Structured Type 2 Diabetes Education to Improve Self-Monitoring Blood Glucose, Self-Care Management, and Diabetes Knowledge in a Multicultural Family Practice Clinic

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Abstract

Background: The family practice providers at the family medicine residency clinic (FMRC) have neither sufficient time nor continuity of care to provide diabetes education to effectively reduce A1c levels. The FMRC has 500 multicultural type 2 diabetes patients with an A1c >7% that has increased by 23.2% in the previous five months. Multiple studies have demonstrated that structured diabetes education can significantly decrease blood glucose readings, improve self-care management, and diabetes knowledge to attain optimal glycemic control.

Objectives: To implement an evidence-based practice (EBP) project in the FMRC to improve participants blood glucose readings, self-care management, and diabetes knowledge.

Methods: A four-week, pre-post, same subject project was conducted in the FMRC. The intervention was a 40-minute structured group diabetes education delivered face-to-face. Outcome measures include self-monitored blood glucose, self-care management, and diabetes knowledge. Based on statistical power analysis, a convenience sample of 21 type 2 diabetes patients with an A1c >7% were recruited. Participants' age ranged from 38 to 82 years old with 71% of the participants African American or Hispanic.

Results: The 7-day average Self-Monitored Blood Glucose (SMBG) decreased from 168.76 mg/dl to 155.05 mg/dl, t=3.97, p<0.001. The modified Diabetes Knowledge Test (DKT) scores improved from 64.55% to 78.84%, t=5.04, p<0.001. The improvement in Diabetes Self-Management Questionnaire (DSMQ) scores was not statistically significant (pre=33.95, post=35.52, p=0.169); however, power analysis showed a small effect size (d=0.28).

 Conclusion: The study found that structured group diabetes education was an effective intervention among type 2 diabetes patients in the multicultural setting to improve SMBG and diabetes knowledge.

Introduction

Type 2 diabetes mellitus is a complex, chronic, and progressive disease that is characterized by high blood glucose, insulin resistance, and impairment in insulin secretion. Poorly controlled or chronic uncontrolled type 2 diabetes is a vicious cycle resulting in disease progression that can eventually lead to "acute, chronic, and serious complications" such as cardiovascular events, kidney failure, blindness, neuropathy, and amputations (Essien et al., 2017; Zheng et al., 2019, p.4). Despite significant advancements in diabetes diagnosis, treatment, and management, many diabetic patients continue with poor glycemic control due to failure of the patient's self-care, "poor patient-provider communication, lack of support from family, inadequate understanding or knowledge of the disease, lack of motivation to change" (Mogre et al., 2018). Structured diabetes education is the foundation of diabetes care to manage their diabetes effectively on a daily basis, to develop confidence, and "to take major responsibility to manage their condition" with blood glucose monitoring, lifestyle modifications, exercise, self-care, knowledge, and medication management for optimal glycemic control (Bukhsh et al., 2017, p.2).

The American Diabetes Association (ADA) standards of care provide comprehensive education based on the most current evidence-based guidelines divided into 16 sections that include diabetes diagnosis, prevention, glycemic targets, pharmacologic approaches, comorbidities, complication management, and diabetes care throughout the lifespan (ADA, 2021). The ADA (2022) promotes diabetes self-management education that is patient-centered, focusing on "supporting patient empowerment by providing people with diabetes the tools to make informed self-management decision" (p.561). An effective way to actively involve type 2 diabetes patients in diabetes self-care management is through an evidence-based diabetes

education that is both visual and verbal, which employs a patient-centered approach to apply strategies in an "empowered, learning environment, and further strengthening patients' self-care ability" (Defeudis et al., 2018; Hung et al., 2017, p.2).

Multiple studies have found that the effectiveness of structured, frequent self-monitored blood glucose (SMBG) monitoring had a statistically significant reduction in blood glucose and A1c levels. The SMBG results can "facilitate analysis and discussion of glycemic patterns" and when structured, provides valuable information to providers and patients to possess the skills, knowledge, and readiness to make lifestyle modifications (Bosi et al., 2013, p. 2887). Cheng et al. (2018) study found that small group diabetes education intervention was statistically significant to improve SMBG and self-care management, although the A1c levels had no significant change. Moreover, these studies have concluded that the Diabetes Knowledge Test (DKT) scores have inverse correlations with blood glucose readings and A1c levels were strongly positive with the Diabetes Self-Management Questionnaire (DSMQ) sum scale that are statistically significant (Bukhsh et al, 2019; Cheng et al., 2018; Sperl-Hillen et al., 2011; Zheng et al., 2019). Bukhsh et al. (2019) study involved a structured diabetes education intervention that found improved self-care management and diabetes knowledge scores utilizing the DSMQ and the modified DKT questionnaires. Studies have estimated "50-80% individuals with diabetes lack of knowledge about diabetes education, …and A1c 7% target is achieved in less than half of type 2 diabetes" patients (Chai et al., 2018, p. 1427). It is estimated that only 16% of type 2 diabetes patients carry out self-care management recommendations, thus structured group diabetes education was recommended to facilitate self-care management and improve diabetes knowledge through "appropriate diet, physical activity, blood glucose monitoring, and adherence

to medication" to achieve their target A1c goals (Beverly et al, 2013; Bosi et al., 2013; Chai et al., 2018, p. 1429; Essien et al., 2017; Sperl-Hillen et al., 2011).

Background and Significance

Type 2 diabetes mellitus is an epidemic affecting 37.3 million or 11.3% of the US population with an expected increase of 30% by 2050 (ADA, 2022; Freeman et al., 2018). As of 2019, there are 8.5 million undiagnosed type 2 diabetes patients, and 96 million diagnosed with prediabetes that without an diabetes education intervention have the potential to develop type 2 diabetes within five years (ADA, 2022; CDC,2021). The diabetes health care cost is estimated at $327 billion annually with associated diabetes expenditures that are 2.3 times higher and twice the mortality rate than non-diabetic patients (ADA, 2022; Freeman et al., 2018). The cost of diabetes care is one-fourth of the US health care expenditures with 61% of costs associated with diabetic patients aged 65 years or older (Powers et al., 2020). It is estimated that more than 50% of the type 2 diabetes population are unable to "attain and sustain a recommended A1c of less than 7.0" and adherence to self-care management is a significant determinant to attain optimal glycemic goal (ADA, 2015, as cited in Freeman, 2018, p.396).

Multiple barriers to diabetes education and self-care management are present in the diabetes patient population that contribute to intervention failure and poor self-care management. Conflicting and busy schedules, competing priorities, lack of motivation, food insecurities, and transportation issues are barriers noted in the literature that cause challenges to self-care management (Mogre et al., 2018). Moreover, type 2 diabetes patients face challenges in their self-care management that "can lead to frustrations and emotional struggles" that hinder glycemic control (Ritholz et al., 2018, p. 304). Another barrier is limited access to available diabetes self-management education (DSME), "lack of or poor reimbursement" that prevents

participation, and misconceptions that initial education is sufficient, thus less than 10%

attendance within the initial 12 months of diagnosis (Powers et al., 2015, p.1379). A patient

centered approach to diabetes education at diagnosis and ongoing can assist the patient "to

overcome barriers and to cope with the ongoing demands in order to facilitate changes" (Powers

et al., 1374). Although uncontrolled diabetes patients find difficulty in "synthesizing self-

management recommendations" into their daily routines, a structured diabetes education

intervention would provide "the knowledge, skills, and confidence to accept responsibility for

their self- management" (Cheng et al.,2018; Powers et al., 2020, p.1638).

Multiple studies have shown that intensive, daily SMBG monitoring promotes the

diabetes patient's adherence to their self-care management that is a significant determinant that

builds confidence and motivation to attain optimal glycemic target goals, control of the disease,

improved overall health, and reduce the financial burden (Cheng et al., 2018; Elgart et al., 2015).

In addition, low self-care management have been associated with higher A1c levels. Structured

group diabetes education based on a patient centered approach that embraces the ADA standard

of care guidelines can empower diabetic patients to improve self-care management, knowledge

of the disease, increase patient participation in treatment decisions, and skills to operate a

glucometer to achieve optimal glycemic control (Mogre et al., 2018).

The family medicine residency clinic (FMRC) is a busy primary care clinic that has over

20 providers and medical residents with teams of registered nurses, licensed practical nurses, and

medical assistants. The FMRC has 20-minute patient appointments that do not allow the

providers time nor continuity of care to deliver sufficient diabetes education to type 2 diabetes

patients. The FMRC tracks the A1c levels through the Healthcare Effectiveness Data and

Information (HEDIS), yet the data is often not used to guide patient care. Moreover, there is a

lack in follow up appointments to review the SMBG readings, A1c levels, co-morbidities, medication management, and long-term treatment goals. Although the ADA standards of care recommend reassessment of A1c levels every 3 months if the A1c is > 7% or changes in medication therapy, the FMRC type 2 diabetes patients A1c levels are only checked once or twice a year (ADA, 2021). Currently, there are 500 diabetic patients with an A1c >7% in the FMRC, representing an increase of 23.2% in the past five months. This significant percentage increase over a short time frame can be equated to the lack of the FMRC follow up appointments, inadequate continuity of care, and absence of a patient centered structured diabetes education program that promotes effective self-care management and improved diabetes knowledge.

Needs Assessment

A strength, weakness, opportunities, and threat (SWOT) analysis was performed to assess the organization and strategies to improve diabetes blood glucose, self-care, and knowledge (see Appendix A). The organizational strengths are related to the hospital's level III trauma accreditation, multiple specialty clinics, experienced physicians, nurse practitioners, and clinical pharmacists that encourages collaboration and furthering educational opportunities that promotes patient centered care. Although a vast array of qualified providers, there were multiple organizational weaknesses with type 2 diabetes patients related to the knowledge gap in diabetes standards of care guidelines, ineffective staff to patient communication, limited access to care, short 20-minute appointments, inefficient use of HEDIS A1c measures related to diabetes care, and lack of individual or group standardized structured diabetes education. Moreover, the covid-19 pandemic had hindered face to face appointments for type 2 diabetes patients. One of the greatest opportunities was the potential for the development of a robust FMRC focus on a

structured group diabetes education program based on the ADA standard of care guidelines with leadership support to promote optimal SMBG control, improved self-management, and diabetes knowledge. In addition, a structured diabetes program would reduce organizational diabetes costs, expansion to the outlying family medicine clinics, provide competition with civilian medical centers, and streamline comprehensive diabetes patient centered care. Implementation would be meaningful to staff and patients in alignment with organizational priorities. An organizational threat would be competing clinic and organizational priorities, current diabetes education program in the internal medicine clinic, patient preference to be seen by a civilian endocrinologist or the veteran's administration (VA), and lack of FMRC providers to implement and develop a structured diabetes education program. The success of the EBP project was achieved through a collaborative relationship between the three project team members, the FMRC leadership, and the organizational senior leadership in a structured group diabetes education setting with shared decision-making opportunities.

Problem Statement

A comprehensive assessment was conducted in the FMRC that found lack of appointment times, inadequate continuity of care, and void of a structured group diabetes education program that potentially led to a significant increase in A1c levels >7%. Many perceived barriers affect the diabetic patient's ability to manage daily commitments in self-care management and application of diabetes knowledge to achieve optimal glycemic control. Multiple research studies have documented that an evidenced based structured group diabetes education was a cost-effective tool to improve blood glucose readings, self-care management, and diabetes knowledge utilizing the DSMQ and modified DKT questionnaires (Bukhsh et al., 2019; Chai et al., 2018; Cheng et al., 2018; Sperl-Hillen et al., 2011; & Zheng et al., 2019). A structured

diabetes education program is critical to build self-confidence and motivate type 2 diabetes patients to engage in blood glucose monitoring, self-care management, and diabetes knowledge to prevent co-morbidities, complications, or mortality.

Purpose

The purpose of this EBP project was to implement an evidence-based structured group diabetes education program within the FMRC to improve SMBG, self-care management, and diabetes knowledge.

Clinical Question

In type 2 diabetes patients in the FMRC (P), how does diabetes education based on the American Diabetes Association (ADA) standard of care guidelines (I) improve self-monitored blood glucose readings, self-care management, and diabetes knowledge (O) compared to current procedure (C) when measured at baseline and four weeks post intervention (T)?

Aims

The EBP project aims to achieve the following over a four-week period:

- To improve type 2 diabetes patients self-monitored blood glucose (SMBG)

- To improve type 2 diabetes patients self-care management behaviors assessed by the Diabetes Self-Management Questionnaire (DSMQ) pre and post intervention

- To improve diabetes knowledge assessed by the modified Diabetes Knowledge Test (DKT) among type 2 diabetes patients pre and post intervention

Objectives

The first objective was to evaluate the effectiveness of an evidence-based structured, group diabetes education based on the ADA standard of care guidelines with SMBG readings by comparing pre and post diabetes education intervention over a four-week period.

The second objective was to improve self-care management to achieve an increased score on the DSMQ between the pre and post diabetes education intervention over a four-week period.

The third objective was to improve type 2 diabetes patients diabetes knowledge score between the pre and post diabetes education intervention over a four-week period.

Review of Literature

Search Strategy

We performed searches on PubMed and SCOPUS to identify evidence regarding the effectiveness of structured diabetes education on patient outcomes. The librarian was consulted during the literature search to assist in the primary choice of appropriate search terms. Keywords used included type 2 diabetes, diabetes education, self-monitored blood glucose, blood glucose, self-care, and diabetes knowledge. The PubMed search resulted in 175 articles while SCOPUS search found 26 articles.

The 201 articles found through PubMed and SCOPUS were reviewed for appropriateness related to the research question and inclusion/exclusion criteria. We removed 94 duplicates and 107 articles were further reviewed. Regarding the research question, 9 articles were excluded as they did not meet criteria and 5 articles excluded as the intervention was not specific or defined. There were 6 articles excluded as there was no diabetes education or self-care interventions, 4 articles excluded for no diabetes knowledge intervention, 7 articles excluded for no reduction in blood glucose and/or A1c post intervention, and 9 articles excluded for absence of face-to-face diabetes education. In addition, six articles were excluded for controversial conclusions in the use of SMBG readings for glycemic control, and three articles excluded as educational only to teach use of glucometer and monitoring blood glucose. There were two articles excluded as pilot studies and one article excluded as an interview only without intervention. Finally, 14 articles

were excluded, as they were systematic reviews, meta-analysis, and observational studies. After

the exclusion, 11 articles remained in this literature review. The details are presented in the

PRISMA form (See Appendix B).

Synthesis of the Literature

The 11 articles together included 2,655 participants. The participants were type 2

diabetes patients with an A1c >7% who attended diabetes self-management education (DSME)

or other structured form of diabetes education. The diabetes education was taught either by

physicians, nurses, pharmacist, or a combination thereof. The research studies had comparable

results that support the use of diabetic education interventions and structured SMBG to improve

diabetes self-care management behaviors and diabetes knowledge. Bosi et al. (2013) and Chai et

al. (2018) found that intensive SMBG reduced fasting and 2-hour postprandial blood glucose to

achieve significant A1c reductions compared to unstructured SMBG data. The concept of

structured, frequent checking of blood glucose provided knowledge and motivation that

facilitates their self-care management and coping skills (Brackney, 2018; Eborall et al., 2015; &

Zheng et al., 2019). Hung et al. (2017) found that using a patient centered diabetes education

intervention was statistically significant (p<0.01) in the long-term effectiveness in enhanced

frequency of SMBG monitoring, reducing fasting blood glucose readings, and A1c levels. In

addition, the use of diabetes questionnaires – Summary of Diabetes Self-Care Activities

(SDSCA), Diabetes Empowerment Scale (DES), DSMQ, and the modified DKT endorsed

structured diabetes education for improved self-care management and knowledge that

significantly reduced blood glucose readings and A1c levels (Bukhsh et al., 2019; Cheng et al.,

2018; Sperl-Hillen et al., 2011; & Zheng et al., 2019). Azami et al. (2018), Cheng et al., (2018),

and Sperl-Hillen et al., (2011) utilized small groups of four to ten participants for the diabetes

education intervention and achieved statistically significant (p<0.001) improvement in SMBG, A1c levels, and self-care management. Thus, the evidence is consistent that an intensive structured diabetes self-management education program is effective in the reduction of blood glucose and A1c levels, improved self-care management, and diabetes knowledge (Azami et al., 2018; Chai et al., 2018; Essien et al., 2017; Sperl-Hillen et al., 2011 & Zheng et al., 2019) (see Appendix C).

EBP Translation Model

The Iowa Model

In the 1990s, the Iowa model was developed by nurses at the University of Iowa hospitals, who developed a research framework to "guide clinicians in evaluating and infusing research findings into patient care" (Buckwalter et al., 2017, p. 175). The Iowa model was based on Roger's theory to incorporate strategies learned when performing research projects. The Iowa model uses a systematic flow chart with steps for problem solving and feedback loops to guide the change process. It is a concise model that "supports the use of case study and expert opinion as evidence, supports pilot trial before implementation occurs across system, and designs as an interdisciplinary approach" (Zhao et al., 2016). A strength of the Iowa model was the concentration on the practice issues that are meaningful to the staff and patients in alignment with the organizational priorities (Duff et al., 2020).

The Iowa Model steps include: 1) identify a problem-focused or knowledge-focused triggering issues/opportunities, 2) state the question or purpose, 3) form a team, 4) assemble, appraise and synthesize body of evidence-conduct systematic research, 5) design and pilot the practice change, 6) integrate and sustain the practice change, 7) disseminate results (Buckwalter et al., 2017). If the change was appropriate, then the change was implemented into practice to

monitor, analyze structure, process, and outcome data (Brown, 2014). The hallmark of the Iowa

model was the integration of the multidisciplinary team interactions between the team members

and patients.

Identifying Issues/Opportunities

A problem-focused trigger was utilized to identify the topic in the FMRC. The project

team members were concerned about the quality of type 2 diabetes management in this clinic.

The increased number of patients with A1C greater than 7 provides an opportunity to implement

an evidence based educational intervention to reduce patients' SMBG readings, improve self-

care management and diabetes knowledge.

Purpose

The purpose of this EBP project was to implement a structured group diabetes education

based on the ADA standard of care guidelines integrated into the FMRC for the type 2 diabetes

patients with an A1c > 7% to improve their SMBG readings, self-care management, and diabetes

knowledge within a 4-week period.

Formation of a Team

A formal team was assembled that consisted of a nurse practitioner and two physicians to

develop and implement a structured group diabetes education.

Assemble, Appraise and Synthesize Body of Evidence

As discussed in the literature review section, a comprehensive literature search was

conducted and 11 research articles were appraised. Evidence was strong supporting the usage of

structured diabetes education.

Design and Pilot the Practice Change

Pre-implementation data from the HEDIS measures showed that the current FMRC setting was void of a formal, structured group diabetes education program. Many patients had elevated A1c levels that have a direct correlation in the elevated SMBG readings, and decreased self-care management, and diabetes knowledge.

The team developed the education intervention based upon the ADA standards of care guidelines. These guidelines were established as to the frequency of the patients SMBG readings, and diabetes education - monitoring, management, medications, and nutrition in a structured group diabetes education. The project team members ensured standardization and consistency between the team members for the delivery of the education intervention, participant education booklet, and the administration of the DSMQ and the modified DKT questionnaires. Furthermore, contingencies were in place for unforeseeable circumstances- participant withdrawal or change in the provider's schedule. The team prepared the required materials for the participants - diabetes education handouts, and the DSMQ and the modified DKT questionnaire prior to the intervention.

Integration and Sustained Practice Change

The key personnel in the EBP project were the three project team members, FMRC leadership, and organizational senior leadership. The DNP student served as the project leader. The FMRC leadership commitment to integration of a structured diabetes education program would improve diabetic outcomes that combined with senior leadership support to solidify and sustain the practice change. The long-term goal was to have an embedded diabetic education program as an automatic step in the workflow process, replicable in the outlying family medicine clinics, and results in optimal glycemic control for type 2 diabetes patients across the organization.

Dissemination of Results

A comprehensive evaluation assessed the value and contribution of the educational intervention to improve patients' SMBG readings, self-care management, and diabetes knowledge. The results were disseminated to the FMRC and the organization senior leadership for long-term implementation of a formal structured, group diabetes education program to improve overall diabetes care, optimal glycemic control, and prevention of long-term co-morbidities and complications.

Methods

Study Design

This EBP project used a pre-post same participant design to evaluate an educational intervention among patients with type 2 diabetes. The project intervention included a 40-minute structured group diabetes education intervention that covered diabetes topics related to monitoring, management, medications, and nutrition in a structured group of three to six type 2 diabetes participants. The project team members delivered the intervention face-to-face in a group session. The intervention was designed using the ADA diabetes care guideline. The pretest data served as the control. Baseline data was collected at the beginning of the diabetes education intervention session. Then the intervention was delivered by one of the three project team members in an FMRC conference room. Outcomes were collected one month after the intervention.

Setting

The overall setting for the EBP project was based in the FMRC at a regional medical military treatment facility (MTF) located in North Carolina. The general demographics of the FMRC included 500 type 2 diabetes patients with an A1c > 7%. The FMRC type 2 diabetes

male population was 259 males with age ranging 18-91 and 239 females ranging 30 to 92 years old.

Participants Recruitment

The goal for this EBP project was to recruit 34 participants. This sample size was pre-determined by statistical power analysis. With alpha of 0.05, it was necessary to recruit a minimum of 34 participants to achieve an 80% power to detect a significant change. However, due to the time strain and practice issues, we recruited only 21 participants.

Patients were approached to participate if they meet the inclusion criteria: (1) patients have a diagnosis of type 2 diabetes mellitus, (2) have a current HbA1c >7%, (3) must be over the age of 18, and (4) able to speak, read, and understand English. The participants were excluded if: (1) gestational diabetes, (2) steroid induced diabetes (3) type 1 diabetes (4) currently pregnant, and (5) cognitive impairment.

The project team members enlisted assistance from clinic providers and staff for recruitment of type 2 diabetes patient during scheduled appointments. The objective was for the staff to ask these patients if they would like to participate in the EBP project and if so, could schedule with the front desk for the 40-minute structured group education intervention.

The scheduled participants were screened by the project team members regarding inclusion and exclusion criteria prior to the scheduled intervention. Due to covid 19 social distancing requirements, the class size was limited to a maximum of six participants.

Cost and Compensation

The study participants are assigned to a regional medical MTF located in North Carolina that are active-duty military, military retirees, or their dependents, thus there were no costs, co-pays, or compensation associated with the study intervention.

Outcomes to be Measured

The study outcomes were threefold: SMBG readings, the DSMQ, and the modified DKT questionnaires. The demographic information - age, gender, education level, duration of type 2 diabetes, and medication (insulin and/or oral diabetes medications) was collected by a pre intervention questionnaire developed by the project team members.

Self-Monitored Blood Glucose (SMBG)

A freestyle glucometer was used by the diabetes patients in this clinic to measure their blood glucose. The participants were given instructions to check their daily am fasting blood glucose using their freestyle glucometer. The capillary blood glucose measurement by a glucometer has a sensitivity of 83.5% and specificity of 97.5% (Nayeri et al., 2017). Before the class sessions and 4 weeks post education sessions, the project team members read and documented the weekly average blood glucose from the patients' meter.

Diabetes Self-Care Management

Diabetes self-care management was measured by the Diabetes Self-Management Questionnaire (DSMQ) (see Appendix D). The DSMQ is a 16-item questionnaire to assess the diabetes patients' self-care activities and glycemic control for the last 60 days on a 4-point Likert scale (Azami et al., 2019). All sixteen items are scaled from 3-0, as 3 represented "applies to me very much", 2 is "applies to me to a considerable degree", 1 is "applies to me to some degree", and 0 is "does not apply to me". The sixteen items are divided into subscales: glucose management (question 1,4,6,10,12), dietary control (question 2,5,9,13), physical activity (question 8,11,15), and health care use (question 3,7,14) (Bukhsh et al., 2017). The sixteen items are scored to determine self-management in diabetes patients with the highest possible score of 48. A higher score represents better self-care management. The

reliability and validity of this tool revealed excellent internal consistencies of the DSMQ Sum Scale and glucose management subscale with a Cronbach's alpha coefficient of 0.96 and 0.91 respectively. There are good consistencies for dietary control and physical activity at 0.89 and good consistency with health care use at 0.73 (Bukhsh et al., 2017).

Diabetes Knowledge

Diabetes knowledge was measured by the modified Diabetes Knowledge Test (DKT) (see Appendix E). This 20-item test assesses the diabetes patient's general diabetes knowledge (Azami et al., 2019). Each question has three answers: true, false, and don't know. The first 16-items are related to healthy diet, foot care, exercise, neuropathy, and illness. The last four items are for type 2 diabetes patients that are currently taking insulin related to blood glucose, insulin, and appointments. In this EBP project, for each question, the project team leader coded the correct answer as 1 and incorrect answer as 0. The summary score provided an overall knowledge score. A higher score represents better diabetes knowledge. The DKT tool was assessed using Cronbach's alpha coefficient that found reliability at 0.77 and construct validity was supported (Fitzgerald et al., 2016).

General Demographics

The study participants demographic information was collected by a pre intervention questionnaire developed by the project team members. The data elements were categorically collected based on: (1) gender – male, female, (2) age by last birthday, (3) education level – < high school, high school or GED, some college, bachelor's degree, more than bachelor's degree, (4) years of diagnosis of type 2 diabetes, and (5) diabetes medication – no diabetes medications, oral medication, insulin, combination of insulin and oral medications.

Data Collection

Prior to the beginning of the 40-minute structured group education intervention, the

project team members distributed and collected the demographic questionnaire, the DSMQ and

the modified DKT questionnaires, along with the collection of the participants freestyle

glucometer to record the prior 7-day average blood glucose readings. The participants were

scheduled a 4-week individual diabetes follow up appointment at the end of the diabetes

education intervention. At the beginning of the 4-week individual diabetes follow up, the

participants freestyle glucometer was collected to record the prior 7-day average blood glucose

readings, and the DSMQ and the modified DKT questionnaires was distributed for the

participants to complete and collected prior to the beginning of the appointment. During the

individual 4-week follow up appointment, the project team member reviewed and reinforced the

diabetes education – monitoring, management, medication, and nutrition information with the

participant. The project team members recorded the pre and post intervention data after each

encounter in a mutually shared Microsoft excel worksheet.

The DNP project team leader was responsible for the collection and scoring of the pre

and post intervention data collected – the prior 7-day average of SMBG from participants

freestyle glucometer, the DSMQ, and the modified DKT questionnaire. A Microsoft excel

spreadsheet was used to securely store data. The pre and post intervention data collected was

checked for accuracy and confirmed by a second project team member.

HIPPA Concerns

Concern with HIPPA information in this project is evident. In research, the regulatory

framework for human subjects is known as the Common Rule. The Common Rule includes

respect for persons, beneficence, and justice and is responsible for requiring study by the

Institutional Review Board (IRB). The project underwent an IRB Non-Research Determination

at a regional medical MTF in North Carolina. Patients presenting with chronic uncontrolled or

poorly controlled type 2 diabetes were targeted for this study. Patients who volunteered to

participate in the education sessions had a group education Ahlta encounter documented on the

day of the event under the project team leader. The project team members reviewed their records

retrospectively and prospectively to evaluate and change specific diabetic objective outcomes.

The patient's personal identifying information (PII) was only used to access their medical record

for necessary data points. All printed PII was secured behind two locks and properly destroyed

at the conclusion of the project. No patient PII or identifying data was used in any data set, the

narrative of the project, or in dissemination.

Project Timeline

The project was developed and implemented over a 15-week period. The EBP proposal

was sent to the organizational IRB that was approved on July 8, 2021. Over the next four-week

period, the project team members began participant recruitment and developed the type 2

diabetes education materials and the diabetes booklet. For the next two weeks, the project team

members met to discuss the flow of events during the structured group education intervention,

ensure uniform and consistency amongst each project team member related to diabetes

education, the diabetes education booklet, frequency and duration of SMBG, and the DSMQ and

the modified DKT questionnaires. The seventh through the tenth week involved the

implementation of the structured group diabetes education pre intervention with pretest data - the

7-day average SMBG, DSMQ, and the modified DKT questionnaires collection prior to each

weekly pre intervention. The post test data was collected prior to each individual 4-week follow

up appointment from the tenth to thirteenth week. In week 14 and 15, the pretest and post test

data were analyzed, and the EBP results were edited and disseminated thereafter (See Appendix F).

Resources Needed

The project implementation necessitated a laptop, a projector, and writing materials for the participants to fill out the questionnaires and to take notes during the diabetes education intervention. The project team members used their government issued laptops to collect data on a shared Microsoft excel spreadsheet.

Evaluation Plan

The outcome evaluation is described above in the methods section.

Data Analysis, Maintenance, & Security

The collection of data was reviewed for any errors, inconsistencies, and to ensure completeness. The Statistical Package for the Social Sciences (SPSS) (IBM, 2021) was utilized to analyze the data. The project team members analyzed the demographics based on the pre intervention patient demographic questionnaire. Descriptive statistics were used to capture the participants' demographic data, to include age, gender, education level, duration of type 2 diabetes, and medication (insulin or oral diabetes medication). Inferential statistics was used to determine the impact of the diabetes education intervention on SMBG, self-care management, and diabetes knowledge based on the DSMQ and the modified DKT questionnaires. A paired t-test was used to analyze the pre and posttest SMBG data, the DSMQ and the modified DKT questionnaires. A McNemar test was used to analyze the modified DKT question 17 and question 18. For all inferential analysis, the alpha was set at 005.

Results

Table 1 presented a summary of the characteristics of the sample. The participant average age was 55 years old, with the minimum age of 38 and maximum age of 82. One-third of the participants were female (n=7, 33%) and two-thirds were male (n=14, 67%). Most of the participants held a bachelor's degree or higher (n=13, 61.9%) and only two participants had education level of GED/high school (9.6%). The participants years of type 2 diabetes ranged from one to five years (n=8, 38%), 5-15 years (n=7, 33%), and >15 years (n=6, 29%). The types of diabetes medications used by the participants was insulin only (n=1, 4.8%), oral medications and insulin (n=13, 61.9%), and oral medication only (n=7, 33.3%).

Table 1. Characteristics of the sample (N=21)

Variables	Frequency	Percent
Age		
• 30-54	9	43%
• 55-65	7	33%
• >65	5	24%
Gender		
• Male	14	66.7
• Female	7	33.3
Education Level		
• GED	1	4.8
• High School	1	4.8
• Some college	6	28.6
• Bachelors	9	42.9
• More than bachelors	4	19.0
Years of Type 2 Diabetes		

• 1-5	8	38
• 5-15	7	33
• >15	6	29
Type of DM Medications		
• Insulin only	1	4.8
• Oral & Insulin	13	61.9
• Oral only	7	33.3

Table 2. Differences in outcomes pre and post intervention

	N	Pre intervention	Post intervention	t (paired)	P value
Self-Monitored Blood Glucose (SMBG) readings	21	168.76 (58.41)	155.05 (50.689)	3.97	**<0.001**
Diabetes Self-Management Questionnaire (DSMQ)	21	33.95 (5.25)	35.52 (5.76)	1.43	0.169
Modified Diabetes Knowledge Test (DKT)	18	64.55 (15.16)	78.84 (10.48)	5.04	**<0.001**

Table 2 summarized the mean, standard deviation, t value, and p-value for the 7-day

average SMBG, the DSMQ, and the modified DKT pre and post intervention data. The first aim,

to improve the 7-day average SMBG, was supported by the data. The mean pre intervention

SMBG was 168.76 and the mean post intervention SMBG was 155.05, t=3.97, p<0.001. The

SMBG readings improved significantly from pretest and posttest intervention.

The second aim, to improve type 2 diabetes patients self-care management, was measured

to ascertain whether the project met this aim, the DSMQ questionnaire was administered to the

participants as a pre and post intervention. For the DSMQ, we reverse coded items 5, 7, 10, 11,

12, 13, 14, and 15 and constructed a summary score. The mean DSMQ for the pretest was 33.95

(5.25) ranging from 24 to 45. For the post test, the mean was 35.52 (5.76) ranging from 22 to 44

For both the pretest and posttest, the distributions are normal. The DSMQ scores improved from pretest to posttest, however, a paired t test showed that the difference was not statistically significant (p=0.169). The Cohen's d of 0.28 indicates that there was a small effect size.

The final aim, to improve the diabetes knowledge, was achieved by a statistically significant improvement in the DKT score. For the modified DKT, we coded the data as correct, incorrect or don't know. Then, we calculated the summary score and divided the score by 18 to obtain the percentage of correct answers for all questions except 17 and 18. The mean modified DKT for the pretest was 64.55 (15.16) and was 78.84 (10.48) for the posttest, t=5.04, p<0.001. The education intervention significantly improved the DKT score.

Both question 17 and 18 of the modified DKT concerned insulin and there were considerable missing values. We reported the two items separately. Table 3 summarized the results.

Table 3. Correct answers for DKT 17 and 18

		Pretest	Posttest	McNemar
DKT 17		4 (30.8%)	11 (84.6%)	P=0.016, significant
DKT 18		6 (54.6%)	6 (54.6%)	Not significant

Regarding question 17, "High blood glucose levels may be caused by too much insulin", at the pretest, 4 people answered the question correctly and at the posttest, 11 participants answered the question correctly. A McNemar test showed that the difference was statistically significant (p=0.016). For question 18, "If you take your morning insulin but skip breakfast your blood glucose level will usually decrease", six participants answered the question correctly at pre and posttest. There was no change.

Discussion

In this EBP project, we recruited 21 type 2 diabetes mellitus adults to participate in a 40-minute structured group diabetes education class. We assessed change in their prior 7-day average SMBG from the freestyle glucometers, self-care management with the DSMQ, and diabetes knowledge with the modified DKT pre and post education intervention. The majority of the participants were males with a higher level of education and utilizing oral and insulin medications that was expected as the clinic serves only active-duty military, military retirees, and their dependents. The higher percentage of male participants is in correlation with historically more males in the military and consistent with the national average of more than 11% of men diagnosed with type 2 diabetes compared to 9% of women. Similarly, Cheng et al. (2018), Bosi et al. (2013), and Zheng et al. (2019) also had a majority of male participants (55%-74%), while Sperl-Hillen et al. (2011) study had a majority with more than college and African American and Hispanic participants. Moreover, the overall US diabetes patient's ethnicity is 12.1% African American and 11.8% Hispanic, which is similar to this EBP project results as 71% of the participants were African American or Hispanic (ADA, 2022; "U.S. Department," 2020).

The ADA guideline based, structured group education was effective and achieved significant improvements in the 7-day average SMBG and diabetes knowledge. These positive results are similar to the evidence we evaluated (Azami et al., 2019, Brackney, 2018, Bukhsh et al., 2019, Chai et al., 2018, Cheng et al., 2018, Eborall et al., 2015, Essien et al., 2017, Hung et al., 2017, and Sperl-Hillen et al. 2011). Moreover, Bosi et al. (2013) study results were similar to our EBP results with improved SMBG readings for self-care management and promoted "the use of intensive, structured SMBG data by clinicians to optimize prescription of diabetes medication" to achieve A1c reductions (p.2890).

A goal of structured diabetes education was the collaborative process to promote the necessary skills with SMBG monitoring, self- care management, and diabetes knowledge. The SMBG improvement may be related to the diabetes participants consistency with checking their blood glucose from learned principles applied in their daily lives, SMBG monitoring that serves as a visible reminder, and learned to act on their SMBG readings with self-confidence and motivation to guide lifestyle modifications to optimize overall diabetes outcomes. Although the participants may not have had prior diabetes education, the improved diabetes knowledge after the diabetes education intervention may have reinforced or expanded their current diabetes knowledge base, increased attention to detail during the intervention, knowledge application at home, and family support. However, there were no significant difference in self-care management as measured by the DSMQ. We observed an increased self-care management score with the effect size of 0.28, but due to the small sample size, this does not reach statistical significance. Compared to blood glucose and knowledge, self-management may be more difficult to improve for multiple reasons. For instance, scheduling conflicts, financial constraints, inconsistencies with dietary and lifestyle recommendations; all those could impact the self-management score.

In summary, this EBP project consisted of a structured group diabetes education intervention with an individual follow up appointment that can be replicated in all family medicine clinics within the MTF. Thus, the FMRC can provide the structured group diabetes education to a large portion of the diabetes patients, with a close follow up with any provider in the MTF to further the education intervention – monitoring, management, nutrition, and medication management to improve long term diabetes outcomes.

Limitations

There were several limitations to this EBP project. First, we had a small sample size due to time strain and practice issues. Second, the time frame between the pre and post intervention was not sufficient to identify long term sustainable intervention effectiveness. Third, the narrow focus of the FMRC population, which serves only active-duty military, military retirees, and their dependents, make it difficult to generalize the result to other populations. Lastly, the continuing and worsening covid 19 pandemic contributed to potential participants willingness to attend an in-person structured group diabetes education intervention.

Implications

The current EBP project infers that the structured group diabetes education intervention effectively improved SMBG readings and diabetes knowledge. The EBP project may have various influences in clinical practice, healthcare policy, quality and safety, and executive leadership.

Practice

The ADA recommendations for strategies for improving diabetes care are multifactorial. Patient centeredness is a guide for an overall approach to diabetes care "that incorporates patient preferences, assesses to literacy and numeracy, and addresses cultural barriers" (ADA, 2015). A patient center approach recognizes that "one size does not fit all" that includes a comprehensive plan (ADA,2021). A collaborative effort among the healthcare professionals within the FMRC promotes a standardized practice for a diabetes education program that could support implementation in the four additional outpatient family practice clinics within the organization. The treatment decisions need to be based on evidence-based guidelines 'that are tailored to the individual patient preferences, prognoses, and comorbidities" (ADA, 2015). Thus, the FMRC may adopt the chronic care model (CCM) incorporated with the structured diabetes education

program to improve "adherence to the recommendations standards" and redefine the FMRC role in delivery of overall diabetes care (ADA,2015).

The current EBP results support the FMRC need to implement a structured group diabetes education program to assist all healthcare professionals in educating diabetes patients, subsequently improving their SMBG readings, self-care management, and diabetes knowledge. As this EBP project was conducted in a small group setting with individual follow up appointments, implementation of a structured diabetes education program with close follow up with any FMRC provider can be applied successfully.

Healthcare Policy

The ADA promotes diabetes standards of care guidelines to provide clinicians the "components of diabetes care, general treatment goals, and tools to evaluate the quality of care" with support for "on-going diabetes self-management education and support" that is critical to prevent and delay complications (ADA, 2021). The ADA continues to be active in providing up to date clinical guidelines and healthcare policy. The main objective of this EBP project was to provide the diabetes participants within the MTF with structured diabetes education that improved SMBG readings, self-care management, and diabetes knowledge. The EBP results have implications as the basis for developing and promoting healthcare policies that support structured diabetes education within the military family practices clinics that may provide evidence and support for state and national policy changes. A change in the healthcare policy that impacts family practice clinics promotes continued development of diabetes standards of care and structured diabetes education as a requirement during routine appointments.

Quality and Safety

The structured group diabetes education intervention played a significant role in improvement of the SMBG readings and diabetes knowledge. The implementation of a structured group diabetes education program within the family practice clinics has the potential to increase the quality and safety of diabetes care. The principles of diabetes safety through a patient-centered approach lends to ensuring the patients have the diabetes knowledge and skills for medication management and application of SMBG readings for daily self-care management. The Agency for Healthcare Research and Quality (AHRQ) provides data and tools that promote improved quality of care of diabetes patients as gaps in diabetes care increase the risk for costs, complications, and death (AHRQ, 2020). The AHRQ has steps to improve diabetes healthcare quality with creating a vision for quality improvement, formation of champions and stakeholders, and implement improvement with staff empowering patients with effective diabetes management skills (AHRQ, 2020).   Thus, the quality of diabetes care can be enhanced through senior leadership assistance, formation of key stakeholders to further develop, implement, and continued promotion of the structured diabetes education, and apply a patient centered approach to empower patients for overall increased diabetes awareness and knowledge.

Executive Leadership

The FMRC leadership and organizational senior leaders play an iatrical part in the overall operations in this regional MTF. The clinic and senior leadership are essential to ensure effective implementation of the practice change within the FMRC and the four surrounding outpatient family medicine clinics within this MTF. Clinic leaders would continually evaluate evidence-based practices and dissemination of research findings that reinforce the structured diabetes education program, policies, procedures, and protocols. The senior leadership are

instrumental in promoting further development of the diabetes education program, provide the

necessary program resources, and on-going staff education and training.

Sustainability and Future Scholarship

The EBP results were disseminated to the FMRC leadership and organizational senior

leadership. Although there has not been a decision regarding implementation of a structured

group diabetes education program, the EBP results can be sustained with formation of policies

and procedures. Sustainability within the FMRC would be multifactorial: the formation of a

train the trainer program for standardization, implementation, and consistency across all the

family practice clinics, evaluate cost-benefit analysis with increased HEDIS reimbursement, and

continual training within the structured diabetes education program. Ensure staff involvement

with education, training, and practice changes in coordination with senior leadership

engagement, effective communication with continual updated plans, and involvement for

sustainability with staff changes.

Future scholarship entails the structured diabetes education program evolving to evaluate

diabetes quality of life indicators, blood pressure, cholesterol, body mass index (BMI), kidney

function, and barriers. The on-going development of an FMRC structured diabetes education

program should include provider training to address barriers to diabetes self-care to ensure

patient centered care and effective communication for shared decision-making opportunities.

The diabetes program must be reviewed quarterly by key stakeholders for continual

development, frequency of staff training, and updated diabetes standard of care guidelines.

Conclusion

Type 2 diabetes is a chronic, progressive disease that if not controlled or managed leads

to complex complications and co-morbities that can be mitigated with a structured diabetes

education program based on the ADA standard of care guidelines. This EBP explored the

effectiveness of a structured group diabetes education intervention among the FMRC type 2

diabetes patients with outcomes aligned with the aims and objectives – improve SMBG, self-care

management, and diabetes knowledge. The EBP results demonstrated that a small group

structured diabetes education intervention program produced a statistically significant result in

improved SMBG and diabetes knowledge. Future studies should be directed towards focusing

on the duration and standardization of the structured group diabetes education program, follow

up appointments should be extended to further evaluate the clinic effect of the program, and

further assessment for potential improvement in self-care management.

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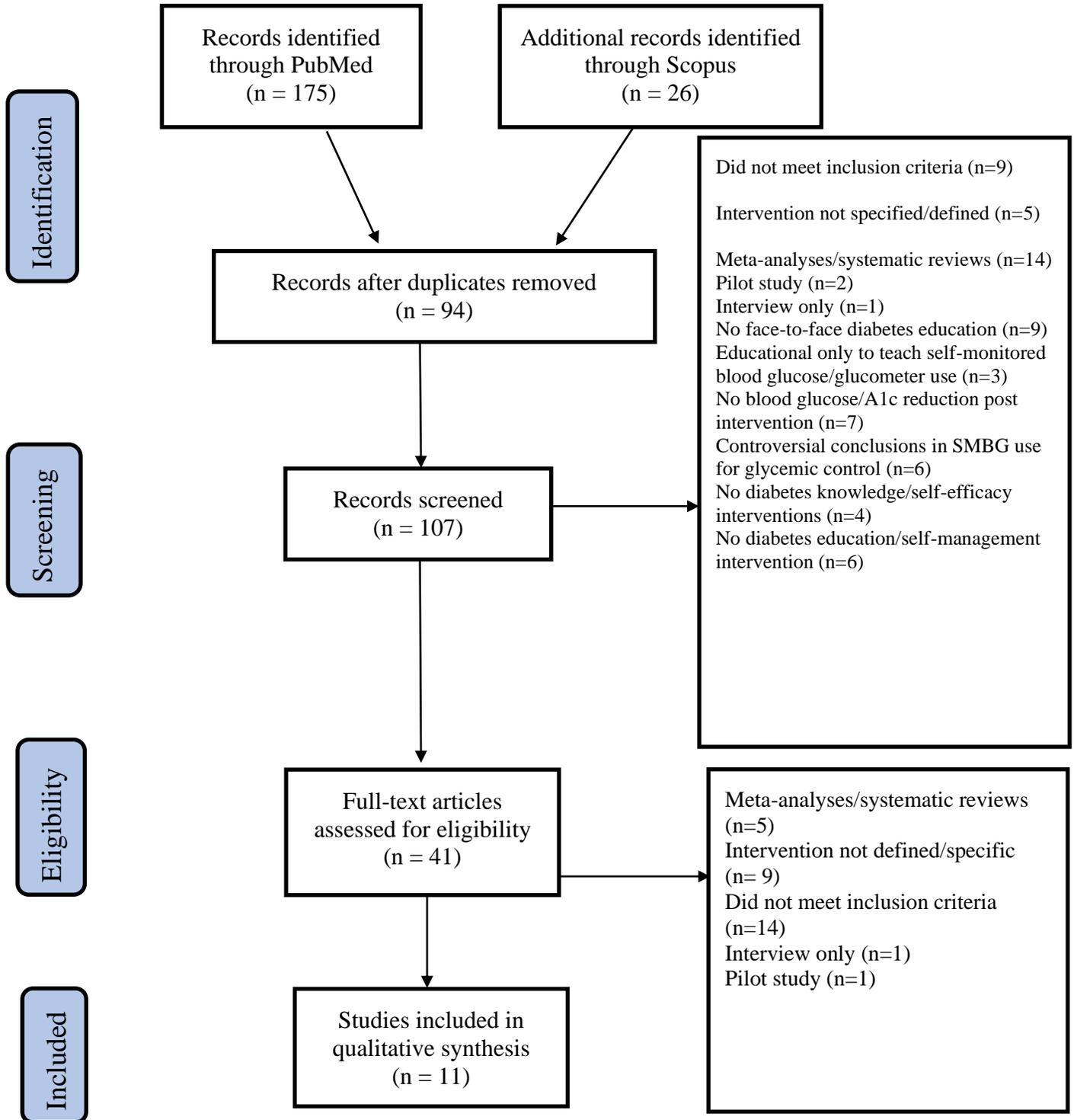
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Appendix A SWOT Analysis

	Helpful To achieving the objective	**Harmful** To achieving the objective
Internal Origin {Attributes of the organization}	**Strengths** • Level III trauma center • Numerous specialties including Endocrinology, Internal Medicine clinics • Experienced staff with physicians and nurse practitioners • Medical residency program led by physician rotation with promotion of the residents to perform research projects -EBP/QI/PI; DNP and Nurse Scientists • One physician in charge of the FMRC and residency program, approximately 16 family medicine physicians, 2 Nurse Practitioners. • FMRC promotes a collaborate environment and overall learning opportunities • All providers are engaged in furthering educational opportunities that promote optimal patient care based on evidence-based practices and standard of care.	**Weakness** • Large organization with multiple specialty clinic • Ineffective communication between and within departments • Inconsistent adaptation of the American Diabetes Association (ADA) standards of care during individual appointments, with gap in diabetes education • Limited access to care, and short 20-minute appointments to allow for effective structured diabetes education • Covid pandemic hindered FMRC patient face to face appointments • Inefficient use of HEDIS A1c levels data to promote diabetes care • Lack of patient centered diabetes care
External Origin {Attributes of the organization}	**Opportunities** • The FMRC is located in a large regional medical MTF in North Carolina with multiple outlying clinics • FMRC and senior leadership support aligned with organizational priorities • A FMRC structured individualized diabetes education contributes to A1c reduction, improved self-care management, and diabetes knowledge • Diabetes cost reduction, improve quality of care • Team education opportunity • Streamlined diabetes patient centered care • Military population and providers are culturally diverse • Competitive environment with civilian community • Higher patient productivity • Expansion of structured group diabetes education within the MTF community modeled through EBP results and other MTFs	**Threats** • Lack of FMRC leadership and senior leadership support • Internal medicine clinic with current diabetes education program • Lack of providers and staff to develop, implement, and teach a structured diabetes education program • Local civilian medical centers with dedicated Certified Diabetes Educators and providers for structured diabetes education programs • Patients desire to be seen by civilian provider/endocrinologist for diabetes care; Retired military patients are followed by the Veteran's Administration (VA) in the same town

Appendix B PRISMA Flow Diagram

Identification

Records identified
through PubMed
(n = 175)

Additional records identified
through Scopus
(n = 26)

Records after duplicates removed
(n = 94)

Screening

Records screened
(n = 107)

Did not meet inclusion criteria (n=9)

Intervention not specified/defined (n=5)

Meta-analyses/systematic reviews (n=14)
Pilot study (n=2)
Interview only (n=1)
No face-to-face diabetes education (n=9)
Educational only to teach self-monitored
blood glucose/glucometer use (n=3)
No blood glucose/A1c reduction post
intervention (n=7)
Controversial conclusions in SMBG use
for glycemic control (n=6)
No diabetes knowledge/self-efficacy
interventions (n=4)
No diabetes education/self-management
intervention (n=6)

Eligibility

Full-text articles
assessed for eligibility
(n = 41)

Meta-analyses/systematic reviews
(n=5)
Intervention not defined/specific
(n= 9)
Did not meet inclusion criteria
(n=14)
Interview only (n=1)
Pilot study (n=1)

Included

Studies included in
qualitative synthesis
(n = 11)

Appendix C Evidence Table

Article #	Author & Date	Evidence Type	Sample, Sample Size, Setting	Study findings that help answer the EBP Question	Observable Measures	Limitations	Evidence Level & Quality
1	Azami, Soh, Sazlina, Salmiah, Aazami, Mozafari, & Taghineja, 2018	RCT	Observer-blinded, two arm parallel group Sample size = n=142, n=72 control group (CG) for usual diabetes education and n=72 intervention group (IG) received self-management information booklet, movie clips, attended four weekly group education Setting = urban primary and secondary outpatient endocrine clinic in Iran	IG had significantly lower A1c levels (47.9%) vs CG; (21.1%) of the IG patients achieved A1c <7% vs zero in the CG (p<0.001) Efficacy expectation using DMSES, diabetes self-management using DS, and Outcome expectation using (PTES) with the IG significantly improved vs CG (p<0.001) Effect of quality of life using WHOQOL showed significant interaction effect (p<0.001) Diabetes education facilitates self-efficacy and behavior changes to enhance self-management behaviors and improved clinical outcomes and A1c levels in the long term.	A1c levels, Diabetes Self-Management Questionnaire (DSMQ), Diabetes Management Self-Efficacy Scale (DMSES), World Health Organization Quality of Life Scale (WHOQOL), Social Support Survey (SSS), Centre for Epidemiology Studies Short Depression Scale (CES-D)	Limited evidence to support the clinical effectiveness of nurse-led diabetes self-management interventions on glycemic control, short follow up of 6 months may be too short to evaluate the long-term effect of the self-management intervention, study may be underpowered to detect significant changes in some variables, thus may be prone to type 2 error, due to statistically significantly greater improvement in intervention group may be related to Hawthorne effect	Level 1, High Quality
2	Bosi, Scavini, Ceriello, Cucinotta, Tiengo, Marino, Bonizzoni, & Giorgino, 2013	RCT	Prospective, parallel-group Sample size = n= 1,024 non-insulin treated type 2 diabetes, n=501 randomized to intensive structured monitoring (ISM)	In the intent to treat group, the ISM patients had greater reductions in A1c than AC patients (-0.39 vs -0.27 %, change of -0.12%; 95% CI, -0,210 to -0.024; P= 0.013) In the PP group, ISM patients had even greater A1c reduction vs AC patients (-0.45 vs -0.24%, change of -	SMBG, A1c levels, secondary outcomes: BMI, blood pressure, heart rate, and cholesterol	Since patients were treated at diabetes clinics, may be hard to generalize the findings to patients treated in primary care settings who generally have less well controlled diabetes The large number of patients excluded makes generalizations is challenging that suggests the SMBG	Level I, High Quality

			with 4-point glycemic profiles performed 3days/week, n=523 randomized to active control (AC) with 4-poing glycemic profiles at baseline, six and 12 months The per protocol (PP) population had 232 (46.3%) ISM patients and 321 (61.4%) AC patients Setting = 39 diabetes clinics in Italy	0.21%; -0.331 to -0.089; P=0.0007) In regards to glycemic risk, ITT group-maintained risk target at month 12 (74.6%, 95% CI, 70.6-78.4 and 70.1%, 66-74.1) in ISM vs AC. The PP population had higher proportion of ISM than AC patients reached risk target (90%vs 82.5%, P=0.038) ITT group diabetes medication prescription changed more with ISM vs AC (p<0.001) The use of intensive structured Self-Monitored Blood Glucose (SMBG) data by clinicians to optimize prescription of diabetes medications and by patients to modify their behaviors improved glycemic control and enabled significantly more intensive structured monitoring patients to achieve significant A1c reductions compared with unstructured SMBG data		regimen may have been too intensive and suggest less frequent SMBG use would encourage more patients to use structured SMBG Use of structured SMBG in both groups The study design precluded assessment of the effect of the comprehensive education provided and increased attention given to patients in both study groups Data for medication changes were combined changes of dose and changes in prescribed medications	
3	Brackney, 2018	Qualitative Descriptive design	Descriptive design, Purposive sample, open ended interview guide Sample size = n=11, seven female and four males	Self-monitored blood glucose (SMBG) is useful when blood glucose readings are integrated into self-management plans. The patients found that checking their blood glucose more frequently related to the desire for the reassurance that the readings brought. Thus,	Routine checking of self-monitored blood glucose, behavior changes, and diagnosis acceptance	Small population size, may not know if this relationship influenced findings Cannot support a correlation or cause and effect relationship between SMBG and diabetes health outcomes Participants were newly diagnosed and may not	Level III, good quality

			Setting = primary care medical clinic	structured SMBG provided knowledge and motivation that support self-care behaviors, coping, and self-efficacy		represent experience of patients with long term diabetes	
4	Bukhsh, Khan, Nawaz, Ahmed, Chan & Goh, 2019	Quantitative	Cross-sectional Sample size = n=218, male = 112 or 51.4%, female = 106 or 48.6%, average age ranging from 45-60 years old Setting= 3 outpatient clinics in Pakistan	Statistically significant ($p<0.05$) improved diabetes knowledge was higher with university education, male, employed, those using only oral medications Strongly positive correlation of DKQ sum scale was observed with DSMQ sum scale (r-0.63, $p<0.001$), with three subscales of DSMQ, mainly glucose management (r=61, $p>0.001$), dietary control (r=65, $p>0.001$), and healthcare use (r=55, $p>0.001$) Diabetes knowledge was significantly related to glycated hemoglobin (r—0.62, $p<0.001$) Participants with good glycemic control scored significantly higher ($p<0.001$) for diabetes knowledge (DKQ sum scale score 18) compared to those with poor glycemic control (DKQ sum scale score of 13) subjects with good glycemic control scored higher for disease knowledge, complications, normal blood glucose and monitoring Improved self-care practices with subjects using oral diabetes medications	A1c levels, Diabetes Knowledge Test (DKT), Diabetes Self-Management Questionnaire (DSMQ)	Its cross-sectional design and location of the studied population, most in urban area, so may not be representative of all people living in rural areas Possibility of self-reporting bias, as patients may be unwilling to reveal deficiencies in self-care practices	Level III, High Quality

| 5 | Chai, Yao, Xu, Wang, Sun, Yuan, Zhang, & Ji, 2018 | RCT | Randomized design

Sample size = n= 118, Education group (EG) n=63 received professional education, Control group (CG) n=55 received routine outpatient education

Setting = Outpatient and inpatient of the First Hospital of Dandong | Compared with CG, EG group showed reduced fasting blood glucose (8.00 mmol/L vs. 6.78 mmol/L, P<0.00), reduced postprandial blood glucose (13.29 mmol/L vs. 7.90 mmol/L, P<0.00), and A1c levels 6.20 vs 6.70, P<0.01) significantly decreased after the sixth month | 2 hour diabetes education in EG vs 5-10 minutes for CG related to healthy diet, exercise, self-monitoring of blood glucose, complication prevention and understanding the risk factors of diabetes; assess BMI, BP, Fasting and post prandial blood glucose, lipid panel, and the Self-rating Anxiety Scale (SAS) and Self-rating Depression Scale (SDS) | Self-management education gives the patient principle of diet and exercise, so the intensity of these might affect clinical outcomes

Did not have a subgroup analysis of whether blood glucose levels related to the severity of anxiety or depression | Level 1, High Quality |
|---|---|---|---|---|---|---|---|
| 6 | Cheng, Sit, Choi, Chair, Li, Wu, Long, & Tao, 2018 | RCT | Randomized, multi-centre, single-blinded with parallel group design

Sample size = n=242 participants, n=121 for intervention group (121), n=121 for attentional control (AC)

Setting= two tertiary hospitals in China | Blood glucose self-monitoring improved in the CG vs IG at week 8 (1.49 vs 2.42) and week 20 (1.49 vs 2.38) was statistically significant (p<0.001)

Statistically significant (p<0.001) effect of patient centered care intervention (assess their experience of poor glycemic control, identifying their needs, building competence, tailored self-management information) in improving the frequency of blood glucose monitoring that increased patient's sense of self-efficacy | A1c levels, Summary of Diabetes Self-Care Activities (SDSCA) that covers diet management, medications, exercise, blood glucose self-monitoring, and foot care | Patient participation to patients receiving diabetes care in tertiary hospitals

Success of concealment of group assignment was not assessed

Although outcomes assessors were blinded to group allocation, cannot be sure that participants did not disclose this information that could damage allocation concealment

The biological measure that is unable to cause performance bias and specific components that were effective cannot be determined

Intervention effects on diet | Level 1, High Quality |

					behavior should be interpreted with caution due to the brevity of the relevant subscale and relatively low Cronbach's *a* of 0.62	
7	Eborall, Dallosso, McNicol, Speight, Khunti, Davies, & Heller, 2015	Qualitative	Semi-structured, mix method design, purposive sampling

Sample size= n=18, SMBG group n=10, urine monitoring group n=8. A sample of the participants in the DESMOND self-monitoring trial were invited to participate in this interview 12 months after attending education sessions

Setting= United Kingdom | Higher treatment satisfaction and continued use of SMBG after structured diabetes education in self-management of diabetes and training in self-monitoring

Participants found SMBG accurate, convenient, and useful for managing their diabetes and understanding their symptoms

Improved sense of control and independence with ability to self-monitor to avoid unnecessary visits to their providers

SMBG facilitated their self-management

Education led to principles for self-care based on their blood glucose readings | Self-monitoring blood glucose, urine self-monitoring | Regarding interviewing at 12 months was that the findings of the main trial was not yet known, thus impossible to explore explanations for trial results in situ

Diabetes services operate differently depending on the country and patients may not have access to free meters and supplies that may discourage testing their blood; | Level III, Good quality |
| 8 | Essien, Out, Umoh, Enang, Hicks, & Walley, 2017 | RCT | Unblinded, parallel-group

Sample size= n= 104, intensive group n=53, conventional education group n=51. The intensive group received 12 structured DSME teaching sessions with self- | The intensive, structured DSME versus conventional education supports patient's management of their blood glucose levels that led to statistically significant (p<0.001) reduction in A1c levels in the intensive group 8.3% vs 10.1% in the conventional group by a mean difference of -1.8% (95% CI: -2.4 to -1.2) | Diabetes Self-Management Education, A1c levels | Initial six intensive education sessions were led by doctors, when ideally all sessions would have been led by nurses to maximize the generalizability of the results where the nurses and educators would be the most obvious group to run the program

Only six-month duration and not clear how sustainable patient adherence and | Level 1, High Quality |

			monitored blood glucose lasting two hours each, while the conventional group had usual care with six DSME sessions total. Setting=Endocrinology Clinic at the University of Calabar Teaching Hospital in Nigeria			improvement in biomedical outcomes would be over longer timescales Mechanisms by which the program was achieved its effects were not explicitly investigated.	
9	Hung, Chen, Livneh, Chen, Guo, & Tsai, 2017	Quasi-Experimental	Used convenience sampling and non random group assignment. Sample size= n=95, experimental group n= 49 received 7 Diabetes Conversation Map Program based education sessions for 7 consecutive weeks in addition to routine health education; control group n= 46 received usual health education lasting for about 20 minutes after medical visit	The intensive, structured DCMP experimental group versus the control group with usual health education supports statistically significant increase in DM health literacy (p<0.05), significantly enhanced frequency of weekly SMBG times (p=. 001), A1c reduction (p=0.01), and FBG reduction (p<0.01)	DCMP, A1c, BMI, health literacy, SMBG, FBG	While interpreting the results- all participants were from single hospital, thus might not be generalizable to populations, using a quasi-experimental comparative research design versus RCT may have weakened the internal validity because of the presence of potentially confounding variables. Lastly, the data on the adherence were unavailable for the study, and caution with interpreting the results.	Level II, High Quality
10	Jiang, Wang, Lu,	Systematic review and	16 trials with 1,745 participants	Self-efficacy focused education would reduce A1c,	A1c levels, DKQ, DMSES, SDSCA	Most included studies that did not employ the RCT designs	Level II, High

	Jiang, & Li, 2019	meta-analysis on self-efficacy focused education in type 2 diabetes patients	were included in the systematic review and ten trials with 1,308 participants in the meta-analysis	enhance self-efficacy, regulate self-management behaviors, increase knowledge, and improve QOL for diabetic patients In 5 studies, 508 participants with significant A1c reduction (95% CI, P<0.001) Outcome of self-efficacy measures with DMSES with 554 participants revealed that self-efficacy was significantly improved (95% CI, P<0.001) Outcomes of behavior improvements measures by the SDSCA with 707 participants showed that self-management behaviors improved greatly (95% CI, P<0.001) Outcomes of diabetes knowledge measured by Diabetes related Knowledge Questions (DKQ) found diabetes knowledge showed a positive effect (95% CI, P=0.01)		which may influence the evidence level of pooled results The sample capacities of most studies were quite limited, and a number of trials had the following biases: blinding, withdrawal, or dropping out The duration of the interventions varied greatly, and it was insufficient to determine the long-term effects of the interventions due to short durations of studies	Quality
11	Klonoff et al. (2011)	Consensus Report	The Coalition for Clinical Research – Self monitoring of blood glucose in San Francisco, CA 12 physician panel members reviewed self-monitoring of blood glucose in epidemiological studies, RCT,	SMBG is an established practice for patients with type 2 diabetes not on insulin treatment. Patients require education on how to respond to the SMBG data to be effective SMBG benefits: -Prevent, identify, treat hypoglycemia -Provide feedback on results of lifestyle and	SMBG	Study design flaws related to SMBG include patients were not instructed on interpreting SMBG meaning and not permitted to respond to the results Small sample size Crossover effect= same provider caring for both groups	Level V

			meta-analyses, target, timing, and frequency, incidence and role of SMBG, and barriers to appropriate use.	pharmacologic treatments -Enhance patient education on impact of nutrition, activity, and medication choices -Provide information to inform treatment modifications and titrations -Increase patient empowerment and adherence to treatment -Targets, timing, and frequency of SMBG should be individualized -SMBG important for patients at risk for hypo/hyperglycemic events -SMBG provide best outcomes if associated with structured educational and therapeutic programs designed to facilitate behavior changes for improving BG levels - Patient centered end points determined by validated questionnaires - Its use has demonstrated efficacy in lowering A1c			
12	Sperl-Hillen, Beaton, Fernandes, Worley, Vazquez-Benitez, Parker, Hanson, Lavin-Tompkins, Glasrud, Davis, Adams, Parsons, & Spain,	RCT	Prospective, multisite Sample size= n=623, n=243 allocated to group education (GE) , n=246 allocated to individual education (IE), n=134 allocated to usual care (UC) (no interventions). participants, two large medical	Type 2 diabetic patients of long duration and HbA1c of 7% or higher improved short term HbA1c outcomes and greater likelihood of achieving an HbA1c level below 7% in the IE vs GE. A1c improved more with IE compared to Usual Care (UC). A1c levels lower in the follow-up period in UC, IE, and GE by an absolute -0.24%, -0.51%, and -0.27%	ADA education program based on the AADE7 Self-Care Behaviors, A1c levels Secondary: Blood pressure, weight, Behavioral Risk Factor Surveillance System (BRFSS), Diabetes Empowerment Scale-Short Form (DES-SF), Diabetes Care	The full A1c impact of the interventions may have been diminished due to data published as the study was implemented led to changes in local and national guidelines that potentially resulted in less effect than what was originally anticipated	Level 1, High Quality

	2011		groups-ABQ Health Partners in New Mexico and Health Partners Medical Group in Minnesota	respectively (P=.01) Intervention groups were associated with improvement of DES (self-efficacy) at 1 month post intervention (IE vs UC effect, 0.16, P=.01) IE significantly more likely than UC to have follow up A1c <7% or lower (95% CI, 1.06-3.16, P=.03). GE group less likely to have A1c <7% at follow up compared to IE (95% CI, 0.39-.94, P=.03) SMBG testing 2x/week or more was higher for IE vs UC (95% CI, 0.90-2.96, P=.11) than for GE vs UC (95% CI, 0.41-1.10, P=.11)	Profile (DCP), Problem Areas in Diabetes (PAID)		
13	Zheng, Liu, Liu, & Deng, 2019	RCT	Single-blinded, two groups, experimental design Sample size= n=60, n=30 in control group (CG) with general education, n=30 in intervention group (IG) with general education plus interventional education Setting = the Cardiovascular Rehabilitation	Diabetes education program statistically significant improvement in self-management practices and glycemic control. Scores of the SDSCA, PAID, blood glucose levels (fasting and 2-hour post-prandial), and A1c levels in the IG were significantly (p=<0.001) improved after the intervention compared to CG.	General diabetes education versus general education plus interventional education focused on nutrition and physical exercise, the Summary of Diabetes Self-Care Activities (SDSCA), Problem Areas in Diabetes (PAID), Fasting Blood Glucose (FBG), postprandial 2-hour blood glucose, and A1c levels	Composition of the analyzed sample (regionalism, resources of the patients – outpatient only) Small sample study, thus did not compare self-management behaviors, psychological condition, glucose control, and educational interventions in different types of antidiabetic therapy Limited intervention patterns.	Level 1, High Quality

			Clinic, Endocrinology Clinic, and Geriatrics Clinic at Xiangya Hospital, Central South University				

Appendix D DSMQ

The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the last 8 weeks, please specify the extent to which each statement applies to you.	Applies to me very much	Applies to me to a consider-able degree	Applies to me to some degree	Does not apply to me
1. I check my blood sugar levels with care and attention. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
2. The food I choose to eat makes it easy to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
3. I keep all doctors' appointments recommended for my diabetes treatment.	☐3	☐2	☐1	☐0
4. I take my diabetes medication (e. g. insulin, tablets) as prescribed. ☐ *Diabetes medication / insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
5. Occasionally I eat lots of sweets or other foods rich in carbohydrates.	☐3	☐2	☐1	☐0
6. I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
7. I tend to avoid diabetes-related doctors' appointments.	☐3	☐2	☐1	☐0
8. I do regular physical activity to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
9. I strictly follow the dietary recommendations given by my doctor or diabetes specialist.	☐3	☐2	☐1	☐0
10. I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
11. I avoid physical activity, although it would improve my diabetes.	☐3	☐2	☐1	☐0
12. I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets). ☐ *Diabetes medication / insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
13. Sometimes I have real 'food binges' (not triggered by hypoglycaemia).	☐3	☐2	☐1	☐0
14. Regarding my diabetes care, I should see my medical practitioner(s) more often.	☐3	☐2	☐1	☐0
15. I tend to skip planned physical activity.	☐3	☐2	☐1	☐0
16. My diabetes self-care is poor.	☐3	☐2	☐1	☐0

Appendix E The modified DKT

Revised Michigan Diabetes Knowledge Scale – true/false version.

Here are 20 statements about diabetes, some are true statements and some are false. Please read each statement and then indicate whether you think it is true or false by putting a circle round either TRUE or FALSE. If you do not know the answer please put a circle around DON'T KNOW.

1. The diabetes diet is a healthy diet for most people * TRUE/FALSE/DON'T KNOW

2. Glycosylated haemoglobin (HbA1c) is a test that TRUE/FALSE/DON'T KNOW measures your average blood glucose level in the past week.

3. A pound of chicken has more carbohydrate in it TRUE/FALSE/DON'T KNOW than a pound of potatoes.
4. Orange juice has more fat in it than low fat milk. TRUE/FALSE/DON'TKNOW

5. Urine testing and blood testing are both equally TRUE/FALSE/DON'T KNOW as good for testing the level of blood glucose.

6. Unsweetened fruit juice raises blood glucose levels. * TRUE/FALSE/DON'T KNOW

7. A can of diet soft drink can be used for treating TRUE/FALSE/DON'T KNOW low blood glucose levels.

8. Using olive oil in cooking can help prevent raised TRUE/FALSE/DON'T KNOW cholesterol in the blood. *

9. Exercising regularly can help reduce high TRUE/FALSE/DON'T KNOW blood pressure. *

10. For a person in good control exercising has TRUE/FALSE/DON'T KNOW no effect on blood sugar levels.

11. Infection is likely to cause an increase in TRUE/FALSE/DON'T KNOW blood sugar levels. *

12. Wearing shoes a size bigger than usual helps TRUE/FALSE/DON'T KNOW prevent foot ulcers.

13. Eating foods lower in fat decreases your risk TRUE/FALSE/DON'T KNOW for heart disease. *

14. Numbness and tingling may be symptoms of TRUE/FALSE/DON'T KNOW nerve disease. *

15. Lung problems are usually associated with having diabetes. TRUE/FALSE/DON'T KNOW

16. When you are sick with the flu you should test for glucose more often. *
TRUE/FALSE/DON'T KNOW

SKIP TO QUESTION 19 IF YOU DON'T TAKE INSULIN

17. High blood glucostimee levels may be caused by too much insulin. TRUE/FALSE/DON'T
KNOW

18. If you take your morning insulin but skip breakfast your blood glucose level will usually
decrease *   TRUE/FALSE/DON'T KNOW

19. having regular check-ups with your doctor can help spot the early signs of diabetes
complications. * TRUE/FALSE/DON'T KNOW

20. Attending your diabetes appointments stops you getting diabetes complications.
TRUE/FALSE/DON'T KNOW

Appendix F Project Timeline

EBP proposal/IRB		July 8, 2021
Education development	Develop type 2 diabetes education that will be presented at the structured group intervention and diabetes booklet for the participant to have for home reference. Participant recruitment	July 12th – August 12th
Participant recruitment	Facilitated by providers and staff during their appointments with type 2 diabetes patients who meet inclusion criteria, and if patients are interested in the diabetes educational intervention, they can schedule at the front desk	July 13th – August 12th
Project team member meetings	Discuss flow of events during each appointment, ensure uniform and consistency among researchers related to diabetes education, diabetes booklet, frequency and duration of SMBG. And DSMQ and DKT questionnaire	July 28th – August 11th
Structured group education intervention	Participants will fill out the DSMQ and DKT questionnaires and demographic information sheet prior to the educational intervention, will receive 40 minutes of face-to-face diabetes education, will collect SMBG average readings from the week prior, and given diabetes education booklet to take home	September 7th– September 28th
One month post intervention	Participants will fill out the DSMQ and DKT questionnaire to give to the project team members and will collect the previous week SMBG readings	October 5th – October 26th
Data analysis	Utilized SPSS	October 27th – November 10th