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Original Paper

Effectiveness of Nurse-led Educational Interventions on Glycemic Control and Self-care Behaviors of Type 2 Diabetics: A Systematic Review

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Abstract

Background: *Blood glucose control is challenging for patients with diabetes and is often associated with self-care behaviors. The effectiveness of nurse-led educational interventions for glycemic control and self-care behaviors in patients with type 2 diabetes is unclear.*

Objective: *To determine effectiveness of nurse-led educational intervention on glycemic control and self-care behaviors in patients with type 2 diabetes.*

Design: *Mixed methods systematic review.*

Data Sources: *A comprehensive search in Medline, CINAHL and Scopus was conducted in February 2023 to identify peer-reviewed papers published between 2003 and 2023.*

Review Methods: *The review was guided by the Joanna Briggs Institute systematic review manual. Data were extracted and assessed by two evaluators using a standardized checklist. Due to the high level of heterogeneity between studies, the data were analyzed using Popay et al.'s (2006) conduct of narrative synthesis in systematic reviews.*

Results: *Ten randomized controlled trials met the inclusion criteria. Studies described nurse-led educational interventions delivered either face-to-face or online. The outcomes of the educational interventions and the measurement tools used were diverse, with many studies reporting attrition. Most studies reported that nurse-led educational interventions improved outcomes for patients with type 2 diabetes.*

Conclusions: *The evidence identifies that nurse-led educational interventions are effective for glycemic control and self-care behaviors in patients with type 2 diabetes. This review demonstrates evidence of approaches that could inform future practice and research to support all adult populations of patients with type 2 diabetes to improve glucose control and self-care behaviors. Future research would benefit*

from well-designed clinical trials that use common outcome measures to provide more information about the effectiveness as well as the sustainability of such interventions.

Keywords

nurse, self-care, glycemic control, type 2 diabetes, HbA1c

1. Introduction

Diabetes mellites refers to a group of metabolic disorders characterized by elevated glucose levels in the blood (Cho, Shaw, Karuranga, et al., 2008). Diabetes has become one of the most prevalent (Leon & Maddox, 2015) and serious (Ogurtsova, da Rocha Fernandes, Huang, et al., 2017) chronic diseases of the modern era, leading to costly and disabling complications that can be life-threatening and reduce life expectancy (Heald, Davies, Stedman, et al., 2019). The number of cases and prevalence of diabetes have been steadily increasing over the past few decades. Approximately 422 million people worldwide have diabetes, 90-95% of whom have type II diabetes mellitus (T2DM) (Saeedi, Petersohn, Salpea, et al., 2019), and this number is expected to increase by 25% in 2030 and 51% in 2045 (Saeedi, Petersohn, Salpea, et al., 2019). This increase is more rapid in low- and middle-income countries than in high-income countries (World Health Organization, 2022).

Prolonged increases in blood glucose levels can lead to extensive damage to blood vessels, affect organs such as the heart, eyes, kidneys and nerves, and lead to a variety of complications (D S, B S., 2011). Fortunately, there is evidence that many of the risk factors associated with the disease can be reduced or eliminated through a combination of medical management and lifestyle changes (Haas, Maryniuk, Beck, et al., 2013). Daily management of diabetes is essential to regulate blood glucose levels (Edeh, Khalaf, Tavera, et al., 2022) and treatment aims to maintain patients' blood glucose levels within the standard range (4%-7%, 20-53 mmol/mol) (Whitehead, Crowe, Carter, et al., 2017). For every 1% reduction in glycosylated hemoglobin, there was a 21% reduction in the risk of complications from diabetes and the relative risk of microvascular complications was reduced by 37% (Wang et al., 2022). In addition, diabetes self-management plays a critical role in improving glycemic control and reducing diabetes-related complications (Dack, Ross, Stevenson, et al., 2019). Diabetes self-management education (DSME) and behavioral support can reduce the risk of developing diabetes-related complications and improve glycemic control (Pal, Dack, Ross, et al., 2018).

AADE7™ self-care behaviors have been defined by the American Association of Diabetes Educators (AADE) as a patient-centered approach to diabetes education and care (Ye, Patel, Khan, Boren, & Kim, 2019). AADE is a professional organization made up of healthcare professionals from different disciplines who are committed to successful self-management as a primary goal in the care of people with diabetes and related conditions (American Association of Diabetes Educators, 2020). Successful self-management includes maintaining a healthy diet, engaging in physical activity, monitoring blood glucose levels, adhering to medication schedules, developing problem-solving skills, and coping with and healthily reducing risk (Ye, Patel, Khan, Boren, & Kim, 2019). This framework highlights seven

key self-care behaviors that are necessary for efficient and effective diabetes self-management (Ye, Patel, Khan, Boren, & Kim, 2019).

Nurses play a crucial role in the prevention and management of diabetes as they make up nearly 60% of the global healthcare workforce (Lascar, Brown, Pattison, Barnett, Bailey, & Bellary, 2018). Nurses provide ongoing support and follow-up and coordinate care with other healthcare providers (Stouten, Pazmino, Verschueren, et al., 2021). Knowledge about diabetes can be of great benefit to patients in managing their self-care, as most complications can be prevented through self-care (Kebede & Pischke, 2019). The International Diabetes Federation highlights the key contribution of nurses in ensuring timely diagnosis of diabetes, helping to prevent type 2 diabetes by addressing risk factors and providing self-management education and psychological support to patients (Lascar, Brown, Pattison, Barnett, Bailey, & Bellary, 2018). Self-care is important for improving the quality of life and delaying complications (Gao, Zhou, Liu, Wang, & Bowers, 2017). High levels of self-care can improve glycemic control and reduce all-cause mortality (Song, Ratcliffe, Tkacs, & Riegel, 2011). Improving diabetic patients' knowledge of diabetes and its complications has significant benefits for maintaining optimal blood glucose levels, improving treatment adherence, reducing treatment costs and slowing disease progression (Świątoniowska, Sarzyńska, Szymańska-Chabowska, & Jankowska-Polańska, 2019).

A systematic review is a literature review that collects and critically analyses multiple studies or papers on a particular topic (Aromataris & Pearson, 2014). It aims to provide a comprehensive and unbiased summary of the available evidence on the topic (Aromataris & Pearson, 2014). Several published systematic reviews have described the impact of different types of educational interventions on patients with type 2 diabetes. For example, Shiferaw et al. (2021) conducted a meta-analysis of 19 randomized controlled trials (RCTs) in which educational interventions were guided by theories or models. The authors reveal that educational interventions have a promising effect on glycemic control and diabetes knowledge. A meta-analysis by Belete et al. (2023) tested the effect of mobile phone text message reminders on medication adherence in adults with type 2 diabetes. This meta-analysis gathered the results of nine randomized controlled trials and demonstrated the beneficial effect of mobile phone text messaging on medication adherence in patients with T2DM. However, implementation and long-term sustainability need to be considered. Zhao et al. (2016) conducted a systematic evaluation and meta-analysis of a theory-based educational intervention for self-management in patients with type 2 diabetes, based on one or more theories. This systematic review showed that theory-based self-management educational interventions improved HbA1c, self-efficacy, diabetes knowledge and self-care activities in people with T2DM.

Despite the growing body of evidence in this area and, given the crucial front-line role nurses play in the prevention and management of diabetes, there have been no reviews of studies which evaluated the effects of nurse-led educational interventions on the characteristics of interventions, their ongoing effectiveness, and methods of implementation. This review will identify and appraise the effectiveness of nurse-led educational interventions for glycemic control and self-care behaviors in people with type

2 diabetes. Facilitating the development of evidence that can inform knowledge and practice to guide and improve the overall health status of people with type 2 diabetes has motivated this review.

1.1 Review Aim

This review aims to review the effectiveness of nurse-led educational interventions in blood sugar control and self-behavior management in type 2 diabetes.

1.2 Research Question

1. What is the effectiveness of nurse-led educational interventions on glycemic control and self-care behaviors in people with type 2 diabetes?

2. What are the characteristics of nurse-led educational interventions that effectively improve glycemic control and self-care in people with type 2 diabetes?

2. Methods

2.1 Design

This review is based on the Joanna Briggs Institute's Synthesis of Evidence Manual (Tufanaru, Munn, Aromataris, Campbell, & Hopp, 2020). The framework describes a set of steps to ensure reproducibility of study results using a systematic approach using PICO and PRISMA flowcharts (Page, McKenzie, Bossuyt, et al., 2021). The PRISMA flowchart will be used to illustrate the steps of the study to be conducted, describing the entire process of identifying and selecting evidence for a systematic review, including the stages of identification, screening, inclusion, and exclusion of studies (Page, McKenzie, Bossuyt, et al., 2021). PRISMA is the preferred reporting item for systematic reviews and meta-analyses, focusing on syntheses to assess the effectiveness of interventions, and is the minimum set of items for evidence-based systematic reviews and meta-analyses.

2.2 Search Strategy

An online search was conducted in three databases: Medline, CINAHL, and Scopus. These three databases are peer-reviewed literature databases, all of which are reliable. These include top nursing and allied health journals and global biomedical literature. Relevant keywords used in the review included 'diabet* or diabetes mellitus or type 2 diabetes or diabetic', 'educational intervention or educational strategy', and 'effectiveness or efficacy or effective or success or outcome or evaluation or analysis or impact'. Boolean operators, such as 'AND' and 'OR', were used to combine search terms. The search limiters were the English language, the time limit was 2003 to 2023 and full text availability. The search was conducted on 20 February 2023. This review used the PICO framework, which is a mnemonic for evidence-based medicine, to construct the themes. The question was as follows, are nurse-led educational interventions (I) associated with improved glycemic control and self-care behaviors (O) in people with T2DM (P) compared with those who do not participate in educational interventions or standard care (C)?

2.3 Inclusion and Exclusion Criteria

Inclusion criteria according to PICO principles: 1) Study population: patients with type 2 diabetes over

the age of 18 years; 2) Intervention: any form of nurse-led educational interventions; 3) Outcome indicators: glycemic control outcomes as measured by HbA1c, and self-care activities such as dietary control, physical activity and self-monitoring of blood glucose; 4) Study type: Randomized controlled trials (RCTs). Exclusion criteria: 1) Exclusion of infant and pediatric patients, patients with gestational diabetes; 2) Articles with educational interventions combined with other interventions; 3) Outcomes that did not assess glycemic control as measured by HbA1c, and self-care activities such as dietary control, self-monitoring of blood glucose and adherence and compliance of medications; 4) Conference abstracts, review articles, dissertations, systematic reviews, observational studies, non-RCTs. Based on the above inclusion and exclusion criteria, the titles and abstracts of the retrieved literature were read carefully by two researchers to screen out those that met the criteria, and then the full text was read for screening.

2.4 Study Selection

After a complete database search, all studies were imported into the Covidence system evaluation management software for duplicate removal and screening. Screening (title and abstract/full text screening) was done independently by two reviewers (YS and XQL). The two reviewers screened the selected studies against the inclusion criteria and resolved differences through discussion. The reasons for the exclusion of studies were recorded.

2.5 Data Extraction

Data were extracted from each identified study and recorded on a standardized data extraction form. Data extracted from the selected studies for this review included the following: author's name, year of publication, country, aim, study design, patient characteristics (number of participants, gender and age), intervention type, duration, comparison and results, and outcome measures. Data were extracted by one researcher and checked and validated by another researcher, inconsistencies in the extracted data were resolved by discussion and consensus.

2.6 Quality Appraisal

The reviewers (SY and LXQ) assessed the quality of 10 studies using the Joanna Briggs Institute's Systematic Assessment Tool: for RCT (2017a). They then independently scored the articles, discussed any issues of disagreement, and reached a consensus. The initial stage of the review involved assessing whether the study's identified 'causes' and 'effects' aligned with the review's objectives. Subsequently, the reviewers evaluated the intervention's specifics to gauge its methodological reliability. This entailed examining factors such as the comparability of the two participant groups at the start of the study, whether the study was conducted in a blinded manner, and if the outcomes were measured reliably. "Yes, No, Unclear, and Not/Applicable" are used for each item Applicable for judgement.

2.7 Data Synthesis

Data synthesis was completed by the primary reviewer. Due to the heterogeneity of these studies, which used different outcome measures and methods of assessing effectiveness, a narrative synthesis (Popay et al., 2006) was conducted to analyse the outcomes included in this systematic review.

Narrative synthesis is a valid method for obtaining an indication of the impact of an intervention (Popay et al., 2006). Following the four elements of the guidelines on a general framework for narrative synthesis, firstly, the methodological characteristics used for each intervention were described. The results of the included studies were then initially synthesized, the relationships between the different studies were explored, and finally, the robustness of the synthesis was assessed.

3. Results

3.1 Search Outcomes

To identify relevant articles for our study, a total of 907 articles were generated from a systematic search of three electronic databases. After removing 222 duplicates, was left with 674 articles. Then we screened these articles based on titles and abstracts, which led us to select 35 articles for full-text evaluation. After carefully evaluating the full texts of these 35 articles, we identified 10 articles that met our inclusion criteria. The search is reported as per PRISMA flow chart in Figure 1, which shows a PRISMA flow chart that depicts each stage of the search and selection process and the reasons why studies were excluded.

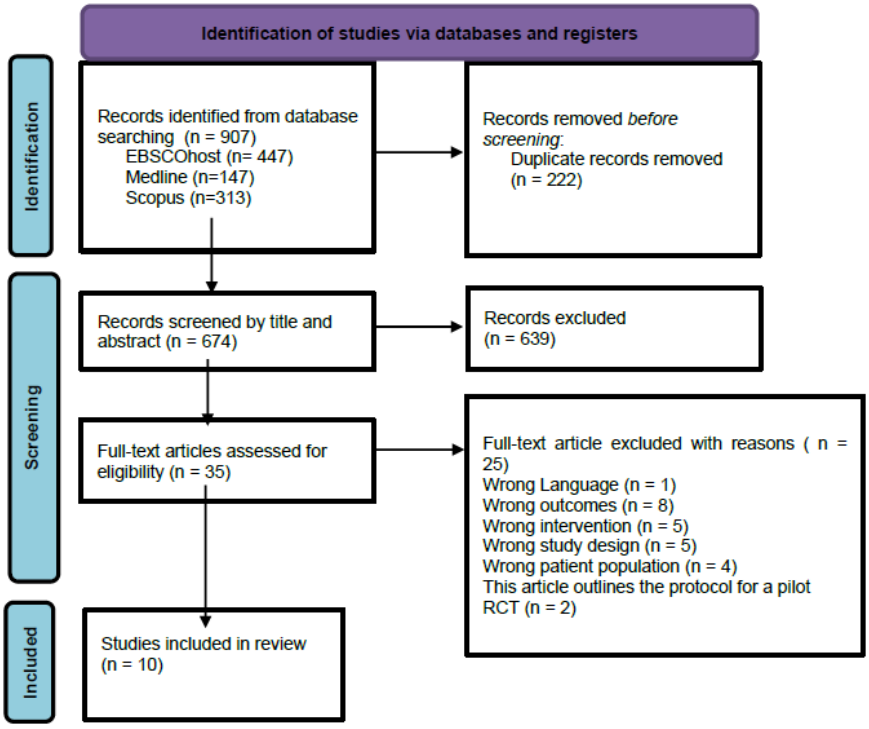

Figure 1. PRISMA Flow Diagram

From: Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*(71). http://doi.org/10.1136/bmj.n71

Table 1. Characteristics of Included Studies

Country of origin	Papers
Iran (5)	Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018
New Zealand (1)	Whitehead, Crowe, Carter, et al., 2017
Qatar (1)	Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016
Brazil (1)	Miranda L de, Ezequiel, Vanelli, et al., 2022
Portugal (1)	do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017
Korea (1)	Kim, 2007

Design	Number of papers	Author
RCTs, Quantitative Research	9	Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007
RCTs, Mixed method	1	Whitehead, Crowe, Carter, et al., 2017

Intervention	Number of papers	Author
Face to face	7	Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022
By telephone	1	Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022
Online	1	Kim, 2007
Combined face-to-face and online	1	do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017

The data extraction table is shown in the appendix. The main characteristics of the specific studies described in this review are presented in Table 1.

Of the ten studies that met our screening criteria, five studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018) originated from Iran, with New Zealand (Whitehead, Crowe, Carter, et al., 2017), Qatar (Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016), Brazil (Miranda L de, Ezequiel, Vanelli, et al., 2022), Portugal (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) and Korea (Kim, 2007) also adding to the knowledge base. The study designs were all randomized controlled trials. Nine studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) used a quantitative method and one study (Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018) used a mixed method design. These studies included different sample sizes ranging from small (20 participants) (Miranda L de, Ezequiel, Vanelli, et al., 2022) to large (181 participants) (Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016), with one study (Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016) having over 100 participants per group and the remaining nine (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) with fewer than 100 participants in each group. A relatively large proportion of female participants were middle-aged and elderly.

3.2 Types of Interventions

All 10 studies tested interventions designed to improve glycemic control or self-care behaviors in people with type 2 diabetes. One study (Whitehead, Crowe, Carter, et al., 2017) tested two interventions, while the remaining projects tested only one intervention. A total of seven interventions were delivered face-to-face, while two studies were delivered by telephone (Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022) or online (Kim, 2007). In addition, the study's interventions (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) combined face-to-face and online educational methods. The educational interventions of three studies (Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016) were designed based on a range of psychological factors, with one study (Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016) using the health belief model, control of positional change, and patient empowerment. The study (Whitehead, Crowe, Carter, et al., 2017) used education and Acceptance and Commitment Therapy (ACT), with two intervention groups (education group and education and ACT group). In addition to this, the remaining seven studies varied in their approach to

educational interventions. The study (Miranda L de, Ezequiel, Vanelli, et al., 2022) used a problem-based intervention. The study (Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021) based its intervention on the Kolb learning style, which is an adaptive, diffuse, integrative and assimilationist educational intervention that educates patients by using individualized learning styles, meaning that different patients have different needs. The study (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) was a diversified educational program focusing on lifestyle management strategies with three face-to-face educational settings, two group activities and one telephone contact for the intervention group and three face-to-face educational interventions for the control group. The study (Kim, 2007) was about a nurse texting service for patients via mobile phones. The study (Alizadeh, Didarloo, & Shojaeizadeh, 2006) was an educational intervention based on an interactive approach. The study (Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022) was a mobile device based educational intervention. The study (Sanaeinasab, Saffari, Yazdanparast, et al., 2020) was designed according to the Health Education and Promotion (SHEP) model.

Seven studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) had a group discussion session, and two studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021) had a brainstorming session. The interventions in all studies included the following areas causes of diabetes and related complications, lifestyle changes such as intensive diet, exercise, medication modification and self-monitoring of blood glucose levels.

In most studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007), the educational intervention was delivered by nurses alone. The remaining studies (Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016), were done using an interdisciplinary approach, meaning that the intervention team included a team of nurses, diabetes specialists, dieticians, pharmacists, and psychologists.

3.3 Target Outcomes and Measurement Methods

The studies reviewed varied considerably in terms of outcome measures. These studies all focused on more than one outcome. This review aims to improve HbA1c levels and self-care behaviors in patients with type 2 diabetes. Three studies (Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) had an outcome indicator of HbA1c and one study (30) had an outcome indicator of self-care behavior. Six studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022;

Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Miranda L de, Ezequiel, Vanelli, et al., 2022) indicators of outcome include HbA1c and self-care behavior. In studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Miranda L de, Ezequiel, Vanelli, et al., 2022) where self-care behaviors were used as outcome indicators, using different questionnaires and evaluation scales, including diet, exercise, medication adherence, and blood glucose monitoring.

3.4 Effectiveness of Interventions

Of the nine studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) using HbA1c as an outcome indicator, only one study did not show a significantly positive impact on HbA1c levels (Miranda L de, Ezequiel, Vanelli, et al., 2022). Of the seven studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) that used self-care behavior as an outcome indicator, four studies (Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Kim, 2007) did not show a positive impact. The study (Whitehead, Crowe, Carter, et al., 2017) had a reduction in HbA1c in both intervention groups (education group and education plus ACT group) but the intervention did not improve self-care behaviors. In the study (Sanaeinasab, Saffari, Yazdanparast, et al., 2020), mean scores for HbA1c levels and self-care behaviors were significantly improved in the intervention group. The percentage of participants with satisfactory glycemic control (HbA1c < 7) improved in both groups, but the improvement was greater in the intervention group. At baseline, 27.5% of the intervention group had an HbA1c<7, and this increased by 10% to 37.5% at follow-up. The increase in the control group was only 5%, from 30% at baseline to 35% at follow-up. In the study (Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021), there was an improvement in self-care behavior in the intervention group ($P<0.001$). There was a significant effect on self-care about diet ($P<0.001$). However, it had a non-significant effect on exercise ($P=0.499$) and blood glucose testing ($P=0.057$) and medication ($P=0.797$). In the study (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017), the educational intervention received by both the intervention and control groups resulted in significant changes in HbA1c in both groups. It is worth noting that the study was analyzed longitudinally, and

only the intervention group participants showed a significant decrease in HbA1c after including variables that were significantly associated with clinical indicators, such as socioeconomic characteristics and comorbidities, as control variables.

Overall, we found some evidence that nurse-led educational interventions can influence patient outcomes in terms of glycemic control and self-care behaviors. However, the content, frequency, and duration of the interventions varied. Of the 10 studies analyzed, nine studies reported a significant positive impact on diabetic outcomes compared to the control group. Of all successful interventions, six studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016) were delivered face-to-face, two by telephone (Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Kim, 2007) and one by a combination of face-to-face and telephone (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017). Six studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016) illustrated that the positive effects of the intervention were maintained throughout the follow-up period (3 to 12 months); three studies (Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) did not mention the duration of follow-up. When focusing on successful studies, this suggests that nurse-led educational interventions generally provided better support than usual care but failed to improve all measured aspects of self-care behavior. The interventions in all studies included the following aspects causes of diabetes and associated complications; lifestyle changes such as intensive diet, exercise, medication modification, and self-monitoring of blood glucose levels.

In one study (Miranda L de, Ezequiel, Vanelli, et al., 2022), no statistically significant differences were observed in glycemic hemoglobin between the two groups, but knowledge of the disease increased in the intervention group. The intervention used in this study was a face-to-face, problem-based teaching approach (Miranda L de, Ezequiel, Vanelli, et al., 2022). Difficulties in glycemic control were observed in a large proportion of people with diabetes and there are multiple reasons for such outcomes, with poor patient adherence to medication identified in studies as one of the main reasons to explain difficulties in metabolic control. The study sample size was relatively small (n = 41) and the follow-up period (6 months) was relatively short, and new studies with longer follow-up periods could help to investigate the impact of a long-term approach in this group of patients. Long-term benefits for the metabolic control of this group of patients can be provided by observing behavioral and clinical changes in the study.

3.5 Quality Appraisal

Most of the studies adhered to the Joanna Briggs quality assessment (2017a). Of the 10 randomized

controlled trials eight studies included (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Bagchegi, Esferjani, Naghizadeh, Albokordi, Zakerkish, & Araban, 2022; Sanaeinasab, Saffari, Yazdanparast, et al., 2020; Salahshouri, Zamani Alavijeh, Mahaki, & Mostafavi, 2018; Whitehead, Crowe, Carter, et al., 2017; Al Lenjawi, Mohamed, Amuna, Zotor, & Ziki, 2016; Miranda L de, Ezequiel, Vanelli, et al., 2022; Kim, 2007) used a list of random numbers or used computer-generated random number lists; 2 studies (Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) did not mention the randomization process. Six studies hid allocation, and four studies (Alizadeh, Didarloo, & Shojaeizadeh, 2006; Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021; do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017; Kim, 2007) did not mention whether allocation was hidden. Treatment groups were similar at baseline in all 10 studies by examining P values and relevant measures in the comparison groups. One study (do Rosário Pinto, Parreira, Basto, & dos Santos Mendes Mónico, 2017) considered the probability of a Type I error. Because of the nature of the intervention, most of the studies were not blinded to both treatment providers and outcome assessors. In one study (Whitehead, Crowe, Carter, et al., 2017), the outcome assessor was unaware of the subgroup, and the remaining studies did not mention whether the outcome assessor was blinded. All studies showed adequate reporting of outcomes and described specific reasons for missing visits.

4. Discussion

This review aims to determine the effectiveness of nurse-led educational interventions on glycemic control and self-care behaviors in patients with type 2 diabetes. In order to generate high quality evidence, only randomized controlled trials were included in this review. The findings suggest that nurse-led educational interventions are effective in improving glycemic control and self-management behaviors in people with type 2 diabetes. According to the results of the comprehensive study, many nurse-led educational interventions were successful, although the format of their delivery (online or face-to-face) varied. For every 1% reduction in glycosylated hemoglobin, there was a 21% reduction in the risk of complications from diabetes and the relative risk of microvascular complications was reduced by 37% (Wang et al., 2022). In addition, diabetes self-management plays a critical role in improving glycemic control and reducing diabetes-related complications (Dack, Ross, Stevenson, et al., 2019).

In previous reviews noted considerable methodological variation between studies (Shiferaw, Akalu, Desta, Kassie, Petrucka, & Aynalem, 2021; Belete, Gemeda, Akalu, Aynalem, & Shiferaw, 2023), which means that it is difficult to determine which educational interventions have the strongest impact on health outcomes for people with type 2 diabetes. Our results suggest that all eight face-to-face interventions were successful in improving outcome indicators for people with diabetes. This finding is similar to the results reported in a previous meta-analysis of patients with diabetes, with significant improvements in hemoglobin levels in the experimental group compared to the control group (Shiferaw,

Akalu, Desta, Kassie, Petrucka, & Aynalem, 2021); The nurse-led educational intervention had a significant benefit in reducing glycated hemoglobin levels in patients with diabetes. In addition, education can improve knowledge and lead to changes in self-care behavior in people with diabetes. Both online interventions were successful in improving outcome measures in patients with type 2 diabetes. This finding, considered together with evidence from another study (Belete, Gemeda, Akalu, Aynalem, & Shiferaw, 2023), suggests that online interventions can be successful in improving the health behaviors of people with type 2 diabetes, as the elderly population is increasing in number and online education can reduce their referrals to health centers. With high levels of technological development in society, online education is in the future to support nurses in diabetes education and maintain positive outcomes over time. The study (Bagchegi, Tabatabaeichehr, Lashkardoost, & Mortazavi, 2021) educated patients through the use of personalized learning, which implies that different patients have different needs and therefore interventions should provide continuous improvement in the spirit of a person-centered approach. This is similar to the study (Rutten, Vugt, & Koning, 2020), in which person-centered diabetes care refers to the development of individualized treatment plans and treatment goals based on each patient's unique characteristics, preferences and abilities, and the empowerment of patients to engage in self-care activities. To ensure that support can be provided as the patient's needs grow.

Regarding factors influencing the effect of educational interventions on glycemic control, this review suggests that the effect of improved glycemic control was not significant in studies that included patients with uncontrolled hyperglycemia (Hba1C>7.0%) (Miranda L de, Ezequiel, Vanelli, et al., 2022). This is inconsistent with a previous systematic review (Mikhael, Hassali, & Hussain, 2020), and this controversy may be due to the small sample size included. However, the intervention group knew more about the disease than the control group, and this increased knowledge facilitated the adoption of self-care measures. Behavioral and clinical changes may provide benefits in the long-term metabolic control of such patients. It is unclear whether the duration of the intervention affects the effectiveness of educational interventions for people with type 2 diabetes. Therefore, the length of educational interventions should be considered in the development of future educational interventions. A systematic review (Taylor, Pinnock, Epiphaniou, et al., 2014) noted that the effect of improving self-management behaviors in type 2 diabetes diminished in intervention studies beyond 12 months of follow-up. The longest follow-up period for the studies included in this review was 12 months, and it is unclear how long the positive effects of the interventions observed in these studies on glycemic control will persist. Ongoing care may be required to maintain the effects shown. The effect of the intervention over a longer time is still unknown and should be further explored in a longitudinal study. Healthcare providers face challenges in providing ongoing self-management support over time and according to individual needs. A combination of online and face-to-face approaches can be used to provide ongoing care. Regardless of the differences in the included studies, it is clear that nurse-led educational interventions are effective in improving glycemic control and self-care behaviors in patients with type 2 diabetes.

4.1 Gaps and future Recommendations

In this review, nurse-led educational interventions resulted in improvements in glycemic control and self-care activities for diabetic patients. Furthermore, maintaining patient involvement is an important determinant of the effectiveness of interventions to promote self-care activities. Further research is needed to examine the impact of the form, content, frequency, and delivery of educational interventions on clinical and patient-reported outcomes in patients with type 2 diabetes to design more effective interventions. In future studies, standardize the methods and outcome-measure evaluations of educational interventions to allow for comparisons and meta-analyses. Based on this review, future interventions will overcome the limitations of existing studies to improve glycemic control and self-care behaviors in type 2 diabetic patients.

4.2 Evidence for Practice

Overall, this review suggests that nurse-led educational interventions are effective in improving glycemic control and self-care behaviors in patients with type 2 diabetes. Microvascular and macrovascular complications in people with type 2 diabetes are directly related to glycemic control. Effective diabetes self-care education provided by healthcare providers can minimize the likelihood of such complications occurring as a result of poor glycemic control. Nurses are often at the forefront of patient care and play a critical role in the management of diabetes, providing education, support, and guidance to patients with diabetes, continually enhancing their educational practice, and contributing to the achievement of good health outcomes. Therefore, there is a need to focus on the education and training needs of nurses, including training in knowledge and skills in blood glucose monitoring, dietary guidance, exercise advice, medication, and complication prevention. This review illuminates evidence that may inform the training and practice of nurses in the management of diabetes.

4.3 Strength/Limitations

A strength of the design of this systematic review is that it follows the PRISMA process of the systematic review framework, adhering to a systematic and replicable framework for evidence procurement, selection, extraction and analysis. The research questions for the review were developed using the PICO framework (population, intervention, comparison and outcome). Data were analyzed using Guidance on the Conduct of Narrative Synthesis in Systematic Reviews (Popay et al., 2006).

It should be mentioned that this review has several limitations that need to be considered in the future. Firstly, there was significant heterogeneity in the included studies, which prevented us from drawing valid conclusions about the effectiveness of the interventions. Second, although all included studies were randomized controlled trials, there was a high risk of bias due to the lack of allocation concealment and blinding. Third, this systematic evaluation only included studies published in English, which may introduce language bias by omitting non-English articles with relevant results. Fourthly, most of the included studies were conducted in Middle Eastern countries and it may be inaccurate to generalize the results of this review to patients living in other countries. There are many different countries in the world and global representation must be taken into account. However, these limitations

are acceptable and additional future reviews are strongly recommended to support the results of the current study.

5. Conclusion

In the review, nurse-led educational interventions produced positive outcomes in terms of HbA1c and self-care behaviors. Due to differences in intervention duration, teaching format and diverse outcome measures, it is difficult to conclude which educational interventions are most effective. In order to make educational interventions more effective, future studies should involve more patients, have longer follow-up periods and establish comparable outcome measures. To determine the best components of educational interventions and delivery methods to maximize their effectiveness. The review highlights ways in which future practice and research can be informed to support all patients with type 2 diabetes to achieve good levels of glycemic control and improve quality of life.

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Appendix

Data Extraction Table

Author, year Country	Aim	Study Design	Sample patient characteristics (number of participants, gender, and age)	Intervention a) Type b) Frequency c)Duration	Outcome and Measurement Tool	Results and Comparison	Appraisal Comment
Lisa C.Whitehead et al. 2017 New Zealand	To determine whether a nurse-led educational intervention alone or a nurse-led intervention using education and acceptance and commitment therapy (ACT) was effective in reducing hemoglobin A1c (HbA1c) in people living with uncontrolled type 2 diabetes compared to	Quantitative RCT	NO (IG/ IG plus/CG) = 34/39/45 Gender Male (IG/ IG plus/CG) = 59%/ 44%/58% Age (IG/ IG plus/CG) =53.76/ 56.1/56.4	A) IG: a nurse-led educational intervention alone IG PLUS: a nurse-led intervention using education and acceptance and commitment therapy (ACT) CG: usual care B)1 day workshop	Data collection at 3 months after baseline and 6 months after baseline. HbA1c, and The summary of diabetes self-care activities measures diabetes self-care activities: general diet, exercise, and blood glucose	HbA1c: IG: -0.21 IG-ACT; -0.04 CG: +0.32 Twice as many participants in the IG demonstrated an improvement as compared to the CG (56% of IG, 51% IG plus ACT, and 24%CG) HbA1c levels were reduced in both intervention groups and the change was statistically significant in the education-only group at 6 months post-intervention. Self-management activities IG plus: improved (10.39-13.25) IG: decreased (7.83-11.09) CG: increased	The results of this study suggest that a 1-day nurse-led group intervention can have an impact on the management of diabetes up to 6 months post-intervention. It is unclear how long the positive effects of the intervention on glycemic control observed in this study will last. Further research exploring the value of group sessions versus individual interventions, the relative advantages of ACT versus education, the impact of maintenance sessions and longer follow-up would enhance

	usual care.				testing	reflective of IG (8.74-11.36) No effect on secondary outcomes was found.	understanding of the value and role of interventions to support glycemic control.
Badriya Al Lenjawi et al. 2016 Qatar	To clarify whether a structured nurse-led diabetes education program based on theories such as the health belief model, control of positional change and patient empowerment was effective in improving glycemic and metabolic markers in South Asian patients with type II diabetes compared to routine	Quantitative RCT	NO (IG/ CG) = 109/181 Gender Male (IG/CG) = 37%/28% Age (IG CG) =55/52	a) an educational program: The structured, group-based program was designed based on a series of psychological theories including the changing locus of control theory, the health belief model, and the theory of patient empowerment. b) 8 h long, divided into four sessions each lasting 2 h, and held once weekly, c) for 12 months	HbA1c	IG: 7.87 CG: 8.42 a significant improvement in the HbA1c in IG, which was on average 0.55 % (95 % CI of −0.94 to −0.16 %) lower than that of CG (p value = 0.012).	The study was theory-based, and utilized empowerment coupled with a change of the locus of control through nondirective counseling. The inclusion of South Asian patients with type II diabetes in a structured, theory-based diabetes educational program that is led by nurses improves glycemic and metabolic parameters after 12 months. Two limitations, one is the lack of resources to track diabetes complications. The other limitation was the attrition rate, which was much higher in the

	outpatient care.						intervention group compared to the control group, possibly due to the fact that the project took place in the summer.
Shahla Vaziri Esferjani et al. 2022 Iran	To evaluate the impact of a mobile-based educational intervention on self-care behaviors and glycemic control among elderly with type 2 diabetes.	Quantitative RCT	No: IG/CG=59/59 Gender: Male (45.85), female (54.2%) Age:60-70 years	IG: intervention via mobile phone in three online sessions. Each training session lasted 60 min. for a total of 9 days They were asked to talk about their problems with the disease to the researcher and other patients in the WhatsApp group at the end of each training session. CG; diabetes routine care follow-up after 3-month	Self-care questionnaire by Glasgow & Toobert, HbA1c	After intervention: Self-care: IG (8.74 units of increase) ($P < 0.001$). no significant changes in CG ($P > 0.05$). IG was significantly higher than CG (53.56 vs 44.95) ($P<0.001$) HBA1C: IG was significantly lower than CG(7.00vs7.32%) the mean changes in patients' HbA1C were statistically significant in IG (0.22 units of decrease) ($P < 0.001$) whereas no such significant changes were observed in CG ($P > 0.05$).	This study also showed a moderate to large effect on the outcome variable. Further studies with longer follow-up are recommended to confirm our results. The inclusion criteria of minimum literacy and being over 60 years old for this study may make it difficult to generalize the results to all patients in the community. Therefore, the results cannot be generalized to people with type 1 diabetes, pregnant women with gestational diabetes and people under 60 years of age with type 2 diabetes.

Layla de Souza Pires Miranda 2022 Brazil	To investigate the effects of problematizing intervention in the treatment of individuals with type 2 diabetes mellitus.	Quantitative RCT	NO (IG/CG) =20/21=48.8%/51.2% Mean age 55.9 years Gender: female 61%, male 39% Hba1C>7.0%, A high percentage of patients had comorbidities such as hypertension (92.7%), dyslipidemia (68.3%), overweight (95%), retinopathy (41%), and neuropathy (39%).	IG: a problematizing intervention, developed within educational groups. held in 6 monthly meetings. Lesson themes: autonomy and self-care; the diet of patients with DM; guidance in specific situations of diabetes; the importance of correct use of medications and glycemic monitoring; healthy habits in diabetes; and myths and truths about the diet of people with diabetes. CG: routine consultations Follow up after 6 months	HbA1C Medication adherence was assessed using the Morisky –Levine Adherence Scale. the Diabetes Knowledge Scale (DKN-A), the Diabetes Attitudes Questionnaire (ATT-19), International Physical Activity Questionnaire (IPAQ) and diet was assessed using food frequenc	In IG, the average of HbA1C was higher at T6 than at T0. CG did not show significant differences over time. Moreover, no significant differences were found between either group at each time point. Adherence to the medications: no statistical differences were observed between the groups in T0 and T6 over time. DKN-A scale and the ATT-19 questionnaire: in T6, IG was higher than CG of knowledge regarding the disease, the average knowledge about the disease in IG increased by 1.73 ± 1.83 points in comparison to only 0.31 ± 2.03 in CG, the average level of knowledge	The sample evaluated during follow-up had difficulties with glycemic control and inadequate glycemic control through a flawed treatment regimen of insulin therapy. Although blood glucose levels were not reduced, the behavioral and clinical changes observed in the study could provide long-term benefits for metabolic control in this group of patients. Regarding the analysis of knowledge levels, a statistically significant increase was observed in this variable after the intervention over time. Problematic interventions are more effective than usual care and could be integrated as an adjunctive resource in the

					y question s	increased significantly in IG over time, a statistically significant increase was observed The food frequency questionnaire and physical activities did not show statically significant difference.	treatment of patients with T2DM in secondary care services. Limitations such as sample size and follow-up time, the development of new studies with longer follow-up times could help investigate the impact of a long-term approach for this group of patients.
Bagchegi O. et al. 2021 Iran	To investigate the effect of education based on Kolb's learning style on self-care behaviors of older people with type II diabetes.	Quantitative RCT	No (IG/CG) =34/28 Gender: 59.68% were female Mean age:66.42(SD=5.27)	a) IG: the educational intervention based on their learning style (described by Kolb as accommodating, diverging, converging and assimilating) CG: the same educational content was presented with a lecture and a booklet. b) Four 45 minutes-sessions	Kolb learning style questionnaire for patients in the intervention group and the Tobert and Glasgow self-care questionnaire for both groups.	The mean self-care scores: IG were 58.15 (SD=10.71) and CG were 44.7(SD=12.12), (P<0.001). Patients with accommodating learning style, who received their style-based education, had more improvement in their self-care behaviors scores (P<0.001). Also, the educational intervention had a significant effect	The results of this study showed that education based on Kolb's learning style was significantly effective in improving self-care in older adults with type II diabetes and was most effective in patients with an adaptive learning style. In addition, the educational intervention had a significant effect on diabetes self-care including diet. As

				(two sessions per week) c) 2 weeks Participants in both groups completed the self-care questionnaires before and one month after the intervention.		on self-care dimensions in diet (P<0.001). But its effect on the area of exercise(P=0.499) and blood sugar testing (P= 0.057) and medications (P=0.797) were non-significant.	older people's health literacy improves, so does their ability to manage their diet and physical activity. Other confounding factors, such as economic and cultural factors, which may influence the self-care behavior of older people with diabetes, were not assessed and this is one of the limitations of this study.
Arash Salahshouri, et al. 2018 Iran	To investigate the effectiveness of educational intervention based on psychological factors on nutritional behaviors as well as levels of fasting blood sugar	Mix method RCT	No (IG/CG) =73/72 Gender: IG/CG 67.1%/69.4%(female) Mean age: IG: 55.93 ± 12.04 years CG: 54.53 ± 9.43 years	a) the educational intervention was designed and implemented based on psychological factors (perceptions, beliefs, fears, concerns, and discomforts towards diabetic diet)) b) 8 one-hour sessions c) 3 months	Questionnaire and via interviews. Perceived Dietary Adherence Questionnaire (PDAQ) focused on proper	Mean scores of adherences to a healthy diet: IG 37.94 increased by 54.77 (P<0.001) CG:no statistically significant (p<0.059) Mean score of Hb1Ac: IG: significantly dropped (7.15 ± 1.68 to 6.18 ± 0.90, p < 0.001) CG: Hb1Ac values	The results of this study showed that an educational intervention based on psychological factors had a positive impact on patients' nutritional behavior as well as HbA1C levels after 3 months of implementation. Understanding the psychological factors associated with dietary

	(FBS) and glycated hemoglobin (HbA1c) in patients with T2D referring to diabetes clinics and healthcare centers in the city of Izeh, Iran.			CG: routine care	dietary adherence. Blood tests: HbA1c levels	increased significantly (7.46 ± 1.89 to 8.13 ± 8.01, $p = 0.024$)	adherence in patients with T2D may help to develop interventions and improve the given factors. One of the limitations of this study was that its findings could not be generalized to the entire Iranian diabetic population, because it was conducted in one geographical area.
Maria do Rosário Pinto, et al 2017 Portuguese	To ascertain whether a multicomponent educational program focused on lifestyle management strategies: (a) is significantly associated with metabolic control; (b) is effective on improving metabolic	Quantitative RCT	No: IG/CG= 64/58 Gender: Mean age=58.95 HbA1c ≥ 7.5%/58.5 mmol/mol	a) A structured multicomponent educational intervention program that includes individual interaction between diabetes educators and patients; group approach, a main theme throughout the activity which was theoretically structured and planned as a trigger to motivate pair discussion, and	HbA1c And controlled for economic difficulties, overweight, self-care adherence score, general and specific diet and medication	HbA1c: IG had a decrease in 11% more (effect-size $r2 = .11$) than CG for HbA1c ($p < .001$). When controlling for socioeconomic characteristics and comorbidities that showed to be associated to each parameter in pre-test, from pre to post-test only EG participants significantly decreased HbA1c [Wilks' $\Lambda = .702$; $F(1,57) = 24.16$;	The multicomponent educational program, structured on the principle of Therapeutic Education, has proven its effectiveness, especially with regard to metabolic control, result reinforced when correlated variables were controlled. Nevertheless, these results should be interpreted with some consideration

	control; and (c) whether metabolic control is maintained after controlling for socioeconomic and health individual variables (comorbidities).			telephone intervention, organized in a sequential global program b) 6 times c) 6 months CG: only 3 face-to-face moments		p < .001; ηp2 = .298; observed power = .998]	due to the limitations of the study, mainly related to the baseline difference in HbA1c levels between groups (EG and CG). There was even an aleatory patient distribution into groups, which leads us to suggest more research with Portuguese patients, analyzing the impact of these programs in health gains, especially if randomization can be achieved.
Hee-Seung Kim 2007 Korea	Whether an Internet-based intervention system using a short-message service (SMS) provided by a nurse on cellular phones could improve	Quantitative RCT	No: IG/CG= 26/25 Gender (Male/female) IG: 11/15, CG: 11/14 Mean age: IG 47.5 years, CG 46.8 years	a) nurse sent optimal recommendations back to each patient, weekly, by an SMS by cellular phone or wired Internet. Interventions include continuous education and reinforcement of diet, exercise, medication	HbA1c levels	IG: A mean decrease in HbA1c levels of 1.15% CG: a mean increase of HbA1c levels of 0.07% (p=0.005).	Although this study suggests that SMS intervention can significantly reduce HbA1c in the short term at 12 weeks, its long-term effectiveness remains to be determined. A limitation of this study is that participants were recruited from the endocrine

	glycosylated hemoglobin (HbA1c) levels, fasting plasma glucose (FPG) levels and 2 h post-meal glucose (2HPMG) levels in patients with type 2 diabetes.			adjustment, as well as frequent self-monitoring of blood glucose levels. b) weekly c) for 12 weeks CG: met the endocrinologist specialist once or twice during the 12 weeks and give them routine suggestions.			outpatient department of a tertiary care hospital in a Korean city. They could not be representative of all Korean diabetic patients, which affects the generalizability of the study results. Another limitation was the lack of control over access to other sites or resources while participants were participating in this study.
Alireza Didarloo 2016 Iran	To examine the impact of interactive approaches-based educational intervention program on beliefs, behavior, HbA1c, and QOL in diabetics.	Quantitative RCT	No: IG/CG= 45/45 Gender: women Age: >30 years	a) Educational intervention based on interactive educational approaches. In instructional sessions, collaborative and interactive teaching methods (group discussion, brainstorming, and question and	A self-reported questionnaire (attitude toward behavior (12 items), blood sample HbA1c	IG had statistically significant reduction in the mean of HbA1c from 9.42 to 7.81 ($P < 0.001$). CG showed no significant changes in the outcomes measured ($P > 0.05$). Mean score of self-care behavior: IG had statistically	Applying an interactive and collaborative approach to education is important, helpful, and valuable in educating female patients with diabetes. When designing educational interventions, the focus should be on the individual needs

				response techniques) were used. b) 60 min per week c) 4 weeks, followed 3 months CG: routine treatment		significant increase 2.4 to 4.3(p<0.001), CG 2.5 to 2.4 (P<0.001)	of each patient, which means that a patient-centered approach is needed. In addition, patients with type 2 diabetes should receive ongoing education. Over time, knowledge is often lost. The shortage of follow-up period, small sample size, and losing samples within the study process were the study limitations.
Hormoz Sanaeinasab 2021 Iran	Assess the efficacy of a comprehensive health education program on different aspects of lifestyle in order to improve glycemic control in persons with T2DM.	Quantitative RCT	No: IG/CG= 40/40 Gender: 59% female Mean age:50.7 years	a) educational strategies included role playing, group discussion, watching a short video, and listening to a lecture, which were implemented. Six face-to-face 90-minute sessions were held on a weekly basis using small groups (8–10 participants in	HbA1c, Health Promoting Lifestyle Profile (HPLP-II)	HbA1C IG:8.8 to 7.9 (p<0.001) CG: 8.9 to 8.5(p=0.48) Nutrition 2.58 to 3.02(P<0.001), CG 2.64 to 2.69 (P=0.029) Physical Activities IG 1.98 TO 2.63(P<0.001), CG 2.05 to 2.09(P=0.01) The percentage of participants with acceptable glycemic control	The findings of the present study indicate that a health education lifestyle program such as the present one may help persons with T2DM significantly improve their lifestyle to the extent that it improves the control of their blood sugar and other metabolic and clinical parameters. The shortage of

				each group). b) weekly c) 45 days CG: routine treatment		(HbA1c < 7) improved in both groups, but the improvement was greater in the intervention group. While 27.5% of intervention group had HbA1c < 7 at baseline, this this percentage increased by 10% to 37.5% at follow-up. The increase among controls was only 5% from 30% at baseline to 35% at follow-up.	follow-up period, small sample size, further research is needed to better understand the usefulness of such programs in diabetics and other medical conditions among those in different cultural settings.