy carbohydrates reduces my stress and anxiety | | | | | |
| Eating healthy carbohydrates makes me feel healthy | | | | | |
| Eating healthy carbohydrates gives me a feeling of happiness and enthusiasm | | | | | |
| Eating healthy carbohydrates gives me the feeling of controlling and beating the disease | | | | | |

**Appendix** (continued)

| **Action guide (external) construct** | | | | | |
|---|---|---|---|---|---|
| | Never | Rarely | Sometimes | Often | Always |
| My doctor advises me to choose and consume healthy carbohydrates | | | | | |
| My family members and relatives help me to choose and eat healthy carbohydrates | | | | | |
| Radio and television play a role in my choice of healthy carbohydrates | | | | | |
| Nutritionists and health care professionals play a role in helping me choose healthy carbohydrates | | | | | |
| My choice of healthy carbohydrates is influenced by books, magazines and newspapers | | | | | |
| Other patients with diabetes influence my decisions regarding the selection of healthy carbohydrates | | | | | |

**Self-efficacy construct**
**Please choose a number from 1 to 10 that best represents your situation. (No. 1: I am not certain, No. 10: I am fully certain)**

1. I can reduce consumption of sweets

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

2. At a party, I can manage to consume foods that are suitable for diabetes

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

3. When I feel hungry, I can reach for diabetes-friendly snacks.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

4. I can replace sweets with fruits and vegetable.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

**Appendix** (continued)

**5.** I can prepare starchy foods so that they have less impact on my blood sugar levels

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

**6.** If my blood sugar drops, I can manage to consume appropriate foods to resolve subsequent signs

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

**7.** I can use colour-coded nutritional information on food to choose healthy (beneficial) food items

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

**8.** Regardless of supervision by others, I can stick to eating carbohydrates that are suitable for diabetes

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

| **Performance construct** | | | | |
|---|---|---|---|---|
| How many servings of whole grain bread have you eaten in the last three days? | A) I have not eaten whole grain bread | B) <2 servings | C) 2-4 servings | D) >4 servings |
| How many servings of fruits have you eaten in the last three days? | A) I have not eaten fruits | B) <2 servings | C) 2-4 servings | D) >4 servings |
| How many servings of vegetables have you eaten in the last three days? | A) I have not eaten vegetables. | B) <2 servings | C) 2-4 servings | D) >4 servings |
| When shopping, do you pay attention to the carbohydrate content (sugar) indicated on the colour-coded nutritional information on food? | Never | Sometimes | Often | Always |
| Is it important for you to have your blood sugar under control? | Never | Sometimes | Often | Always |
| Is it important for you to have your weight under control? | Never | Sometimes | Often | Always |