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ORIGINAL ARTICLE

Development of Simplified Diabetes Nutrition Education Tools for Patients with Type 2 Diabetes Mellitus in Basrah, Iraq

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ABSTRACT

Background: Effective patient education is an essential component in management of type 2 diabetes mellitus (T2DM). This study aimed to develop simplified Diabetes Nutrition Education Tools (SDNETs) to educate patients with T2DM.

Methods: The study began with a published need assessment study. SDNETs were developed guided based on Health Belief Model theory, literature reviews and guidance from a panel of reviewers recruited for content validity. Then, face validity, readability, and acceptability were assessed using a 14-item Health Literacy (HL) scale and the Suitability Assessment of Materials (SAM) instrument in 30 patients with T2DM.

Results: Internal reliability was assessed using Cronbach's α (0.72, n=30), while test-retest reliability (0.86, *n*=30) was evaluated utilizing Pearson correlation. SDNETs had a HL score of 57.1% indicating the readability and acceptability among the patients. The SAM instrument's score was 85% indicating the SDNET curriculum's suitability.

Conclusion: The Iraqi-based culture-integrated plate method was the most straightforward and comprehensive technique in the SDNET curriculum. The SDNETs were determined to be a valid and reliable tool for improving glycemic control through diabetes nutrition education among patients with T2DM in Basrah, Iraq.

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Introduction

Type 2 diabetes mellitus (T2DM) is a chronic disease that affects whole-body organs (1, 2). The International Diabetes Federation (IDF) estimates that approximately 589 million adults worldwide to suffer from diabetes in 2024. If current trend is continued, this number will be doubled by 2050 (3). T2DM in the Arab world has witnessed a dramatic increase during the last 30 years (4). About 19.7% of people were diagnosed with T2DM in Basrah, Iraq (4). Optimal diabetes management requires multidisciplinary approaches, including physical activity and nutrition education, to control glycemic (5). Nutrition education (NE) was shown to be necessary to raise health literacy (HL) about nutrition and diabetes. Simple and available NE

tools seem essential to be developed to assist healthcare practitioners with nutritional advice (6). The standard NE session is time-consuming and requires specific information of dietitians which may only be available in some settings (7). Also, the complexity of NE can be a barrier for T2DM patients to apply since most of them have a low HL understanding (8). In Iraq, NE is usually distributed via home booklets that cover the general nutritional advices and target audiences at all levels of HL (9). These reasons have led to a need for simplified diabetes nutrition education tools (SDNETs) tailored to the unique needs of T2D patients (10).

The SDNETs are initiatives that aim to address these needs. These tools enroll dietitians, endocrinologists, and researchers to work collaboratively in order to create simplified educational materials that provide practical tips and guidance for T2DM patients. These materials draw on evidence-based guidelines tailored to the patient's cultural and dietary preferences and HL levels. The Health Belief Model Theory guides the materials (10). Besides, the materials are designed to be delivered in various formats, including printed brochures, group discussions, and presentations, to ensure patient accessibility. By providing patients with access to simplified and culturally appropriate SDNETs, these tools hope to improve glycemic control. Thus, this study aimed to develop SDNETs for patients with T2DM in Basrah, Iraq.

Materials and Methods

This development process is a cross-sectional study followed a published need assessment study (Pre-development Phase) (8) as a comprehensive review and education materials development process. The SDNETs were developed and guided by the health belief model theory based on literature reviews and guidance from a panel of reviewers recruited for content validity between previous October and April. T2DM patients were randomly included in the study, so there was no bias in data collection. The Generalized Model for Program Planning utilized at Faiha Specialized Diabetes, Endocrine and Metabolism Center (FDEMC) served as the basis for this investigation. This study determined the factors associated with glycemic control and needs assessment for patients with T2DM aged 19-60 years with no vision or hearing difficulties and severe sicknesses such as renal failure and cancers (8). The results from the cross-sectional study informed the content for developing education materials, which involved designing and assessing SDNETs. Later, the effectiveness of the developed SDNETs was evaluated (11).

Results of our previous study (8) were employed together with the worldwide dietary guidelines to develop SDNET materials. Therefore, the development phase in this study was identified as the following essential needs: (i) the deficit in patients' HL, (ii) patients' nutrition and health knowledge deficits in the areas of calorie and dietary intake, especially for vegetable intake, (iii) dietary fiber and vegetable intakes as indicators of lower intake of healthful foods, (iv) extra macronutrients like carbohydrate intake associated with the deficit in patients' physical activity levels, (v) most of the patients being on insulin therapy and had poor HbA1c, (vi) unavailability of up-to-date nutrition education sessions to target T2DM patients, and (vii) up-to-date instructional materials, such as a patient manual, posters, workbooks, and hands-on materials related to nutrition and a healthy diet. It is necessary to mention that culturally based food plates for diabetes or other populations in Iraq were unavailable.

The development of SDNETs resulted in involvement of the design and review process by ten experts comprised of eight nutritionists and two endocrinologists. The tools were written in both English and Arabic languages and consisted of 13 units under six modules based on the Health Beliefs Model (HBM) theory (12) including (i) overview of T2DM, (ii) the complications of diabetes, (iii) benefits of a healthy lifestyle, (iv) challenges that diabetes patients face, (v) following a healthy lifestyle and (vi) cues for the action (Table 1). Seven distribution choices were enrolled as food model, household measurements, lecture-discussion group, brochures, PowerPoint presentation, films, and the whiteboard, based on the findings of the previous study (8). The captioned photos module visually featured colorful illustrations, a straightforward language, and appropriate examples for the targeted culture. Thirty T2DM patients were pretested on SDNETs to gauge their readability, comprehension, and level of understanding. The specific SDNETs for T2DM underwent several steps to be developed in a simplified manner. Figure 1 displays the details of that process until the final draft of the SDNETs.

The development of simplified nutrition education material contents included numerous steps. First, the data were collected based on literature review to prepare for the first draft. The draft of SDNETs was evaluated during numerous discussion sessions with the supervisory committee and health professionals from FDEMC. This committee evaluated the suitability of the materials' language, reading level, design, and content and the suitability of time dedicated to conduct the SDNETs.

Table 1: Topics and contents of Simplified Diabetes Nutrition Education Tools (SDNETs).

Module	Module Unit	Module strategies	Content
Module 1	Unit 1	Overview of Diabetes	Definition of diabetes, Causes of diabetes, Signs and symptoms of diabetes, Risk factors of diabetes
Module 2	Unit 2	The complications of diabetes	Complications of diabetes, The target of the blood sugar profile
Module 3	Unit 3	Suitable physical activity program	Benefits of Exercise, Types of exercise, Duration of exercise, Simple tips to be physically active
	Unit 4	Concept of carbohydrate management	Principles of weight management, The target for weight reduction
	Unit 5	Carbohydrates counting	Carbohydrates and carbohydrate exchanges, Added sugar, Food exchange system
	Unit 6	Eating vegetables before carbohydrates	Dietary fiber, Antioxidants, What is the first, Food sequence
	Unit 7	Iraqi-based diabetes plate	My plate, Idaho plate, Using a plate based on food sequence, Teaching individuals the kinds and quantities of food that are appropriate for each meal by using a plate, Depicting portions of food and appropriate food options for meals
	Unit 8	Portions control and estimation of serving size	Menu planning, Estimation of serving size
	Unit 9	Total amount of fat consumed by diabetics	Food label, Types of healthy fats, Tips for healthy cooking
Module 4	Unit 10	Challenges that were facing diabetes patients	Possible causes of hypoglycemia and hyperglycemia, Signs and symptoms of hyperglycemia, Hypoglycemia and hyperglycemia management, Precautions for hypoglycemia during exercise, Tips for fasting for diabetic patients, The challenge of eating outside
Module 5	Unit 11	Follow healthy lifestyle	Tips for eating outside, Healthy eating
	Unit 12	Summarization	Review of the program, Question and discussion
Module 6	Unit 13	Printed materials serve as cues for action.	Readiness to change

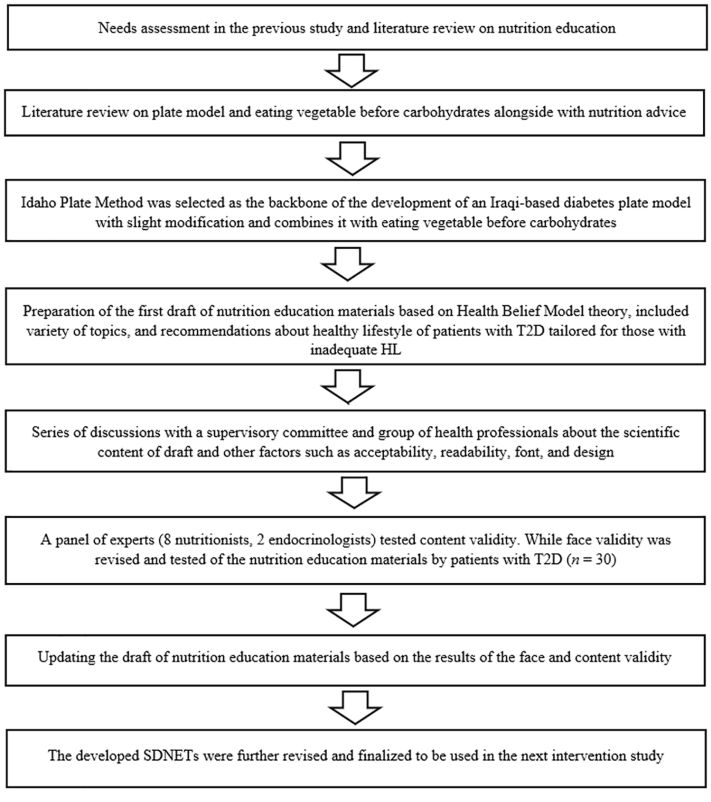

Figure 1: Development process of SDNETs. T2DM: Type 2 diabetes mellitus; HL: Health Literacy; SDNETs: Simplified Diabetes Nutrition Education Tools.

There were notes and recommendations too, which were used to improve the materials. Second, the draft of the materials was updated based on the findings of the first step. The SDNETs were implemented to assess face validity among patients with T2DM at FDEMC and their feedback, recommendations, and acceptance levels. All written content and verbal and visual information were available in Arabic. They were back-to-back translated into English as per health professionals' suggestions. All the nutrition educational materials were pretested, revised, and finalized using face (recruited 30 patients) and content validity (included nine nutritionists and one endocrinologist).

The first format of the SDNET materials was established and used to enlighten the SDNET topics among patients with T2DM. The plate method (7, 13-15) was chosen as the backbone of developing an Iraqi-based diabetes plate model and the eating vegetables before carbohydrates method (16) to support the SDNETs. The plate method was integrated with the "eating vegetables before carbohydrates" method (Figure 2 and Figure 3). In the second module, two units (unit 2 and unit 3) were initially selected from several modules and units to be simplified and comprehensive. In addition, to simplify things, the two units were integrated into one module. To be effectively communicated and understood by patients, this module was tested with 30 patients in Basrah, Iraq. The subjects with T2DM were randomly selected based on gender, age (18-64 years), and educational level (primary to university or higher). Researchers developed and modified the plate while the experts at FDEMC, Basrah, Iraq did validation. The meal should follow this food sequence and be finalized with a cup of milk or milk products and a small piece of fruit in one meal, with the preferred postprandial to decrease glucose absorption (17). The plate should indicate a similar design for lunch or dinner at breakfast, except that vegetable intake was optional but recommended (7, 15).

Hence, the Iraqi-based diabetes plate served as a simple and direct message on planning a healthy diet that was satisfactory and balanced. The SDNETs were organized and drafted to form the basic materials of SDNETs. These primary forms of materials were developed as educational brochures and materials. Educational brochures were illustrated to contain diabetes management manners and nutritional advices that could provide more helpful information on each topic in a separate lecture. Furthermore, regular foods containing carbohydrates (grain, dairy groups, and fruit) enabled patients with T2DM to have excellent and stable glycemic control (16). The format consisted of printed pamphlets and verbal and visual information using videos and slides of PowerPoint (Microsoft Corporation, California, USA, 2016).

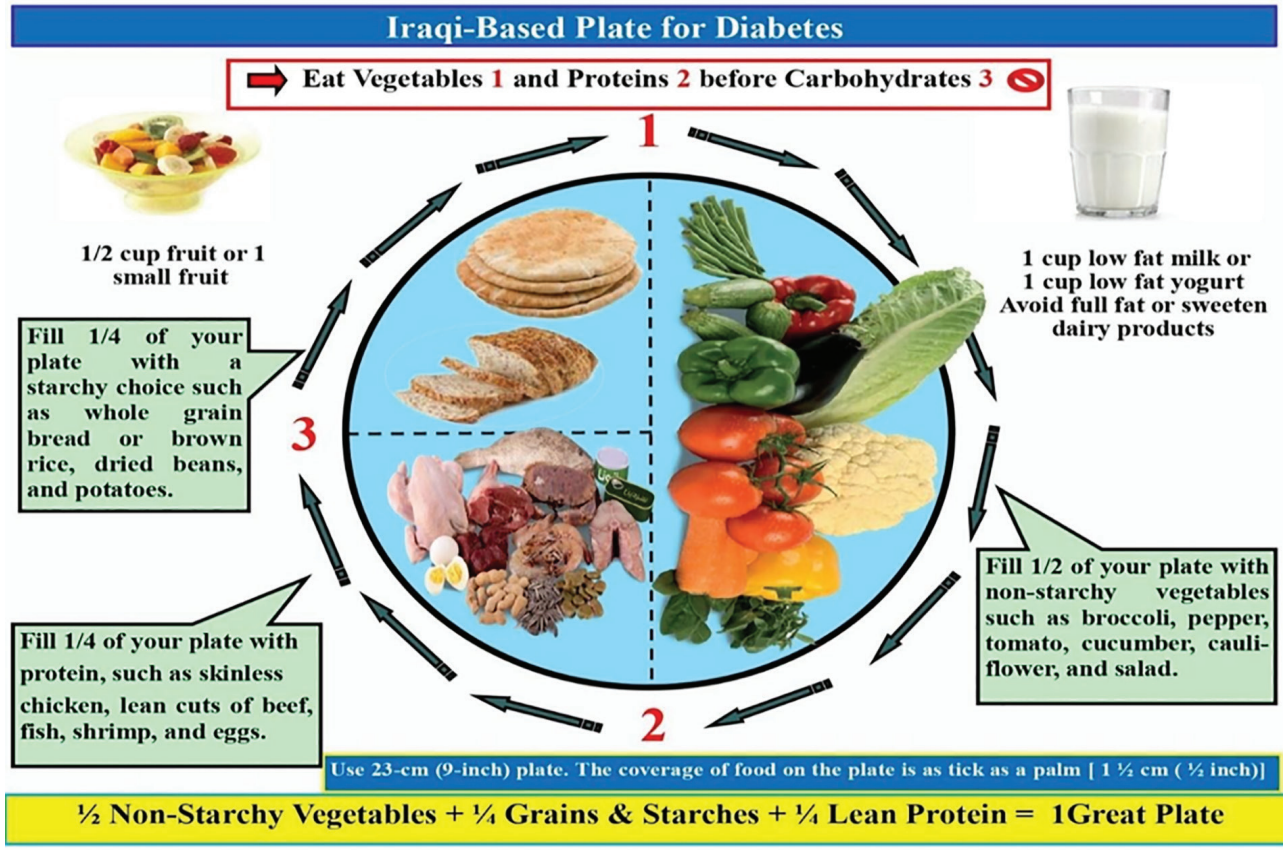

Figure 3: The Integrated plate method with eating vegetables before carbohydrates method.

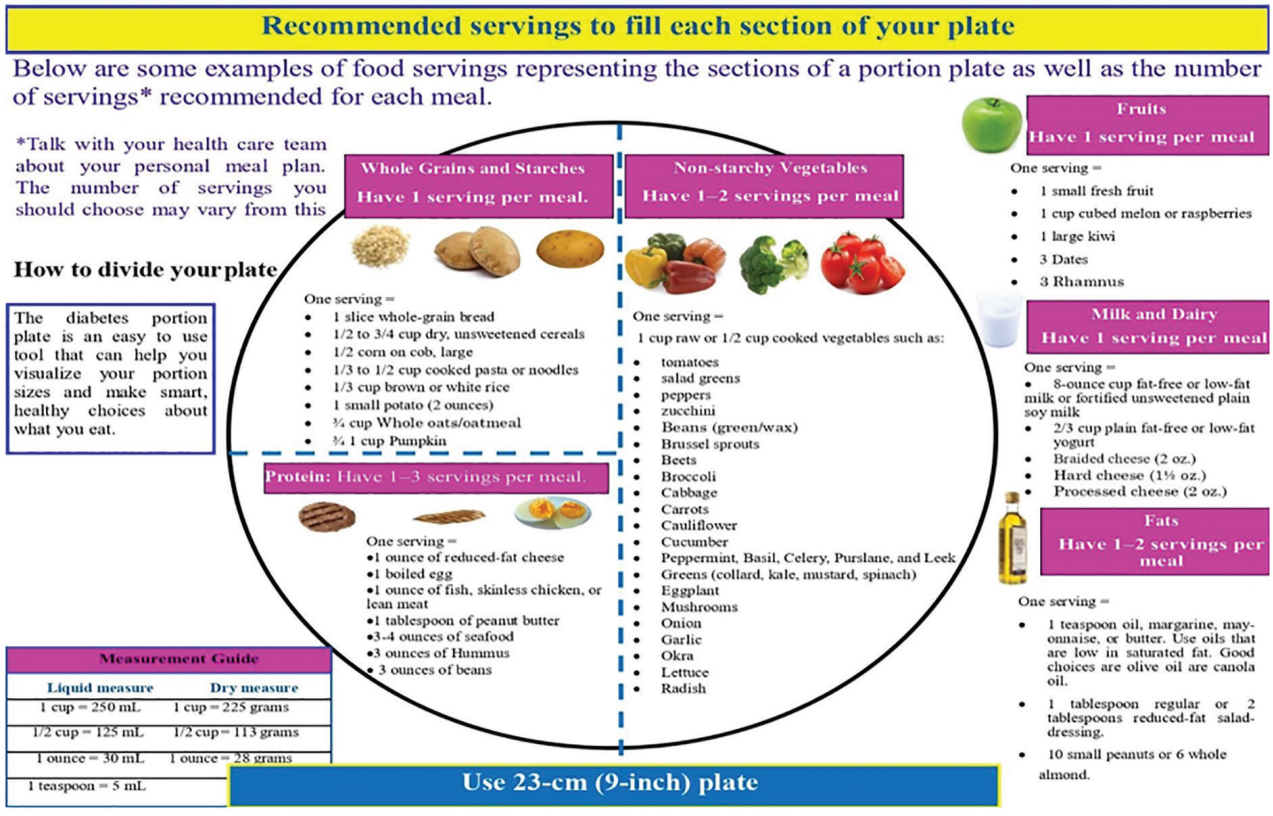

Figure 2: The Integrated plate method with eating vegetables before carbohydrates method.

The education materials were prepared with elaborate information in a simple Arabic language. Relevant pictures and live photographs of healthy food were taken to make it effective and attractive to patients (18). This study used standard Arabic with native languages, culturally appropriate, and as short sentences with quantifiable and practical examples (19). The patients preferred educational materials to be colored trifold leaflets that included illustrations and were written in Arabic language using the 16-point simplified Arabic typeface (19). The SDNETs were intended to assist patients with T2DM in managing their diabetes and to improve their HL and knowledge about a healthy lifestyle. The development of these educational materials was based on the need for SDNETs, which emerged from the results of content analysis in the current study and a previous study (8), with support and evidences from some literature.

In addition, local and international guidelines, the recommendation of previous interventions and results in the last study were helpful resources in constructing educational materials using SDNETs. According to the HBM theory, the SDNETs included aims based on individual insights (perceived susceptibility and perceived severity) and the probability of action (perceived benefits, perceived barriers, and taking action) that influenced the dietary intake behavior of the patients (12). HBM also helped guiding the students to increase the effectiveness of the intervention (11). The HBM suggested that health behaviors were strong-minded by the interaction of patients' health beliefs and readiness to take action (20).

The needs should be evidenced showing that the intervention was effective to achieve outcomes through the evaluation and identification of behaviors, motivations, barriers, predisposing factors, and enabling factors associated with poor glycemic control. The dietary guidelines used in determining the content of SDNETs were outlined by the non-published Iraqi Nutrition Guideline in United Arab Emirates (21), International Diabetes Federation (22), American Diabetes Association (23), Clinical Practice Guidelines for Diabetes Mellitus (24), and Joslin clinical nutrition guideline (25). Appropriate reading level, language, and local terminology in the nutrition educational materials were suitable, easy, and simple to be understood by Iraqi patients afflicted with T2DM.

The format was consisted of printed pamphlets and verbal and visual information like videos and slides of PowerPoint (Microsoft Corporation, California, USA, 2016). Relevant pictures and live photographs of healthy food were taken. This study used standard Arabic with native languages, culturally appropriate advice, and short sentences with quantifiable and practical examples (19). The patients favored educational materials such as color trifold leaflets exemplified with pictures and written in Arabic using the Simplified Arabic font in

16-point size (19). Twelve classes make up SDNET's curriculum, and these classes were guided by HBM (Table 1).

The format and content of SDNETs for T2DM were assessed using the Suitability Assessment of Materials (SAM) instrument to define the material's cultural appropriateness and sensitivity to the essential to understand and clarify nutrition education facts with low HL and low numeracy. The SAM was developed in a previous study (26) and assisted in determining the deficiencies of educational materials that may decrease their appropriateness for low HL, as well as in understanding and clarifying nutrition educational facts (26). Meanwhile, in its development, the SAM was utilized by several other authors to assess different educational materials (26). For the SAM, raters scored each material distinctly in 22 items that were divided into six sets. These sets included content, graphics, layout and typography, educational stimulation and motivation, and cultural relevance (26). Materials were scored as 2, 1, or 0 point (superior, adequate, and not suitable, respectively) for each item for a total of 44. The total point score was designed as a percentage to determine whether, overall, the material was not suitable (0-39%), adequate (40-69%), or superior (70-100%). In this study, the result of SAM was 34 of 44; it represented about 77%, which means the SDNETs were readable and acceptable among patients. That means materials were readable and acceptable for patients with T2DM.

The content of SDNETs for T2DM patients in a written format was assessed for readability, acceptability, and accuracy. Nevertheless, the written, verbal, and visual information formats were pretested on the targeted population before the user to ensure the validity and reliability so that it could be later implemented in the SDNETs. The validation procedure aimed to certify a nearby match between Iraqi patients with T2DM, content, and the strategies selected to meet these needs and ensure that the content met their needs and expectations (27). A convenient sample of thirty T2DM patients fulfilled the required standards and they were recruited to evaluate the SDNETs employing a functional, communicative, and critical HL questionnaire (3-level HL Scale or 14-item HL Scale). Health staff involved in the care of patients with T2DM for at least one year was also evaluated.

The compliance statement in this study was carried out strictly with ethical norms and regulatory criteria that govern clinical research. The research efforts adhered to the principles of the Declaration of Helsinki and any local regulations. This study complies with Iraq's rules and regulations regarding research that involved human beings, including legislations related to data protection and patient privacy. This study followed the most suitable guidelines available on Equator network.org. Furthermore, it followed the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist. The scale had adequate validity and reliability in the literature among patients with T2DM (28, 29). Each item in this scale was rated using a 4-point scale, ranging from "never" (1 point) to "often" (4 points). This scale did not exist in Arabic; thus, the study first performed pretest to face validity (recruited 20 patients) and content validity (included nine nutritionists and one endocrinologist). Second, back-to-back translation guaranteed correct translation and ensured the semantic equivalence between the original and the translated scales. One of the official translation institutes in Basrah city, a panel of three English teachers, and one who was native Arabic, translated the scale from English into Arabic and then reversed to the Arabic version.

Experts (two dietitians and one public health physician) among nutrition specialists and dieticians and the Community Health Department, Faculty of Medicine and Health Sciences, Putra University, Malaysia assessed the content validity of these educational materials. At the same time, face validity and reliability were evaluated in the first pretest among 30 patients with T2DM and the second pretest among 10 patients with T2DM who were not selected for the precision and clarity of meaning, language, and flow of matters used. The developed and validated SDNETs were used in a published study later (11).

Ethical considerations and consent were obtained from FDEMC and University of Putra at Malaysia. The authors of the original article commissioned the validation of the SDNETs. The study protocol was submitted to the ethics committee for anonymous peer review. The process of obtaining informed consent was integrated into the face-to-face interview, and the interview could not commence without the explicit assent of the patients. The patients' identity was safeguarded by encryption. IBM SPSS Statistics for Macintosh (Version 25.0, IBM Corporation, Armonk, New York, USA) was utilized to analyze all of the collected data. A component analysis was used to evaluate the construct validity. The evaluation of internal reliability was conducted by employing the Cronbach α coefficient for every domain and the overall scale. A p value less than 0.05 was considered statistically significant.

Results

Table 1 shows the content of SDNETs that cover

12 classes during the study period. The first class was consisted of the objectives of the program and background information about T2DM and the second class mentioned the complications of diabetes. The third class was about physical activity and how to start a suitable exercise program and the fourth class was about the relationship between carbohydrate glycemic index and glycemic load. The fifth class was about counting carbohydrates, while the sixth class was about eating vegetables before carbohydrates. The seventh class discussed a simple diabetes meal plan using an Iraqi-based diabetes plate. Meal plan with portion management and estimating serving sizes were covered in the eighth class.

In contrast, the ninth class focused on the right kind and quantity of total fat consumption for diabetic patients and the tenth class was about eating out and diabetes. At the same time, the eleventh class gave general recommendations about a healthy lifestyle, and then the last class summarized and reviewed the program in addition to questions and discussions (Table 1). The developed Iraqi-based diabetes plate worked and visualized how the five main food groups, namely grains, fruits, vegetables, meats, and dairy products were occupied in a 9-inch plate (23 cm). Half the plate should be occupied with non-starchy vegetables at breakfast, lunch, or dinner, and then one-quarter should contain proteins (eggs, cheese, fish, chicken, or lean meat) and last, whole grain products filled the remaining one-quarter. The meal should follow this food sequence and be finalized with a cup of milk or milk products and a small piece of fruit in one meal, with the preferred postprandial to decrease glucose absorption (Figure 2 and Figure 3).

The patients were satisfied with the simplified method and the diversity of information. They were enthusiastic about attending the following classes to obtain sufficient information, which was essential and beneficial for diabetes, as it was evident from the study results. There were interactive discussions, as well as questions and answers to clarify some points or give an additional explanation between the researcher and the patients. At the end of each class, the patients were satisfied and enthusiastic about the information obtained and the performance provided by the researcher.

In this study, SAM and the 14-item HL scale were used to assess the validity of the SDNETs, specific for T2DM. The total point score of SAM was calculated as a percentage that determined whether, overall, the material was superior (70-100%), adequate (40-69%), or not suitable (0-39%). In this study, the result of SAM was 85% (34 out of 44), which means the SDNETs were readable and acceptable among patients. That means materials were readable and acceptable to patients with T2DM. Furthermore, the 14-item HL scale score was 57.1 out of 70, which means the materials were acceptable and readable among patients with T2DM in this study. The Pearson correlation for SDNETs was 0.86, and Cronbach's Alfa was 0.69.

Discussion

The important role of diet in cell function has discussed before (30). Regarding diabetes, it can alter many body enzymes such as ALT, ALP and AST (31), the hemogram, the lipid profile and the body weight (32, 33). Various factors were demonstrated to affect self-care behaviors and health outcomes in subjects with T2DM (34-36). The development and validation of nutrition educational tools for diabetes management highlighted the critical role of tailored educational interventions in improving patient outcome. The Results.docx study outlined a SDNETs for Iraqi adults with T2DM, emphasizing the effectiveness of culturally adapted materials, such as the Iraqi-based diabetes plate to enhance patient understanding and satisfaction. The program, which covered 12 classes on carbohydrate management to meal planning using an Iraqi-based diabetes plan demonstrated significant improvement in patient knowledge, dietary behavior and clinical outcome. Our study revealed a high patient satisfaction together with materials scoring to 85% on SAM and 57.1 out of 70 on HL scales, indicating their readability and acceptability. However, the study acknowledged limitations such as its regional focus and reliance on self-reported dietary data.

Similarities and differences emerge when comparing others to our study. Gebreyesus and colleagues evaluated the patient-centered nutritional education in North Ethiopia and emphasized the importance of tailored nutritional education in improving glycemic control and dietary behaviors (10). They found significant improvement in food selection, meal planning, and calorie needs among participants, though clinical outcome like HbA1c showed only marginal improvements. These findings align with our study, where patient engagement and simplified educational methods were key points to success. However, their research highlighted the challenge of translating behavioral changes into significant clinical outcomes, suggesting that longer intervention periods might be necessary for measurable metabolic improvements (10).

Another study by Gortzi and colleagues in Greece focused on a 3-month Mediterranean diet intervention for T2DM patients and reported

significant reductions in body mass index (BMI), fasting blood glucose (FBG), and lipid profile (37). Similar to our findings, Gortzi *et al.* emphasized the important role of individualized dietary plan and face-to-face interaction with dietitians (37). Their results and our findings underscored the importance of culturally adapted dietary guidelines regarding the Mediterranean diet in Greece or the Iraqi-based diabetes plan in Basrah. However, they noted a challenge of sustaining behavioral changes, such as smoking cessation and alcohol reduction, which were not addressed in our study. Bhosale *et al.*'s study on a millet-based nutrition education toolkit for T2DM patients revealed the value of innovative and patient-centered tools. The toolkit's high content validity (S-CVI/Ave: 0.98) and face validity (92% patient agreement) demonstrated its relevance and effectiveness in promoting dietary changes (27). Like our study, their work emphasized the need for culturally appropriate, visually engaging materials to address patient awareness and adherence gaps.

Kapp *et al.* evaluated the diabetes nutrition education by digital video disc (DVD) for low-literacy adults in South Africa and found that multimedia tools with simple language, culturally appropriate visuals, and interactive elements could significantly improve patient engagement and knowledge retention (38). Our findings are also in agreement with Powers *et al.*'s report, which advocated diabetes self-management education and support (DSMES) as a cornerstone of diabetes care, particularly when delivered at critical times (e.g., diagnosis, annual reviews) and tailored to individual needs (39). Lambert and colleagues provided insights into the design of effective nutrition educational materials and emphasized consumer preferences for plain language, actionable content, and appealing visuals (40) that is similar to our findings, where the high SAM and HL scores indicated the materials to be well-received. They evaluated nutritional education materials and showed that they could further enhance the SDNETs by addressing barriers such as information overload and unclear purpose (40), which were not discussed in our study.

We demonstrated that the Iraqi-based diabetes plan and the Mediterranean diet were effective as they aligned with local food practices and preferences. The tailoring education to individual needs was illustrated to improve the engagement and outcome (30). Our study simplified methods could similarly enhance the patient's satisfaction; while behavioral improvement was noticed suggesting that nutritional education alone may need to be complemented with longer-term support or to be integrated with care models. Lambert *et al.*'s findings on consumer preferences for educational materials highlighted an area for improvement in the SDNETs, particularly in reducing information density and enhancing clarity. Combining visual, auditory, and written elements (e.g., DVDs, brochures, recipe books) caters to diverse learning preferences and literacy levels. Rigorous validation processes (e.g., SAM, CVI) can ensure materials to be scientifically accessible (40).

Despite these strengths, limitations such as regional specificity (e.g., Basrah City in the Iraqi study) and reliance on self-reported data suggest the need for broader, longitudinal studies to assess long-term impacts. Future researches can explore scalable models for integrating these tools into routine care, as recommended by Powers' consensus report (39), to maximize their potential in diverse settings. Overall, these studies can collectively advocate personalized and evidence-based education as a transformative strategy in diabetes management. Our study's regional findings limit generalizability and echoing the need for further broader and multi-center studies. There other limitations in our study too as it was limited to just adult T2DM patients in Basrah City and it is impossible to extrapolate the findings to all Iraqi patients in other age groups. Also, most food intakes were presented as self-reported ones that can make it susceptible to bias. Our study was conducted in a politically unstable region of southern Iraq with difficulties for the researchers; while the strength is that our study was the first studies in Iraq to develop successful SDNETs for adult patients with T2DM in Iraq.

Conclusion

The Basrah SDNETs share valuable insights and growing evidences to show structured, culturally adapted nutritional education programs can effectively improve diabetes management. By integrating insights such as behavioral theory, patient-centered design, longer intervention periods, and optimized educational materials; future programs can enhance both behavioral and clinical outcomes for T2DM patients globally. Further researches should explore the possibility of such programs in diverse settings and their integration with multidisciplinary care teams, as well as leveraging both traditional and innovative methods to address diverse patient needs.

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Authors' Contribution

Data analysis and cleaning: SAH and NHAJ. Data entry, supervision, analysis, and explanation were accomplished by AAM. All authors have approved this version of the manuscript.

Conflict of Interest

The authors do not mention any potential conflicts of interest.

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