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Empower You: an Adult Type 2 Diabetes Mellitus Management Program with Utilization of a Mobile Phone Application

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EMPOWER YOU: AN ADULT TYPE 2 DIABETES MELLITUS MANAGEMENT PROGRAM WITH UTILIZATION OF A MOBILE PHONE APPLICATION

by

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DEDICATION

This project is dedicated first and foremost to my family. To my parents, Carmen, and Jeffery Jahn; you two are the epitome of working for what you desire. You two have taught me that you will get nowhere unless you put your head down and just keep going until you reach the top. To my sisters, Kali Mesdjian and Kara Jahn; you have been my biggest support system since starting this program, and I would be nowhere without your guidance. Without all of your unwavering support and belief in me, I would not be obtaining this degree.

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ABSTRACT

In 2018, 34.2 million Americans had diabetes and there continues to be 1.5 million Americans diagnosed with diabetes every year (ADA, 2018). Due to this increasing prevalence, self-management of type 2 diabetes mellitus (T2DM) is essential to disease management. The PICOT question for this project was: In adults with T2DM with a hemoglobin A1C (HbA1C) greater than 8% in a diabetes specialty clinic (P), what is the effect of a multimodal smartphone application (I) compared to prior nonuse of the application (C) on average blood glucose readings (O) over an 8-week period (T)? The project was completed in a large, metropolitan area located in southcentral Wisconsin. There was a total of 11 participants, comprised mostly of males with a range from 46-76 years of age. The Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model was utilized to guide the development and implementation of this project. The project used a within-group design that evaluated the effect of a multimodal smartphone application on average blood glucose levels. Data were collected through patient-owned glucometers that were connected via Bluetooth to the mySugr© application. Pre-intervention and post-intervention blood glucose level data were analyzed using a paired sample *t*-test. Secondary outcomes included time in range (TIR), estimated HbA1C, and DES-SF scores. Statistically significant differences were found for average blood glucose levels (p = .008), TIR (p = .0025), estimated HbA1C (p = .00048), and DES-SF scores (p =.007). Findings from this project demonstrated that the use of a multimodal smartphone application can lower average blood glucose levels.

Keywords: type 2 diabetes mellitus, blood glucose, self-management, smart phone application

CHAPTER 1

INTRODUCTION

Background

Chronic disease in the United States affects six in ten adults and costs $3.8 trillion in annual health care costs (CDC, 2021). The key lifestyle risk factors for chronic disease include tobacco use, poor nutrition, lack of physical activity, and excessive alcohol use (CDC, 2021). The top seven leading chronic diseases include heart disease, cancer, chronic lung disease, stroke, Alzheimer's disease, diabetes, and chronic kidney disease (CDC, 2021). With diabetes being one of the leading chronic diseases in the United States, disease management is essential. In 2018, 34.2 million Americans had diabetes and there are 1.5 million Americans diagnosed with diabetes every year (ADA, 2018). Diabetes was the seventh leading cause of death in the United States in 2017 and may even be underreported as a cause of death (ADA, 2018). Type 2 diabetes mellitus (T2DM) specifically comprises 90-95% of persons with diabetes mellitus (CDC, 2019).

T2DM requires lifelong management and has been known to be challenging for patients to regulate. Self-management is one of the main goals of treatment and is essential for the management of the disease. Due to the many complications resulting from T2DM, glycemic control is one of the most important goals of management (Lizarondo, 2021). Diabetes self-management education is a crucial part of successful disease management and can assist people with T2DM feel more confident with knowledge of their chronic illness (Pal et al., 2013).

T2DM usually affects people over the age of 45 years but is becoming more and more prominent in children and young adults (CDC, 2019). With T2DM, the cells in the body do not respond normally to insulin that is produced by the pancreas, causing the pancreas to secrete more insulin in an attempt to regulate the glucose in the blood (CDC, 2019). Over time, the pancreas cannot keep up with the rising levels of glucose in the blood and the high levels of glucose eventually lead to T2DM (CDC, 2019). T2DM also affects the ability of the body to metabolize carbohydrates, fats, and proteins (Pal et al., 2013). The disease can lead to many systemic health complications, such as diabetic ketoacidosis; neuropathy; skin and eye complications; foot complications; nephropathy; and cardiovascular disease (ADA, 2018). With its many possible complications, T2DM can be extremely difficult to effectively manage and poses many challenges for patients with the diagnosis. Because of the complexity of T2DM, the topic has been heavily researched in an attempt to find effective ways to implement lifestyle changes and effectively manage the disease.

The purpose of this evidence-based practice (EBP) project is to implement the identified best practice for improving self-efficacy behaviors and perceptions, average blood glucose levels, and time in range in adult patients with T2DM. The clinical question being addressed is "What is the best practice for adults with T2DM to improve average glycemic control, and self-efficacy?" The secondary clinical question is "What is the effect of a diabetes-specific multimodal smart phone application on self-efficacy behaviors and perceptions, glycolate hemoglobin A1c (HbA1C) levels, and blood glucose levels?"

Data Supporting Need for the Project

Global, National, Regional, and State Data

T2DM is becoming more and more prevalent across the world. The World Health Organization (WHO) acknowledged that globally, the prevalence of people living with diabetes rose from 108 million in 1980 to 422 million in 2014 (WHO, 2021). The WHO also reports that 1.5 million deaths were directly caused by diabetes (WHO, 2019). The WHO reports that adults with diabetes have a two-to-three-fold increased risk of heart attacks and strokes (WHO, 2021). The United States also struggles with T2DM management and reports that 10.8% of Americans are living with T2DM (America's Health Rankings, 2021). Specifically in Wisconsin, the state ranks below the national average in terms of percent of people living with T2DM but does rank 8th in the nation with 8.7% of the population living with diabetes (America's Health Rankings, 2021).

Because of the increasing prevalence of T2DM in Wisconsin, the cost of diabetes-related care is $5.5 billion each year (ADA, 2018). It is important to note that an estimated 30,000 people in Wisconsin are newly diagnosed with T2DM each year (ADA, 2018). The prevalence of this disease, as well as its self-management challenges, pose and support the clinical question and warrants further investigation with the proposed project.

The project site is a clinic located within Dane County in south central Wisconsin. The county houses 546,695 people with 5.4% of the population being veterans who would access the project site for health care (Healthy Dane, 2019). White, non-Hispanic persons comprise 79.2% of the population, 5.5% are Black or African American, and 6.3% are Asian (Healthy Dane, 2019). Black and Hispanic persons' death rate related to complications of diabetes are more than two times higher than that of their white counter parts in Dane county (Healthy Dane Collaborative, 2018). The clinic is in a stable socioeconomic area where 95.8% of the population aged 25 years or older have a high school degree or higher, 51.4% of the population 25 years or older have a bachelor's degree or higher, and the mean household income in this county is $73,893 (Healthy Dane, 2019). In Dane county, 95.1% of people also do have some form of health insurance compared to the other counties in the state that average 93.5% of people (Healthy Dane, 2019). In Dane County alone, diabetes complications account for 12.8 per 10,000 hospitalizations in persons 18 years or older (Healthy Dane Collaborative, 2018).

Clinical Agency Data

This project is a pilot T2DM management project aimed at reducing average blood glucose readings and in turn reducing HbA1C levels. The clinic where the project will take place is in a moderate-size, metropolitan area in south central Wisconsin. The area is located is a stable socioeconomical location. All patients who attend this clinic are either active service military members or retired military service members. Since the project site is part of a national health care system that is commonly known, patients travel from all over the state of Wisconsin to come to this clinic to receive their care. Of note, because of the COVID-19 pandemic, many in-person appointments have been changed to telehealth visits related to travel restrictions and the health care system's ability to maintain telehealth for patients. Because of the COVID-19 pandemic, the health care system has increased its use of MyHealtheVet; an online communication tool that increases communication opportunities between patients and providers. This communication tool can help patients with prescription refills, viewing their appointments, secure messaging with providers and clinic staff, and viewing test results or medical records (Rohrer, 2020). At the project site, 50% of patients are already registered for this feature and 15% are actively using secure messaging with their providers (Rohrer, 2020).

The patient population attending the health care facility totals 169,574 (National Center for Veterans Analysis and Statistics, 2017). Greater than 30% of patients that receive care at the project site are over the age of 65 years. Nearly 40% of patients receiving care at the project site have a median income of $50,000 to $99,000 per year (National Center for Veterans Analysis and Statistics, 2017). The patient population receiving care at the project site is mainly comprised of males (National Center for Veterans Analysis and Statistics, 2017).

The project site is known for its research and up-to-date practice policies. The site prides itself on significantly contributing to advancements in health care for veterans and other Americans from every walk of life (U.S. Department of Veteran Affairs, 2021). The proposed doctor of nursing practice (DNP) project was developed in conjunction with the nurse practitioner who is employed at the project site. There are also providers who work in conjunction with the nurse practitioner who have also acknowledged that the use of the application could aid in the self-management of T2DM.

Discussion with the nurse practitioner who is assisting the student project leader in this program revealed that the goal for HbA1C levels for majority of the patients at the project site is 7.5% (J. Phelan, personal communication, July 26, 2021). After a review of the electronic medical record software used at the project site, it was determined that the clinic treats well over 200 patients and manages patients with type 1 diabetes mellitus (T1DM) and T2DM. For the purpose of this project, only the patients with T2DM will be eligible for participation. The clinic staff acknowledged that many patients do not check their blood glucose as they are advised; they feel there is no point or feel that their provider is not actually looking at glucose readings (J. Phelan, personal communication, July 26, 2021).

The need for this project was discussed at length with the nurse practitioner at the project site. Current patients that do not use the application are responsible for driving themselves to clinic appointments, bringing their current glucose meter to each appointment and having their meter downloaded when in the clinic. This allows the provider to view the trends of the patient's blood glucose readings, but appointment time is spent looking over glucose readings during the actual appointment. If the application was used and patients are able to upload a generated portable document format (PDF) report of blood glucose readings, the provider would be able to review readings before the appointment and appointments would be more time efficient.

The application that is proposed for use in this project is already available to all patients that receive care at the project site. The nurse practitioner acknowledges that there are many barriers to implementation of the application use for patients. Barriers include but are not limited to; many patients do not know about the application, patients not knowing how to properly use it or connect it to their glucose meter, or inconsistency of checking blood glucose because they view it as pointless (J. Phelan, personal communication, July 28, 2021). Each patient at the project site is provided with a glucose meter and the instruction manual includes instructions on application use. Not many patients actually read the instruction manual, resulting in low uptake and low knowledge of the application (J. Phelan, personal communication, July 28, 2021). On occasion, some patients will forget to bring their meter to their appointment which makes it very difficult to make necessary changes to a patient's management plan (J. Phelan, personal communication, July 28, 2021). The use of the application could ease patient burden for transporting their meter to all appointments and increase time in care management or care adjustment at each appointment.

Purpose of the Evidence-Based Practice Project

Purpose Statement and PICOT Question

The purpose of this EBP project is to determine if implementation of identified best practice in a diabetes specialty clinic will result in lower average blood glucose readings for patients with T2DM resulting in lower HbA1C levels. Specifically, this project will address the following PICOT question: In adults with type 2 diabetes mellitus with a HbA1C greater than 8% in a diabetes specialty clinic (P), what is the effect of a multimodal smartphone application (I) compared to prior nonuse of the application (C) on average blood glucose readings (O) over an 8-week period (T)?

EBP Project Description

The proposed project will include the implementation of a multimodal, diabetes-specific mobile phone application and the evaluation of its effect on average blood glucose levels, TIR, and patient's self-efficacy of disease management. Participants will be recruited via retrospective chart review and recruited if they have a HbA1C greater than 8%, have T2DM, have a smart phone or tablet, are 18 years or older, and are English speaking. The project will be implemented by the student project leader, a nurse practitioner, a clinic nurse, and a clinical pharmacist. At the start of the project, participants will evaluate their self-efficacy through the Diabetes Empowerment Scale- Short Form (DES-SF) (Appendix I) and their last HbA1C level will be retrieved by the student project leader via chart review. Permission to utilize the DES-SF was granted by the Michigan Diabetes Research Center (Appendix H). The application that will be utilized for the project will be mySugr©. This application will be available to each participant that has an Accu-Chek Guide Me© glucose meter, which the project site supplies for participants. There will be an initial visit with each participant once consent is obtained to explain the goals of the project and how the project will be implemented. The project duration will be 8-weeks and each participant will be contacted weekly or biweekly via phone call or video chat to discuss any problems, concerns, or questions. The participants will be given the option of how frequently they would like to be contacted throughout the 8-week duration of the project. Also, during the weekly or biweekly meetings, participants will be asked to upload their blood glucose report readings into the MyHealtheVet system for review by their health care provider and the student project leader. At the completion of the 8-week project, participants average blood glucose levels and time-in-range will be evaluated by the student project leader, participants will complete another DES-SF (Appendix I) and fill out a project satisfaction survey (Appendix D). The student project leader will then analyze the data and disseminate the findings with key stakeholders, the project site evidence-based practice coordinators, participants, and Valparaiso University.

CHAPTER 2

EBP MODEL AND REVIEW OF LITERATURE

Evidence-based Practice Model

Overview of EBP Model

EBP is an essential competency for all healthcare professionals and fosters an environment of change (Dang & Dearholt, 2018). Dang & Dearholt (2019) define EBP as "a problem-solving approach to clinical decision-making within a healthcare organization" (p. 4). The EBP model chosen to guide this project is the Johns Hopkins Nursing Evidence-Based Practice Model (JHNEBP). The JHNEBP model was developed by a combination of nurses and faculty from Johns Hopkins University School of Nursing who desired to create a way to transition EBP into nursing practice (Melnyk & Fineout-Overholt, 2019). This model is initiated with a team's curiosity about best practices related to a specific problem or clinical area (Melnyk & Fineout-Overholt, 2019). After the clinical problem has been identified, the practice question, evidence, and translation (PET) process begins. Within the PET process, there are a total of 18 steps that are followed to guide the project. In the practice question step, there are five steps that include: Recruitment of interprofessional team, development and refining the EBP question, defining the scope of the EBP question and identification of stakeholders, determining responsibility for project leadership, and scheduling of team meetings (Melnyk & Fineout-Overholt, 2019). The evidence step consists of five more steps, including: Conducting internal and external searches for evidence, appraising the level and quality of each piece of evidence, summarizing the individual evidence, synthesizing overall strength and quality of evidence, and developing recommendations for change based on evidence synthesis (Melnyk & Fineout-Overholt, 2019). The final step of the JHNEBP model is translation, which includes the last eight steps: Determining fit, feasibility, and appropriateness of recommendations for translation path; creating an action plan; securing support and resources to implement action plan; implementing action plan; evaluating outcomes; reporting outcomes to stakeholders; identifying next steps; and dissemination of findings (Melnyk & Fineout-Overholt, 2019). With the utilization of the PET process, the project is planned, completed, and findings are shared at its completion.

The JHNEBP model was chosen for this project because of the versatility of the model. The model can be used by an individual or by a group, which allows it to be used in many different settings. The PET process allows for organization of the project and gives the project facilitator a guide for best practice searching, implementation, and sharing the findings of the project.

Literature Search

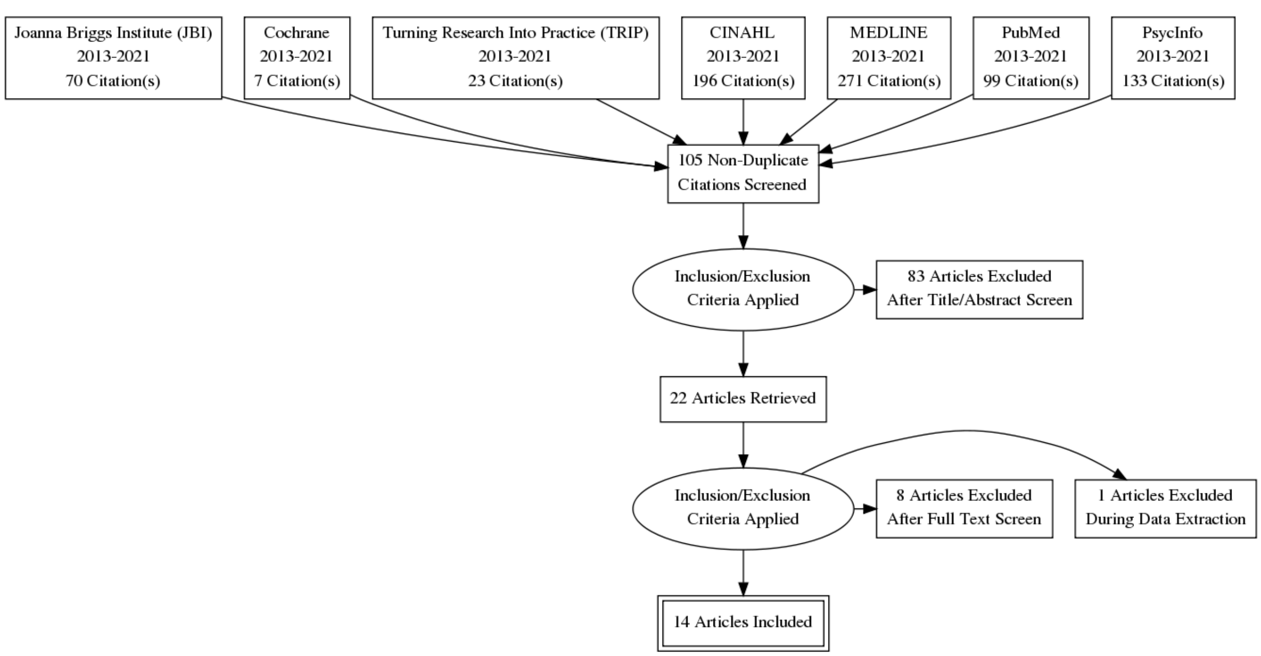
Sources Examined for Relevant Evidence

An exhaustive search of the literature was performed by the student project leader and included searches from Joanna Briggs Institute (JBI), Cochrane Library, Turning Research into Practice (TRIP), Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE, Pubmed, and PsycInfo. A further hand-search of the literature was performed and included searches in the Journal of Medical Internet Research (JMIR), The United States Preventative Services Task Force (USPSTF) website, and the American Diabetes Association (ADA) website. A PRISMA chart was created by the student project leader and is available for reference within this paper. The key words used in a variety of different searches included: “Diabetes mellitus”, “type 2”, diabetes, self-manag*, “lifestyle modification”, “hemoglobin A1c”, and adult*. Many different combinations of the key words were used to result in a final, best search of the literature. The different combinations of the key words were also used to narrow the literature search in the databases listed above. Different limiters were used in the different databases to limit the search to relevant literature. Limiters included the year range from 2013-2021, scholarly peer-reviewed articles, United States clinical practice guidelines, and the English language. The Research Services Librarian from Valparaiso University was involved in assisting in the determination of a systematic search and helped determine that a successful exhaustion of the literature was achieved.

After an exhaustive search within each database, 105 articles were identified for screening based on their title. After these were identified, inclusion and exclusion criteria were created to narrow the search further. Articles that were excluded included those with patient populations including type 1 diabetes mellitus or gestational diabetes mellitus, pediatric populations, and those that included insulin pumps or continuous glucose monitors. These factors do not meet the goals of this project; therefore, they were excluded. With the application of the exclusion criteria and abstract screening, 84 articles were excluded from the literature search. The remaining 22 articles were retrieved and fully examined by the student project leader. As a result of this full examination, additional articles were identified as not acceptable for inclusion. The final literature synthesis consisted of 14 articles from a variety of databases listed below in Figure 2.1.

Figure 2.1

Literature Search



Levels of Evidence

The tool used for leveling of the evidence was the Melnyk and Fineout-Overholt (2019) hierarchy of evidence. Using this hierarchy system allows the student project leader to evaluate the reliability of the chosen pieces of evidence. The evidence hierarchy provides guidance with VII different levels of evidence, with level I being the highest, and level VII being the lowest level. The higher the level of evidence within the hierarchy, the more confident the reader can be about having similar health outcomes in similar patient populations (Melnyk & Fineout-Overholt, 2019). The evidence utilized in this project consists of three evidence summaries, eight systematic reviews, one meta-analysis, one clinical practice guideline, and one randomized controlled trial (RCT). After evaluation of each piece of evidence using the above tool, it was determined that 13 pieces of evidence were level I and one piece of evidence was determined to be level II. Table 2.1 provides the specific level determined for each piece of evidence chosen for inclusion in this project.

Analysis and Appraisal of Relevant Evidence

After an exhaustive search of the literature, 14 pieces of evidence were utilized to determine best practice for self-management of T2DM. Each piece of evidence was evaluated for level and strength or quality of the evidence (Appendix L) The Critical Appraisal Skills Programme (CASP) tool and the Appraisal of Guidelines Research and Evaluation (AGREE II) instrument were used to evaluate the evidence. The CASP tool, a formal tool for evaluation of systematic reviews and RCTs, was chosen for its effectiveness and ease-of-use. The AGREE II tool was used in the appraisal of the clinical practice guideline (CPG) from 2017. This tool was chosen because it can be applied to all types of CPGs (Schmidt & Brown, 2019). With the utilization of the CASP and AGREE II tools, there were 12 pieces of evidence that were determined to be strong quality, the CPG was determined to be excellent, and the RCT was determined to be good quality (Table 2.1). Table 2.1 provides a summary of the literature that was chosen for utilization in this project and includes the databases where they were found, the level and type of evidence, the quality, and the tool used to evaluate them. The majority of the evidence utilized in this EBP project consisted of systematic reviews, as this level of evidence has been considered the heart of EBP for some time now (Melnyk & Fineout-Overholt, 2019). For this reason, other pieces of evidence determined to be of good quality were excluded.

Table 2.1

Summary of Evidence

Author/yr	Database(s)	Level of Evidence/Type	Quality/Tool
Minoee (2021)	JBI	I/Summary	Strong/CASP
Manuel (2020)	JBI	I/Summary	Strong/CASP
Lizarondo (2021)	JBI	I/Summary	Strong/CASP
Alexandre (2021)	JBI	I/SR	Strong/CASP
Pal et al. (2013)	Cochrane	I/SR	Strong/ CASP
VA/DoD	TRIP	I/CPG	Excellent/AGREE II
Aminuddin et al. (2019)	CINAHL	I/SR	Strong/CASP
Wang et al. (2019)	CINAHL	II/RCT	Good/ CASP
Yoshida et al. (2018)	CINAHL	I/Meta-analysis.	Strong/CASP
Cai et al. (2019)	Medline	I/ SR	Strong/CASP
Hou et al. (2018)	Medline	I/SR	Strong/CASP
Cui et al. (2016)	Pubmed	I/SR	Strong/CASP
Hou et al. (2016)	Hand search	I/ SR	Strong/CASP
Wu et al. (2017)	Hand search	I/SR	Strong/CASP

Construction of Evidence-based Practice

Synthesis of Critically Appraised Literature

The goal of this evidence search and appraisal was to determine best practice for self-management of T2DM. Studies and reviews regarding self-management of T2DM have used a variety of interventions, including behavioral interventions, self-management behaviors via different modes of technology, and provider-based interventions. Both intervention types were categorized overall as disease self-efficacy and were evaluated many times throughout the literature. With glycemic control being the major goal of treatment, the main outcome measurements were average blood glucose and HbA1C levels. Within the search of the literature, it was determined that mobile phone applications can improve self-management and HbA1C levels of patients with T2DM (Minooee, 2020; Wu et al., 2017; Manuel, 2020; Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). An extensive, systematic literature search was undertaken by the student project leader to determine best practice.

Technology

There are many different interventions that fall under the term technology in T2DM management. These technologies include computer-based interventions, telephone interventions such as text messaging or calling, and mobile phone applications.

Computer-based. Computer interventions across the literature consisted of non-interactive learning modules, educational learning videos, touch screen interactive learning, and e-mail (Pal et al., 2013; Yoshida et al., 2018). A systematic review evaluated the effectiveness of computer-based educational interventions on HbA1C levels and found that this type of intervention was not statistically significant in studies lasting more than six months (Pal et al., 2013). This review found that the computer-based interventions showed a HbA1C reduction of 0.1% (95% CI -0.3-0.1) over the 6-month period, which was not statistically significant (Pal et al., 2013). This diminished effectiveness resulted in nonsignificant results and was seen again in computer-based interventions lasting six months or longer (Lizarondo, 2021). Another evidence summary suggested that at least 12 video messages over a 12-month period resulted in a significant reduction in HbA1C levels at 0.6% reduction (Lizarondo, 2021). Based on these results, the use of the computer-based interventions is inconclusive. Computer-based interventions were also not associated with higher self-efficacy compared to other technology interventions (Pal et al., 2013).

Telephone. Phone calls and text messaging have been utilized and studied as well for management of T2DM. Across the literature, there was a variety of contact points and differing durations of these interventions. Intervention time frames varied from four weeks to 12 months. The effectiveness of telephone follow-up also varied across the literature. One evidence summary suggested that telephone follow-up should be utilized in the management of patients with T2DM (Manuel, 2020). Another summary reported that patients with T2DM should be offered follow-up phone calls, but the intensity and frequency of the phone calls remains unclear (Lizarondo, 2021). Mobile text messages may provide benefits in supporting self-management of long-term illness, but this intervention’s effect on T2DM was not conclusive (Minooee, 2020).

Mobile-phone applications. The use of a diabetes-specific mobile phone application was compared to other technology-based interventions throughout the literature. Worldwide mobile phone usage is anticipated to exceed 5 billion by the end of the next decade (Hou et al., 2016). Because of the increase and convenient use of mobile phones, the utilization of mobile phone applications has significant potential to help with chronic disease management. Mobile-phone applications were the most promising in reducing HbA1C levels and had the most statistically significant results (Wu et al., 2017; Manuel, 2020; Lizarondo, 2021; Pal et al., 2013; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). The literature revealed applications that were manual entry and Bluetooth capable. Mobile phone applications across the literature included tracking self-care interventions, including blood glucose monitoring; exercise; diet; and blood pressure. Application effectiveness was evaluated using HbA1c levels and glycemic control. The use of a mobile phone application has been shown to decrease HbA1C levels and maintain better glycemic control compared to computer-based and telephone interventions (Minooee, 2020; Manuel, 2020; Lizarondo, 2021; Pal et al., 2013; Aminuddin et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). Mobile phone applications that had direct data transmission using wire or wireless connection were also associated with a trend towards reduced HbA1c levels (Wu et al., 2017). Regarding technology, the use of a mobile phone application appears to be the most consistent way to effectively reduce HbA1C levels through T2DM self-management.

Provider-based Interventions.

Provider-based interventions included setting target HbA1C levels and providing feedback on blood glucose readings (Minooee, 2020; VA DoD, 2017). One of the main factors for successful disease management has been acknowledged to be interventions led by health professionals (Alexandre et al., 2021). Regular medical reviews with practitioners were associated with lower HbA1C levels and more effective self-management (Minooee, 2020; Alexandre et al., 2021). One CPG concluded that improvements were seen in HbA1C levels when patients had the ability to upload glucose monitor device data for review by their provider (VA DoD, 2017). In another systematic review, studies with low provider feedback saw a 0.33% HbA1c reduction (95% CI 0.07-0.59); in contrast, studies with high provider feedback saw a 1.12% decrease in HbA1c levels (95% CI 0.91-1.32) (Hou et al., 2018).

Outcomes

Average Blood Glucose

Throughout the literature, glycemic control was consistently measured through HbA1C levels and is defined as a HbA1C level of less than 8.0 (ADA, 2018). In the review of the literature, glucose levels were commonly equated or measured with HbA1C levels as this gives an average of glycemic control. HbA1C levels reflects the average glucose over the previous two to three months (ADA, 2021). This provides a way to monitor and measure a patient's average blood glucose over the prior three months and allows the clinician to evaluate the patient's progress in regard to the body's metabolic ability (ADA, n.d.). While HbA1C target levels can vary by each person's age and other medical conditions, generally speaking, the goal for most adults with T2DM is a HbA1C less than 7% (ADA, n.d.). Similarly, average blood glucose levels were chosen as primary outcomes in many pieces of literature chosen for evaluation and utilization in this project. Throughout the literature, the use of a mobile phone application showed a statistically significant reduction in HbA1C levels (Wu et al., 2017; Pal et al., 2013; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016).

The American Diabetes Association (ADA) discusses in their 2021 guidelines the term time in range (TIR). This idea encompasses blood glucose readings that are within target, below target, and above target (ADA, 2021). Each patient has their own target range and allows for individualization of treatment and care plans. TIR is associated with many microvascular risk factors, but the ADA recommends that this measure be used in future clinical trials and can be used for assessment of glycemic control moving forward (2021). TIR accounts for time below target and time above target and acknowledges that these can be useful parameters for providers for evaluation of the treatment regimen (ADA, 2021).

Wu et al. (2017) performed a systematic review of RCTs to evaluate the effectiveness of diabetes-specific mobile phone applications and their effects on disease management and effect on average glucose levels. Within this systematic review, it was concluded that the use of a mobile phone application was associated with a clinically significant HbA1C reduction of 0.48% (95% CI 0.19%-.78%, I^2=76%, P<0.001) compared to those who received standard of care alone (Wu et al., 2017). Similarly, another systematic review found that the use of a diabetes-specific application resulted in a statistically significant HbA1C reduction of -0.55% (95% CI -.60 to -0.40;

P<0.001) (Aminuddin et al., 2019). Hou et al. (2018) performed a systematic review and meta-analysis regarding the use of diabetes mobile phone applications and their effects on HbA1C levels. It was found that applications were associated with a mean HbA1C reduction of 0.57% (95% CI 0.32-0.82; P<.01) (Hou et al., 2018). A RCT evaluated the effectiveness of a mobile phone application and its effect on average blood glucose readings. It was concluded that continuous care utilizing a mobile application significantly lowered the patients' blood glucose levels and reduced HbA1C levels six months after initiation of the intervention (Wang et al., 2017).

Wu et al. (2017) evaluated the effectiveness of the mobile phone application comparing different types of diabetes and found that the application was most effective in lowering HbA1C levels for patients with T2DM (MD 0.67%, 95% CI 0.30%-1.03%, I^2=47%, P=.11). This same systematic review also concluded that applications with direct data transmission and a structured display were associated with larger trends towards reduced HbA1C levels (Wu et al., 2017).

Self-Efficacy

Self-efficacy is defined as one's confidence in one's ability to successfully execute behaviors required in producing desired outcomes (Aminuddin et al., 2019). Self-efficacy activities for persons with T2DM include correct medication titration adherence, diet knowledge, adequate exercise, and blood glucose control. Of note, the terms self-efficacy and self-management were used equally and have the same meaning throughout the literature. A patient's knowledge about T2DM and motivation should be assessed and considered when thinking about self-efficacy (Alexandre et al., 2021; Wang et al., 2019). A systematic review suggested that if a patient has a positive relationship and support from family/friends and the provider, their self-efficacy may be much higher than if those two factors are missing (Alexandre et al., 2021).

In summary, the results of the literature review provided evidence indicating that diabetes-specific mobile phone applications can be utilized to improve self-efficacy of patients with T2DM and HbA1c levels (Minooee, 2020; Wu et al., 2017; Manuel, 2020; Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). Throughout the literature search, it was determined that mobile health applications and their use for chronic disease management are increasing and have been shown to be an effective tool for increasing self-efficacy or self-management.

Recommendation for Best Practice

Best practice recommendations include a diabetes-specific multimodal mobile phone application that has the capability for providers to provide feedback to the user (Wu et al., 2017, Alexandre et al., 2021; Minooee, 2020; Lizarondo, 2021; VA DoD, 2017; Hou et al., 2018). The use of a diabetes-specific multimodal mobile phone application has been shown to effectively decrease average blood glucose levels and in turn decrease HbA1C levels and complications of T2DM (Minooee, 2020; Wu et al., 2017; Manuel, 2020; Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). Of note, in the ADA 2021 standards of care, TIR should also now be evaluated as a measure of glycemic control and will be used more often moving forward.

The clinic where the project will be held has a pre-established agreement with Accu-Chek Guide Me© and the Roche© application mySugr ©. This agreement allows the meter and the mobile phone application to be interconnected via Bluetooth. This allows for patients to track glucose readings, physical activity, diet, and medication adherence. This mobile phone application has the capability of generating reports that are available for downloading by the application user and can easily be sent to healthcare providers. The reports allow the provider to evaluate estimated HbA1C levels, average blood glucose readings, and time in range. Based on the reports, the application meets the standards of care of the ADA. Thus, the use of the Accu-Chek Guide Me© and the mySugr© mobile phone application may result in improved self-efficacy and disease management, which in turn may result in improved blood sugar monitoring efforts, medication adherence, and involvement in physical activity. The literature shows that diabetes-specific mobile phone applications can assist patients in achieving lower average blood glucose readings and HbA1C reduction ranging from 0.48% to 0.57% (Pal et al., 2013; Aminuddin et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016).

Computer-based interventions and phone or text messaging interventions have shown to have some beneficial effects on HbA1C levels and self-efficacy. Across the literature, the results from these interventions have been less consistent than those results of interventions involving mobile phone applications. HbA1C levels were reduced by a range of by -0.2 to -0.57 (Pal et al., 2013; Yoshida et al., 2018). The use of computer-based interventions were found to be more variable and less consistent with the reduction of HbA1C levels compared to other interventions.

The literature also suggests that measuring baseline self-efficacy is beneficial before starting any technological intervention (Minooee, 2020; Alexandre et al., 2021; Lizarondo, 2021; Aminuddin et al., 2019; Wang et al., 2019). Performing baseline assessments may be beneficial, so time is not wasted going over self-management education that is already known to the patient. After mobile phone application education and implementation occurs, both individual self-care behaviors and self-efficacy should be monitored (Alexandre et al., 2021).

CHAPTER 3

IMPLEMENTATION OF PRACTICE CHANGE

The proposed project included the implementation of a diabetes-specific multimodal mobile phone application and the evaluation of its effect on average blood glucose levels, time in range, and self-efficacy. This project was created in conjunction with the project site nurse practitioner to determine if the utilization would aid in T2DM management. The project was implemented by the student project leader, a nurse practitioner that oversaw and assisted the student project leader, and one clinical pharmacist. Participants were recruited through retrospective chart review and recruited by staff at the project site. Participants were 18 years or older, had a HbA1C greater than 8%, had a smart phone that was used to download the application used for the project, had an Accu-Chek© Guide Me glucose meter for utilization in combination with the application, and were English speaking. The Accu-Chek© Guide Me meter could be connected via Bluetooth to the mobile phone application, allowing data to flow over into the application without requiring any further action from the user. Exclusion criteria from this project was patients under the age of 18, patients who did not have a smartphone, patients that utilized continuous glucose monitors and/or insulin pumps, patients whose primary language is something other than English, and pregnant women. Patients with drug or alcohol abuse, dementia, or any other debilitating diseases that could have affected their ability to comply with the project requirements were also excluded. The project compared pre- and post- average blood glucose levels and TIR to evaluate the effect of the mobile phone application. Secondary outcomes were the effect of the mobile application on estimated HbA1C levels and self-efficacy. The estimated HbA1C levels were generated within the application using participants average blood glucose levels throughout the duration of the project.

The mobile application that was utilized was mySugr©. The application was a multimodal smart phone application that allows users to enter personal data including diet, exercise, glucose levels and medication administration. The main management functions that were utilized in this project were average glucose levels, exercise, and diet tracking. The exercise and diet tracking features were classified as self-management behaviors. The application also automatically generated estimated HbA1C levels, average blood glucose levels, and TIR. Once participants were recruited and consent was obtained, there was an estimated 1-hour phone call with each participant to collect demographic data (Appendix C), ensure proper education of the application (Appendix K), ensure glucose meters were connected correctly, and a provided explanation of the project's goal was given (Appendix B). Within the consent, participants agreed to participate and were informed that they could withdraw from the project at any time and if they chose to withdraw, their health care was not to be impacted. Demographic information including age, date of birth, gender, highest education level, employment status, ethnicity, days spent in the hospital related to diabetes over the last year, number of times blood glucose is checked per day, how well the participant felt they manage their diabetes, and how regularly HbA1C was checked was collected prior to starting the project. Demographic information was obtained with the use of a written form that was completed by the student project leader over the phone and by chart review (Appendix C).

Participants were contacted biweekly throughout the duration of the project to encourage compliance. During these contact points, participants were asked how the application was working for them, what problems they were experiencing, or if any technology was proving to be troublesome. If during these phone calls the participants were experiencing low or high blood glucose levels, the provider was notified via chart notification, or the participant was instructed to call the project site triage phone line. If needed, the participants were able to contact the student project leader with any questions or complications with the application via secure messaging through the healthcare system. The participants were also asked to take a self-efficacy inventory, the DES-SF, to assess knowledge at implementation and completion of the project. The reliability of the DES-SF was determined to be adequate ($\alpha = 0.84$) (Anderson et al., 2003). This scale was an eight item Likert scale that evaluates self-efficacy. At the completion of the eight-week period, participants post-intervention average glucose level data was compared to pre-intervention data. Participants were asked DES-SF questions post-intervention and asked to take a survey regarding project satisfaction (Appendix D). The participant satisfaction survey was an eight item Likert-type scale and had participants answer a series of questions requiring answers ranging from strongly agree to strongly disagree. Data was then analyzed by the student project leader and shared with the project site key stakeholders.

Participants and Setting

Stakeholders that took part in the practice change included a nurse practitioner provider at the clinic, a clinical pharmacist, and the student project leader. The nurse practitioner has worked in the diabetes specialty clinic for seven years, managing patients with similarities to the project participant population. The clinical pharmacist has worked at the project site for more than 20 years, managing patients with diabetes. Clinical pharmacists at the project site were able to adjust and prescribe diabetes medications as needed without the prescribing authority of a physician or advanced practice provider. The pharmacist’s role in the project was to help with patient recruitment and continue the project for patients who were started on the application. Two additional providers were invited to participate but declined related to other commitments of the academic medical center. However, they expressed interest in receiving the findings of the project and would consider implementation based on project findings.

The project site was in a moderate-size, metropolitan area located in southern Wisconsin. The project site was part of a larger health care system that has many locations throughout the United States. The clinic where the project took place was a smaller, specialty clinic that manages various types of endocrine disorders. The nurse practitioner and clinical pharmacist involved in the project worked specifically within the diabetes management area of the endocrine clinic and only manage patients with T1DM and T2DM.

Participants who took part in the project included persons with T2DM with HbA1C levels greater than 8%, who had access to a mobile smart phone, were 18 years or older, and spoke the English language.

Pre-Intervention Group Characteristics

The participants that were recruited included patients with T2DM with a HbA1C greater than 8%. The age range of participants ranged from 36-74 years, with majority of the sample being composed of men. This was to be expected with the patient population as all patients that receive care at this clinic were active-duty servicemen or veterans. The average educational level of participants was high school educated or higher. Majority of the participants were no longer working.

Intervention

To prepare for the initiation of the project and resulting practice change, a variety of steps were taken. First, the student project leader evaluated the literature to determine best practice for management of T2DM. The student project leader then collaborated with the nurse practitioner who helped facilitate the practice change. The project location had Accu-Chek Guide Me© glucose meters; this meter could be connected via Bluetooth to the application mySugr©. mySugr© was a multimodal, diabetes-specific smart phone application that was used for the project. This application allowed users to connect their glucose meter via Bluetooth to track their blood glucose levels. Users of the application could also track diet choices, exercise, and any necessary medication administration. The application also had the ability to generate PDF reports of blood glucose readings that were uploaded into the MyHealtheVet electronic chart of any participants for providers to review.

Participants were recruited via retrospective chart review and through recommendations of the clinic staff at the project site. If a participant was identified as eligible to participate in the project, the student project leader contacted them through MyHealtheVet secure messaging, through communication with their provider, or via phone call. Potential participants that did not have MyHealtheVet activated were contacted by phone by the student project leader about how to connect with the MyHealtheVet coordinator at the project site (Appendix G). Each participant that met the inclusion criteria and expressed interest in the proposed project was given a 1-hour introductory meeting to explain the goals of the project: lowering average blood glucose readings, increasing TIR, and increased self-efficacy. In the introductory meeting, the student project leader collected demographic information (Appendix C), assisted the participant in downloading the application, conducted an educational session to explain use of the application and how to upload information into MyHealtheVet (Appendix G), and had the participant fill out the pre- DES-SF.

The intervention itself included the use of the diabetes-specific, smart phone application. Participants were asked to track their blood glucose levels at least once per day with their Accu-Chek Guide Me© glucose meter for eight weeks; this information automatically flowed into the smart phone application. Every two weeks, participants uploaded their PDF report of blood glucose levels to the MyHealtheVet electronic medical record for review by the student project leader, nurse practitioner, and clinical pharmacist. Participants were contacted via phone by the student project leader on a biweekly basis to address any problems or concerns with the use of the application. The student project leader evaluated average blood glucose readings and TIR with each upload of the PDF to monitor compliance.

Comparison

Participants that were selected for this project were English speaking and reading, 18 years or older, clinically diagnosed with T2DM, had a HbA1C of 8% or higher, and owned a smartphone. For this project and the site that was selected for the project, majority of the participants were middle aged to elderly males with uncontrolled T2DM. HbA1C levels of selected participants ranged from 8%-12% before the implemented intervention.

Throughout the literature, best practice was identified as the use of a multimodal, diabetes-specific mobile phone application (Minooee, 2020; Wu et al., 2017; Manuel, 2020;

Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). The use of a mobile phone application has been shown to decrease HbA1C levels and maintain better glycemic control (Minooee, 2020; Manuel, 2020; Lizarondo, 2021; Pal et al., 2013; Aminuddin et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016).

Outcomes

The primary outcome of the project was average blood glucose levels. The goal of the project was to utilize the diabetes-specific mobile phone application to overall lower average blood glucose levels and increase TIR. The participants' pre-intervention HbA1C level and average blood glucose level were retrieved via retrospective chart review. The post-intervention average blood glucose levels were evaluated and collected through chart review of the uploaded PDFs from the mySugr© application on a biweekly basis. Secondary outcomes evaluated were estimated HbA1C levels generated by the application and self-efficacy. Self-efficacy was measured by using the DES-SF. This was an eight-item form and was created as a shorter version of the Diabetes Empowerment Scale (Anderson et al., 2003). With the eight items, each item required an answer ranging from strongly disagree to strongly agree. The goal of the form was to measure diabetes-related psychosocial self-efficacy (Anderson et al., 2003). The reliability of the DES-SF was determined to be (α = 0.84) (Anderson et al., 2003). All data that was collected from each participant was managed by the student project leader using a deidentification coding system.

At the completion of the project, the student project leader evaluated and analyzed the data collected. For analysis, a paired sample t-test was used to evaluate the effectiveness of the intervention. A Wilcoxon signed-ranked test was used to evaluate the effectiveness of the interventions on self-care perceptions and self-efficacy.

Time

This project started on September 1, 2021 and had open enrollment for participants which lasted from September 1, 2021 to October 31, 2021. With the utilization of open enrollment, the student project leader anticipated an adequate number of participants and ensured adequate data was collected during the project implementation. Data collection was completed by December 31, 2021. Refer to Appendix J for a full timeline and visual of the implemented intervention.

Protection of Human Subjects

Participants and their data were protected throughout the duration of the project. An online ethics course was completed by the student project leader on April 5, 2021 through the Collaborative Institutional Training Initiative (CITI). The completed training was entitled *Social Behavioral Educational Researchers*; the completion certificate for reference is located in Appendix F. IRB review was determined to be exempt from Valparaiso University and permission to complete the project was obtained from the Chief Nursing Officer who regulated EBP at the project site. Written consent for participation in the project was obtained after reviewing the goals of the project, potential risks, benefits and harms, and the right to discontinue the project at any time. Before presenting any of the data that was collected during the project, the project was reviewed by the Nurse Executive Committee at the project site as this was part of their requirement. All data that was collected during the project was kept secured via lockbox and password protected computer. To ensure confidentiality for participants, each participant was identified by using a code number. At the completion of the project and data analysis, all data that was outside the participants' chart was immediately destroyed.

CHAPTER 4

FINDINGS

This EBP project was created to determine the effect of a multimodal smart phone application and its effect on average blood glucose levels for adults with T2DM over an 8-week period. The project will also evaluate the effective of the application for TIR and self-efficacy of their disease through the DES-SF. Following the literature search, it was determined that this intervention was most effective for patients with a HbA1C level of 8% or greater. Average blood glucose levels were compared from pre-intervention and post-intervention through the use of the mySugr© application. Secondary outcomes included TIR, DES-SF scores, and estimated HbA1C levels. Statistical analysis was performed on project outcomes to determine significance of the obtained results. Patient satisfaction scores were also collected at the end of project implementation to evaluate ease of use of the application and project process. Participant responses were recorded at the final phone meeting.

Participants

A total of 16 participants were initially recruited to participate in the project; of these, five participants (31%) were lost to attrition prior to starting the intervention. The five participants who were lost to attrition had similar age, sex, education level, and employment status as compared to the participants who completed the project. The majority of the participants in this project were Caucasian males (81.8%) with an employment status of retired (72.7%). This was similar to the preintervention participants as well. Further demographic data for participants who completed the project can be found in Table 4.1.

Providers involved in the project were one nurse practitioner working in the diabetes specialty clinic who assisted with the development of the DNP project and one clinical pharmacist who worked specifically in the diabetes clinic as well. An additional clinic nurse was involved via providing coordination of care for participants enrolled in the project. There were two attending providers who decided not to participate in the project because of other commitments to the academic medical center. They were required to train and oversee resident and fellow physicians and felt the project would be too much of a responsibility on top of their other requirements. They expressed their sympathy for not participating but were interested in evaluating the results of the project.

Table 4.1

Participant Demographic Data

Demographic	*n* (%)
Age	
Mean/ *SD*	66/8.28
Range	46-76
Gender	
Male	9 (81.8)
Female	2 (18.2)
Race	
African American	0 (0)
American Indian	0 (0)
Asian	0 (0)
Caucasian	11 (100)
Hispanic	0 (0)
Other	0 (0)
Employment	
Part time	1 (9.1)
Full time	2 (18.2)
Retired	8 (72.7)
Unemployed	0 (0)
Education	
Primary school	0 (0)
High School	5 (45.5)
University	6 (54.5)
Diabetes Management	
Weak	2 (18.2)
Moderate	6 (54.5)
Strong	3 (27.3)

Changes in Outcomes

The primary outcome of this project was average blood glucose levels after an 8-week period. Average blood glucose levels were measured pre-intervention and compared to post-intervention results. Secondary outcomes for the project were TIR, estimated HbA1c levels, and DES-SF scores. Primary and secondary outcomes were measured and evaluated by statistical analysis. In addition to these outcomes, patient satisfaction scores were collected to evaluate patient perceptions of the project.

Statistical Testing and Significance

For data entry and statistical analysis, the 25th version of SPSS was utilized. Paired-sample *t*-tests were used to evaluate average blood glucose levels, TIR, estimated HbA1C levels, and patient satisfaction scores. A Wilcoxon Signed Ranks test was performed to evaluate DES-SF scores from before and after the 8-weeks of the intervention. Statistical significance for all the analyses was determined as $p < .05$.

Findings

The primary outcome of this project was average blood glucose levels. Pre-and-post-intervention data were evaluated using a paired sample *t*-test and were found to be statistically significant. Secondary outcomes of this project included TIR, estimated HbA1C levels, and DES-SF scores. The secondary outcomes were evaluated used a paired sample *t*-test and were found to be statistically significant. Further analysis was performed for independent variables and their effect on average blood glucose levels.

Primary Outcome

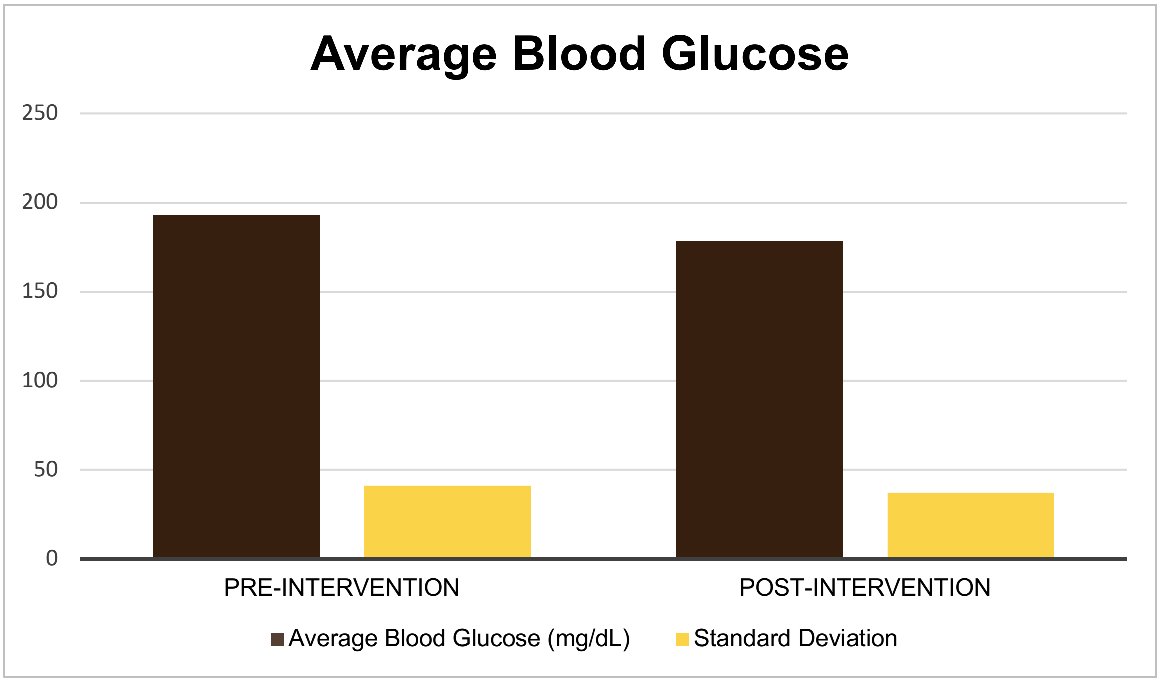
Average Blood Glucose. A paired samples *t*-test was utilized to evaluate the pre-and-post-intervention data for average blood glucose over the 8-week period. The mean pre-intervention average blood glucose was 192.7 mg/dL (*SD* = 41.01). After the 8-weeks of the intervention, the mean average blood glucose was 178.54 mg/dL (*SD* = 37.28). With this data a paired-samples *t*-test was performed and a significant difference was found in the average blood glucose of the participants from the beginning of the program to the end of program (*p* = .008). The average decrease in blood glucose was found to be 14.18 mg/dL (*SD* = 14.09). Figure 4.1 demonstrates the difference between pre-and-post average blood glucose levels.

Furthermore, an analysis was performed to evaluate the effects of education, gender, age, employment, days in the hospital, perception of diabetes self-management, and patient satisfaction on average blood glucose levels. A linear regression model was performed, and it was determined that the variables of different education levels (*t* = .001), gender (*t* = .190), age (*t* = .-.123), employment (*t* = .296), number of days of hospitalization (t = -.234), and self-management (*t* = .648) did not influence average levels of blood glucose.

After this, a further analysis was performed to evaluate education, age, education and age, and gender to determine if these individual demographic characteristics had a significant impact on average blood glucose. A Kruskal-Wallis test was used to evaluate education and its effect on average glucose levels and was found to be not significant (*p* = .173). An independent *t*-test was used to evaluate age and its effect on average blood glucose and was also not significant (*p* = .123). A linear regression model was performed to evaluate the combination of education and age on average glucose levels. The independent variable of age was not significant (*p* = 0.076); the independent variable of education was not significant either (*p* = 0.130). Thus, participants' age and education level did not have an effect on average blood glucose levels for the participants in this project. Lastly, an independent *t*-test was calculated to evaluate average blood glucose levels for males and females. This calculation was not significant (*p* = .904), indicating there is not a difference between male and female participants in this project.

Figure 4.1

Pre-Post Intervention Average Blood Glucose

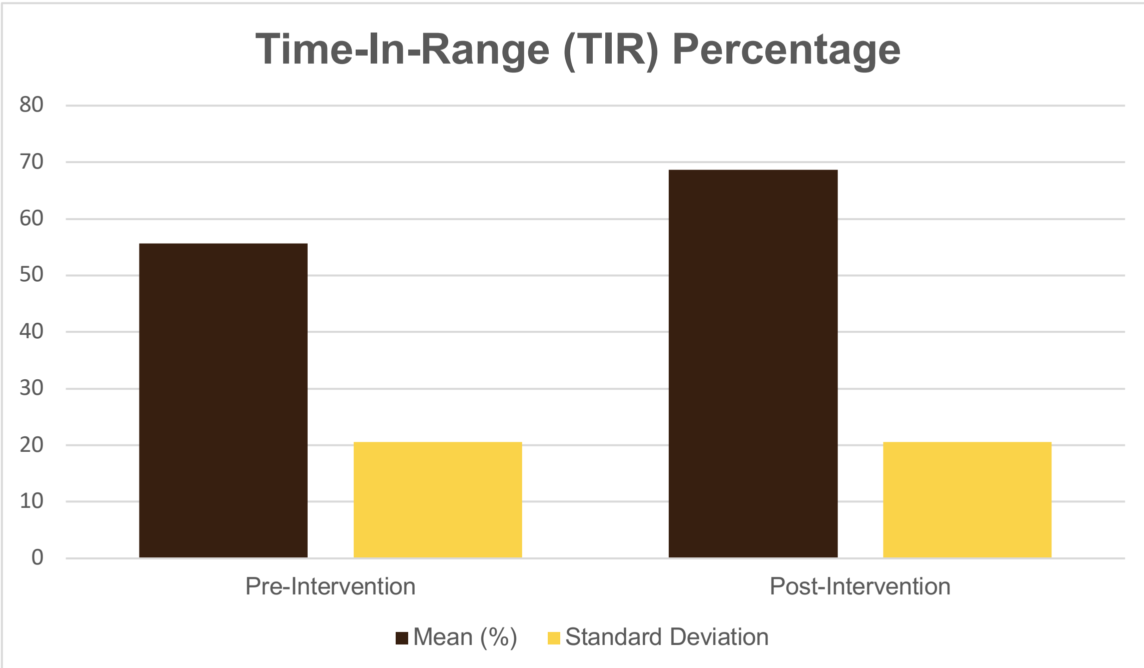


Secondary Outcomes

Time In Range. TIR was evaluated by running a paired samples *t*-test. The paired samples *t*-test was statistically significant (t (10) = -3.58, p = .005). The mean for pre-TIR (M= 55.63, SD = 20.56) was significantly different from the post-TIR (M= 68.63, SD = 20.60). Since the test statistic is negative, another analysis was performed and found the one-sided p-value to be p = .0025). Figure 4.2 demonstrates differences between pre-and-post TIR.

Figure 4.2

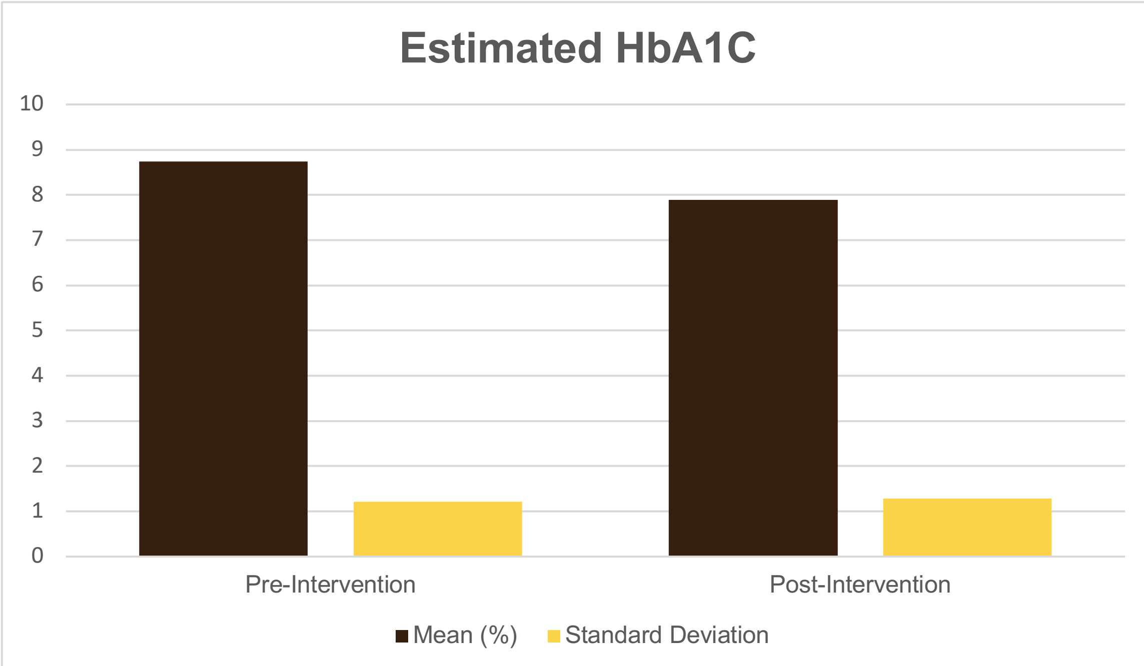
Pre-Post Intervention Time-In-Range Percentage



Estimated HbA1C. A paired samples *t*-test was performed to evaluate pre-and-post estimated HbA1c levels. The participants' mean pre-HbA1C level (M = 8.74, SD = 1.22) was higher than the post-HbA1C levels (M = 7.89, SD= 1.28) for the participants. After running the paired samples *t*-test, the difference in the data was found to be statistically significant (t (10) = 5.068, p = 0.00048). Figure 4.3 demonstrates differences between pre-and-post estimated HbA1C levels.

Figure 4.3

Pre-Post Intervention Estimated HbA1C



DES-SF. A Wilcoxon Signed Ranks Test was performed to analyze DES-SF questionnaire scores from the beginning to the end of the project. The DES-SF post-total was significantly different from the DES-SF pre-total (p = 0.007). When examining the ranks, it appeared that nine out of 11 times, the DES-SF post-total was higher than the DES-SF pre-total. With this conclusion, the participants had higher scores or improved on the questionnaire from the beginning of the project to the end.

CHAPTER 5

DISCUSSION

The purpose of this EBP project was to lower average blood glucose levels through the utilization of a multimodal smartphone application. The project was created to answer the following PICOT question: In adults with type 2 diabetes mellitus with a HbA1C greater than 8% (P) in a diabetes specialty clinic, what is the effect of a multimodal smartphone application (I) compared to prior nonuse of the application (C) on average blood glucose readings (O) over an 8-week period (T)? This chapter will discuss and interpret statistical testing of the project, strengths and limitations, and implications for future practice.

Explanation of Findings

Overall, the project supported the use of a multimodal smartphone application for the self-management of adults with T2DM. Results were consistent with the literature that was used to create this project, in which this intervention was shown to be the most effective. Participant findings, project findings, statistical and clinical significance and analysis will be discussed further in this section. Of note, there has not been any new research with differing results or interventions related to the use of a multimodal smartphone application since the above literature search was performed.

Demographic Findings

Demographic data for participants were collected and analyzed to evaluate if any significant differences existed between gender, age, and education level. Race was excluded from the analysis because all of the participants were Caucasian. After analysis of the 11 participants, there was no difference for gender (p = .904), age (p = .123), or education level (p = .173). Age of the participants had no impact on the results of the project. While there was no significant difference in gender and its effect on average blood glucose levels, there was a large discrepancy for males and females in the participant sample. Within the 11 total participants, there were nine (n = 9) males and only two (n = 2) females. There was no statistically significant difference between gender, but if the sample size was larger and consisted of more females, the results of gender impact could differ. In regard to education level, all of the participants had at least a high school level education. Because of this, implementation of the reading material and troubleshooting during the project was much simpler. If the education levels of the participants were to be lower, reading materials for the project would need to be adjusted.

Average Blood Glucose

Based on the paired-samples *t*-test that was calculated for the intervention, a statistically significant difference was found for average blood glucose levels after an 8-week period. Participants were asked to track their blood glucose at least twice daily over the 8-week intervention period and upload their results every two weeks to maintain compliance. Average blood glucose levels were compared from the initial upload and at the end of the project. A two-sided analysis was completed and there was a significant difference in the average blood glucose levels of the participants from the beginning of the program to the end of the program (p = .008). The mean from beginning average blood glucose levels to end average glucose levels was M = 14.18 (SD = 14.09). It was determined that there was sufficient evidence to support that the average blood glucose levels of the participants from the beginning of the project was larger than the average blood glucose levels of the participants from the end of the project.

TIR

Time in range (TIR) is discussed by the ADA as the idea of blood glucose readings being within target, below target, or above target (ADA, 2021). Each patient has their own target for blood glucose that allows for individualization with TIR. TIR has been associated with many microvascular risk factors, and the ADA recommended that this measure be used in future clinical trials and can be used for assessment of glycemic control moving forward (ADA, 2021). Because of this, the NP that assisted the student project leader with the project development recommended using this measure in the project. A paired samples *t*-test was used to evaluate the TIR in this project and produced a statistically significant result from the start of the project to the end of the project (p = .0025). This could be assumed because of the statistically significant results with decreased average blood glucose levels. If participants overall had lower blood glucose levels, the TIR would increase. The inverse would be true as well. If participants did not have lower blood glucose levels, their TIR would not improve or could have possibly become worse.

Estimated HbA1C

Throughout the literature, glycemic control was consistently measured through HbA1C and was defined as a HbA1C less than 8.0 (ADA, 2018). A HbA1C level provides insight into a person’s average blood glucose over a prior period of three months and monitors progress in regard to the body’s metabolic ability (ADA, n.d.). HbA1C was initially going to be used to evaluate the participants progress in the project over a 12-week period. Because of the restrictions from the project site, this idea had to be discarded. Instead, the application that was chosen for the project had the ability to generate an estimated HbA1C level based on the blood glucose PDF reports over a two-week period. The participants pre-estimated HbA1C was then compared to the post-estimated HbA1C and evaluated using a paired samples t-test. It was determined that pre-to-post estimated HbA1C demonstrated a statistically significant difference for the participants (p = .000486). It would be more accurate to obtain the blood test for HbA1C instead of using an estimated number but because of project site restrictions, estimated HbA1C levels were used in its place.

DES-SF

A Wilcoxon Signed Ranks Test was used to evaluate pre-DES-SF and post-DES-SF scores. After running this test, a significant difference was found in the scores (p = .007). When examining the ranks, nine out of eleven times the DES-SF post-total had a higher score than the DES-SF pre-total. With this conclusion, the participants had higher scores, or they improved on the DES-SF questionnaire from the beginning of the intervention to the end of the intervention.

The average pre-DES-SF total was 30.55 and the average post-DES-SF total was 33. Two participants scored the same from pre to post scoring. A Cronbach's alpha was performed for the eight domains of the DES-SF questionnaire to evaluate internal consistency of the questionnaire. Ideally, high levels of internal consistency would be demonstrated by an alpha of greater than 0.7 and results closer to 1.0 would demonstrate an even higher level of reliability. The pre-DES-SF alpha results were .809 compared to post-DES-SF alpha of .684. These results suggest that the pre-DES-SF scores were more reliable than post-DES-SF scores. These results can be more beneficial with a larger sample size.

Patient Satisfaction

Patient satisfaction scores were measured at the end of the project used an 8-item Likert scale tool. An independent samples *t*-test was used to evaluate if there was a difference in average blood glucose levels between not-satisfied participants, who rated 1-3 on the satisfaction survey questions, and satisfied participants, who rated 4-5 on the satisfaction survey (Appendix D). When comparing the two groups, there was not a significant difference in the average amount of glucose no matter if they were satisfied with the project or not. An analysis was also performed for each question on the satisfaction survey to assess how frequently each answer was chosen. For many of the questions, participants answered with a six, which signified that they strongly agreed with the question. Many of the participants also responded with a 4, which signified that they agreed with the question. Overall, the participants were satisfied with the project except for when it came to evaluating question six of the survey (Figure 5.1). Question six of the survey evaluated how participants felt that the application helped them track their diet and exercise. Almost half of the participants responded with one or two, which signified that they either strongly disagreed or disagreed with the statement. This may be related to lack of knowledge of how to enter this into the application. Participants were given instruction on this during the initial phone meeting, but when asked why this data was not entered or they felt that the part of the application was not helpful, the most common response was that they forgot to do it, or it was too complex.

Strengths and Limitations of the DNP Project

Strengths

A thorough and comprehensive search of the literature was performed with the assistance of the Valparaiso University College of Nursing and Health Professions librarian. Finding and analyzing the highest quality evidence was a major strength of this project and played a large role in its development. Throughout the search of the literature, the use of a mobile phone application was shown to be best practice and had the strongest evidence for successful outcomes, which was the reason for implementing mySugr© in this project.

In addition to the comprehensive search of the literature, there were many identified strengths throughout the duration of the project. One of the main strengths of this project was interprofessional communication. During the development phase of this project, there were many identified challenges which pushed the student project leader to communicate efficiently and effectively to ensure the project would be implemented to its fullest potential. Another strength was the technology that was chosen for the project; this included the mySugr© application, the Accu-Chek Guide Me© glucose meter, and the MyHealtheVet secure messaging system. Working with technology that the clinic already had supplied for patients facilitated and provided a smooth implementation phase of the project. With the ability of the glucose meters to connect via Bluetooth to the application, it was much easier for participants to remain compliant with the project and send their data for review. The ability for participants to be able to join the project at no cost to them was also a significant benefit.

Lastly, the support from the NP that worked closely with the student project leader led to great success with the participants. The NP was willing to be very attentive to MyHealtheVet messages that were being sent in by participants. This included reviewing their data and providing feedback and medication adjustments in a timely manner. The student project leader was able to smoothly implement the project and discuss results with the NP from each participant's data. The clinic staff was also very supportive of the project. RNs would direct participant data to the student project leader's inbox on MyHealtheVet to provide notification of their data submission. The student project leader was then able to review and discuss results with the NP.

Limitations

There were many identified barriers in the planning and implementation phase of this project. During the planning phase of the project, the student project leader encountered many problems with the facility itself. The original project idea was to implement the same application and to have the main outcome be HbA1C levels after 12 weeks of implementation. Each contact with participants was planned to be in person or through video chat through the electronic medical record used by the facility. The EBP coordinator of the facility deemed that it was unethical to have participants have another HbA1C drawn just for the purpose of this project; therefore, this idea had to be discarded. The in-person visits had to be discarded as well, related to the COVID-19 pandemic and restrictions regarding extra persons in the clinic. Video calls were not able to be conducted related to specific security clearance being needed for the clinical facility. Phone visits were used in place of in-person and video visits. Phone contact visits were also a challenge related to calls dropping or phone calls not being answered. To manage all of these challenges, the student project leader engaged in multiple meetings with the EBP coordinator of the facility, an EBP nurse employed by the healthcare system, the nurse practitioner involved in the project, and the student project leader's project advisor.

During the implementation phase of the project, more challenges arose. One of the main challenges experienced during implementation was with the technology used. The application mySugr© was used along with the electronic medical record employed by the facility. Because contact time with participants had to be conducted over the phone, explaining to participants how to upload their PDF forms from the application was extremely difficult. The average age of participants was 66 years of age, and many were unfamiliar with how to work a smart phone application. The PDF forms were then uploaded through the secure messaging system used by the facility. There were multiple steps needed for downloading the PDF from the application, saving it to the participants computer, and then uploading it into the secure messaging system. This posed a significant challenge to many participants due to the lack of knowledge for using a laptop or desktop computer. Along with technology, many participants did not have high-speed internet or strong Wi-Fi connections. This was a challenge because much time was spent on the phone waiting for the application to generate the PDF or for the computer to get to the correct page for uploading the documents.

Lastly, time allowed for the project was a large challenge. Implementation of the project had a very limited time window. The project was implemented from September 2021 through December of 2021. This only allowed two months for recruitment of participants and two months for implementation. Since data were collected for 8-weeks, only two months was allowed for recruitment of participants. If the student project leader was allowed more time for recruitment of participants, the number of participants might have been higher. A full timeline of the project can be found in Appendix J.

Sustainability

The goal at the end of implementation was for the project site to continue the student project leader’s project at its completion. After completion, the plan was for the patient education resource center (PERC) at the project site to continue education and onboarding of patients with the application use. The student project leader was going to supply the PERC with resources that were supplied to project participants during project implementation. A short educational session was provided to PERC employees about how the application works and how to educate patients on its use. The PERC already assists patients with the use of MyHealtheVet, so no further action will be needed in that aspect of continuation with this piece of the project. The educational flyers created by the student project leader that were used in the project for education were also given to the PERC for use and continuation of the application. Ideally, this was seen as the best way to maintain sustainability after discussion with the NP.

After discussion with the PERC, it was determined that they were not able to assist patients with this, as they are already extremely busy with other aspects of care. Instead, the student project leader worked with the clinic CDCES to establish how the project would still continue. The educational packets that were created are going to be either sent to the patient's MyHealtheVet account or mailed to their house. Patients will be able to contact the PERC for help with access to MyHealtheVet and getting this set up. For getting the application set up, they will be instructed to follow the directions in the packet and contact the clinic with any questions; the clinic CDCES will follow up with them.

The nurse practitioner who assisted the student project leader with implementation of the project also suggested continuation through the CDCES. The CDCES was involved in the recruitment process of the project and is very familiar with the process needed for continuation of the application use. The CDCES will be responsible for referring patients to the PERC for further educational needed regarding the application use and MyHealtheVet use.

Relevance for EBP Model

The JHNEBP model was used to plan, implement, and evaluate the project. The JHNEBP model was created as a way to transition EBP into practice (Melnyk & Fineout-Overholt, 2019). In this model, there are a total of 18 steps that are broken down into the three main categories known as the PET process: practice question, evidence, and translation. Overall, this model was a good fit for this project. In the practice question phase, all steps were used except for the scheduling of team meetings step. This step was just simply not feasible within this clinic because of the COVID-19 pandemic and the differing duties of the NP and the nurses in the clinic. The clinical pharmacist also was not easily able to attend meetings. The student project leader connected with each member of the team individually and communicated what other members of the group were thinking or what concerns were present.

In the evidence step, all five steps were used. The student project leader conducted internal and external searches for evidence, appraised the level and quality of each piece of evidence, summarized the individual evidence, synthesized overall strength and quality of evidence, and developed recommendations for change at the project site based on the evidence found (Melnyk & Fineout-Overholt, 2019). Lastly, all eight translation steps were used: determining fit, feasibility and appropriateness of recommendations for translation path; creating an action plan; securing support and resources to implement action plan; implementing action plan; evaluating outcomes; reporting outcomes to stakeholders; identifying next steps; and disseminating findings (Melnyk & Fineout-Overholt, 2019).

Based on the student project leader's experience with the JHNEBP model, a recommendation would be made to divide the translation step into two phases or two separate steps. This phase comprised much of the time spent with the project. The eight steps in this phase could be divided into planning which would include: determining fit, feasibility and appropriateness of recommendations for translation path, creating an action plan, and securing support and resources to implement action plan. The second part of this phase would include: implementing action plan, evaluating outcomes, reporting outcomes to stakeholders, identifying next steps, and disseminating findings. The student project leader felt overwhelmed with all of the duties listed in this phase. To avoid this, the PET process could be divided into four phases instead of three or divide the translation phase into two separate parts so that this step is more manageable.

Recommendations for the Future

The findings from this EBP project provided valuable information for the self-management of T2DM that was consistent with the previous literature search. Further research and education recommendations will be discussed in detail. These recommendations can be considered and used to guide or improve future EBP project and continue to improve the self-management of T2DM.

Research

Further research is needed to explore the effect of mobile phone applications for the management of T2DM. Within the literature search, there was a lot of evidence for the use of different technological devices for the management of T1DM, but solid evidence for management of T2DM was scarce. Many of the studies evaluated many different types of technology including computer-based interventions, telephone call based, or mobile-phone applications (Minooee, 2020; Wu et al., 2017; Manuel, 2020; Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016). Because mobile phone usage is expected to exceed 5 billion by the end of the next decade, more research regarding the use of specific mobile phone applications is needed to further evaluate its effect (Hou et al., 2016). Going forward, it would be ideal for researchers to start utilizing TIR when evaluating patient outcomes since this is now the standard of the ADA. Additionally, to be eligible for this project, participants had to be at least 18 years of age. The mean age of participants in this project was 66.0 (*SD* = 8.2). Further research should be focused on younger populations with T2DM in the hopes that people with more experience with technology could utilize the mobile phone applications to their fullest ability.

Education

Education is an extremely important part of taking care of patients as an advanced practice nurse. Participants in this project were started with an introductory educational session where they were instructed how to properly connect their glucose meters to the mySugr© smartphone application, how to use the application, and how to upload their PDF forms to the MyHealtheVet secure messaging system. Participants were also instructed and educated on how they would be contacted and what the options were for the NP to contact them after submitting their PDF documents for review. Participants were provided education but along with them, key stakeholders in the project were educated on the project as well. Clinic staff were given information regarding the application and how they would be able to help participants if questions arose.

Education should be provided to advance practice nurses that this is the best way to encourage patients to take control of their T2DM. Research should be presented in a way that demonstrates that when patients are provided with feedback on their data, their average blood glucoses are more likely to improve. Moving forward, education should be provided to physicians and advanced practice providers who could be managing patients with T2DM. Education should also include diabetes educators as this could be something that nurses of this role could take on to assist patients with implementation of a mobile phone application.

Conclusion

Diabetes was the seventh leading cause of death in the United States in 2017 and affects 34.2 million Americans, with an additional 1.5 million new diagnoses every year (ADA, 2018). With the aging population and obesity rising in the United States, this number of affected Americans will only continue to grow. Due to the many complications and complexities that come along with uncontrolled T2DM, effective disease self-management is essential.

This project answered the PICOT question: "In adults with type 2 diabetes mellitus with a HbA1C greater than 8% in a diabetes specialty clinic, what is the effect of a multimodal smartphone application compared to prior nonuse of the application on average blood glucose readings over an 8-week period?" Results from this project support the use of a multimodal smartphone application for the management of T2DM in adults. The goal of the project was to evaluate if the smartphone application would be beneficial in adults with T2DM and overall lower average blood glucose levels. Secondary outcomes included TIR, estimated HbA1C levels, and DES-SF scores. Statistically significant results were found in average blood glucose levels, TIR, estimated HbA1c levels, and DES-SF scores. The results of this project are consistent with the prior evidence found throughout the literature search in determining a mobile phone application is the most effective way for patients with T2DM to lower their average blood glucose effectively

(Minooee, 2020; Wu et al., 2017; Manuel, 2020; Alexandre et al., 2021; Lizarondo, 2021; Pal et al., 2013; VA/DoD, 2017; Aminuddin et al., 2019; Wang et al., 2019; Yoshida et al., 2018; Wu et al., 2019; Hou et al., 2018; Hou et al., 2016; Cui et al., 2016).

Sustainability of this project was discussed with the clinic staff to allow for continuation of the use of the application for management of adults with T2DM. Because the clinic provides glucose meters and a free Pro-version of the application, the project is much easier to sustain. Overall, the use of the mobile phone application mySugr© represented a way for participants to lower average blood glucose levels in a cost-effective manner and increase their interaction with their healthcare provider.

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BIOGRAPHICAL MATERIAL

Kelsey R. Jahn

Ms. Jahn graduated Magna Cum Laude from Valparaiso University with a Bachelor of Science in Nursing in the spring of 2019. During her undergraduate studies she competed on the Valparaiso University women's soccer team and served as a team captain for her final two seasons. During this time, she received presidential academic honors and was a member of Sigma Theta Tau International. In the fall of 2019, she decided to return to Valparaiso University to further her education and enroll in the Doctor of Nursing Practice (DNP) program. After a short time working in Merrillville, Indiana on a cardiac intermediate care unit, she quickly realized family was most important to her and she moved back home to Madison, Wisconsin. For the last two years, she has been working as a pediatric medical-surgical nurse on a high-acuity inpatient unit. Ms. Jahn has served as a resource and a preceptor to younger nurses on her unit and has a passion for helping nurses gain confidence and solidify their nursing skills. She has a passion for rural areas in south central Wisconsin that have limited healthcare access and hopes to increase care to families of rural, underserved Wisconsin cities.

ACRONYM LIST

ADA: American Diabetes Association

AGREE II: Appraisal of Guidelines Research and Evaluation

CDC: Centers for Disease Control

CASP: Critical Appraisal Skills Programme

CINAHL: Cumulative Index to Nursing and Allied Health Literature

CPG: Clinical practice guideline

DES-SF: Diabetes empowerment scale- short form

DNP: Doctor of nursing practice

EBP: Evidence-based practice

HbA1C: Glycolate hemoglobin A1C

JBI: Joanna Briggs Institute

JHNEBP: Johns Hopkins Nursing Evidence-Based Practice Model

PDF: Portable document format

PET: Practice question, evidence, and translation

RCT: randomized controlled trial

TIR: Time in range

TRIP: Turning research into practice

T1DM: Type 1 Diabetes Mellitus

T2DM: Type 2 Diabetes Mellitus

USPSTF: United States Preventative Services Task Force

WHO: World Health Organization

APPENDIX A

Evidence-Based Practice Project Flyer

Empower You: An Adult Type 2 Diabetes Mellitus Management Program

Provider Information:
Purpose: This is an evidence-based practice pilot project aimed at reducing glycated hemoglobin, while also trying to encourage self-care perceptions and behaviors, including medication adherence, blood glucose monitoring, and physical activity through the use of the diabetes-specific mobile smart phone application mySugr©.

Inclusion Criteria: Participants must be 18 years or older, have type 2 diabetes, have the most recent HbA1c of greater than 8%, and have access to a mobile smart phone. Pregnant women, patients on insulin pumps or continuous glucose monitors are not able to participate in this project.

Evidence-Based Project Information:

- No cost 8-week project to encourage self-management behaviors for persons with T2DM will be managed by the DNP student project leader
- Free, diabetes-specific mobile phone application, mySugr© to be downloaded to participants smart phone (Android or Apple compatible)
- 1-hour in-person or video introductory visit provided with the student project leader to discuss mySugr©, technology involved in the project, and goals of the project. Participation is voluntary, participants can drop out at any time with no effect on care provided at the clinic, and written consent will be obtained.
- The project will include:
    - Evaluation of most recent HbA1C level
    - Pre/post project average blood glucose readings and time in range
    - Pre/post project satisfaction survey
    - Weekly/ biweekly phone contact with student project leader to assess project compliance, any technologic issues, or questions
    - Participants with significant hypo/hyperglycemia episodes will be referred to their healthcare provider
- Each participant will be encouraged to try and use the application for at least 8-weeks, upload their data into MyHealtheVet, and send to the student project leader. They may choose to stop the program at any time for any reason.

Questions or Possible Participants?

- Contact student project leader- Kelsey Jahn
    - 608-852-3749 or Kelsey.jahn@valpo.edu

APPENDIX B
Patient Information Flyer

Empower You: An Adult Type 2 Diabetes Mellitus Management Program

Type 2 diabetes mellitus is one of the top seven most common chronic disease, and the number of people with diabetes is getting higher every year.

Managing diabetes is hard and can cause many problems like heart attack, stroke, bad vision, pain in the feet, and bad kidneys. A HbA1c level above 8% makes the risk higher.

The use of a mobile phone application has been shown to lower blood sugars, increase exercise, help with medications, and lower HbA1c.

Empower You is a program at William S. Middleton Veterans Affairs Hospital and was made because of research that shows mobile applications lower HbA1c taking medication, blood sugar, and doing exercise.

When you join the 8-week program, you will get hands-on and written details for downloading the free app, using the app, and uploading your information for your health care provider to review at a time that is easy for you.

The program will use the app mySugr©. This can be used with an Android or iPhone. There is no cost to join.

Please ask you provider if they think you could be in the program. You must be 18 years or older, have type 2 diabetes, have a HbA1c more than 8%, and have a smart phone. Pregnant women are not able to be in this program.

Student Project Leader Contact Information
Kelsey Jahn
RN, BSN. DNP-FNP Student
Program Leader
Contact Information
608-852-3749
Kelsey.jahn@va.gov

Project Affiliates
Jessica Phelan FNP-BC
Diabetes Specialty Clinic
William S. Middleton VA Hospital
Clinical Site Preceptor

Rose Flinchum
Valparaiso University Project Advisor

APPENDIX C

Demographic Form

Empower You: An Adult Type 2 Diabetes Mellitus Management Program

Kelsey Jahn RN, BSN, DNP Student, Student Project Leader
Valparaiso University
Demographic Data Collection Form

Instructions: Fill out the blanks OR check the box that applies to you. Please complete the form and return to the student project leader.

Code: ____________ (Project leader use only)

Age (in years): ____________

Date of birth: ______________

Gender: ▢Male ▢Female ▢Non-Binary ▢Prefer not to choose
▢Prefer to self-describe: ____________

Highest Educational Level:
▢Primary school (K-8th grade)
▢High school (9-12th grade)
▢University (Post 12th grade)

Employment:
▢Employed Part Time
▢Employed Full Time
▢Unemployed

Ethnicity:
▢African American
▢American Indian
▢Asian
▢Caucasian
▢Hispanic
▢Other

Days in hospital from Diabetes in the past year:
▢0-1 days
▢2-3 days
▢4-5 days
▢6 or more days

Number of times per day you check blood sugar
▢0
▢1
▢2
▢3 or more

How well you feel you manage T2DM:
▢Weak management
▢Moderate management
▢Strong management

Do you get HbA1c checked regularly?
▢Yes
▢No

APPENDIX D

Patient Satisfaction Survey

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
The application was easy to set up	5	4	3	2	1
The application was easy to use	5	4	3	2	1
The application Bluetooth was helpful with data	5	4	3	2	1
The application helped me with checking blood sugars	5	4	3	2	1
The application made it easy to send blood sugars to my provider	5	4	3	2	1
The application helped me track my diet & exercise	5	4	3	2	1
Throughout the project, I was satisfied with the application	5	4	3	2	1
I will continue to use the application	5	4	3	2	1

APPENDIX E

Application Information Handout

Connecting your Smartphone to mySugr©

- mySugr©, the application used in this project has Bluetooth capability. To connect your device to your phone, follow these steps:
  - On your mobile phone, turn Bluetooth ON and open mySugr©
  - On your meter, make sure it is turned off. Press and hold ⇐ ⇒ buttons at the same time until Bluetooth symbol appears. Both (Link) and (volume) show on the screen and will flash.
  - Find the 6-digit PIN on the back of your meter.
  - On your mobile phone within the mySugr© application, follow the on-screen instructions and select the meter that shows. When directed, enter the meter's 6-digit PIN (do this quickly, the meter will time out after 30 seconds).
  - On the meter, your screen will either show OK if connection was successful or Err if unsuccessful.
  - If the Err message is shown, try the above steps again or contact the student project leader at 608-852-3749.
- Transferring Data
  - If the meter is paired with the mySugr© app correctly as above, data will be sent to the app automatically with no action needed.
  - Note: turning off your smart phone Bluetooth connection will NOT unpair your meter from the application.
    - If turning Bluetooth back on after having it off, follow these steps:
      - With the meter off, press and hold ⇐ OR ⇒ buttons until the last stored result appears on the screen
      - Press and hold the (Power) button until the Bluetooth symbol appears. Then proceed as you normally would to check your blood sugar.

Creating a PDF report of your data:

- On your smart phone, open the mySugr© app
- On the bottom toolbar, click on the report button
- Once on report screen, you will see an option for file format. Click on this and a drop-down menu will appear. Slide through the options until you find PDF.
- You will then see a section titled period. This is referring to the time of blood glucose readings. Selected the 2-week option.
- Then hit the export button. From here, a PDF form will generate and show on your screen.
- If using APPLE PRODUCTS, click the button in the upper right-hand corner of your screen that appears like an arrow. Scroll down the options menu until you see "save to files". Click this and save the report to "My downloads".
- From here, open the "files" application on your iPhone. If you do not have it on your screen, you can search for it in the search bar.
- Your downloaded report from mySugr© should appear here.

- Once the report is generated and you have located it, you can attach this PDF file into your MyHealtheVet chart.

APPENDIX F

IRB Training

CITI PROGRAM

Completion Date 05-Apr-2021
Expiration Date N/A
Record ID 41849116

This is to certify that:

Kelsey Jahn

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Group 1: Social Behavioral Educational Researchers
(Curriculum Group)
Group 1: Social Behavioral Educational Researchers
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Valparaiso University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w2fea36d7-f33d-4fa8-a5ec-08b855f139cd-41849116

APPENDIX G

MyHealtheVet Informational Flyer

My healthevet
www.myhealth.va.gov

Your VA Personal Health Record

Take Control of Your Health and Wellness

My HealtheVet provides you with opportunities and tools to make informed decisions and manage your health care.

What is My HealtheVet?

My HealtheVet is VA's private and secure online Personal Health Record (PHR) for Veterans, active duty service members, their dependents and caregivers. Its online resources and tools offer you greater control over your care and wellness.

My HealtheVet provides you with trusted health information 24/7.

Having this information at your fingertips can help you make informed decisions about your overall health and wellness.

How to Get Started?

1. Log into ***www.myhealth.va.gov***
2. Select the "Register" button
3. Fill out the required fields and submit
4. *Upgrade your account

VA | U.S. Department of Veterans Affairs
Veterans Health Administration
Office of Connected Care

What Can I Do On My HealtheVet?

Pharmacy
Refill your VA prescriptions, track delivery, view a list of your VA prescriptions and other details.

Health Records
View, print, or download information from your VA medical record.

Messages
Communicate securely online with your VA health care team and other VA staff about non-urgent information or questions.

Appointments
Manage your upcoming VA medical appointments and get email reminders. VA patients with a Premium My HealtheVet account can schedule and cancel VA appointments at participating facilities.

My HealtheVet Help Desk

Toll Free Telephone Number: **1-877-327-0022**, **1-800-877-8339** (TTY)
Monday – Friday to 7 a.m. - 7 p.m. Central Time
For more information visit ***www.myhealth.va.gov***.

Local My HealtheVet Coordinator

Fgj_pwPnf pcp

Toll Free Telephone Number: **1-888-478-8321 extension 17173**
Wm. S. Middleton Memorial VA Hospital

*** To gain access to all features, you must register & upgrade your account to Premium by verifying your identity.**

There are 3 ways to verify your identity to upgrade your account:

/, Mljgj c u gf BQJmem mpGlk c apbcl rg jq ?dcppcegrcpj e*qk njwjme gj u gf _qgel gj n_prl cprmsnep bc wnsp_aamsl r,
0, @vt gbcmt ggg u gf rf c KwFc_jrf cTcr Anmpbgj _rnp a jj 4. 6-06. -6/ 51 rmqcr sn _t gbcmt ggg rmt cpgjwmspgbcl rgw
1, Gi ncpgml at the Main Hospital in the Patient Education Resource Center OR at the front desk at any of our Outpatient Clinics.

Appendix H
Permission To Utilize DES-SF

Campbell, Pam
to me

11:54 AM (3 hours ago)

Dear Kelsey,

Please feel free to use our DES-SF survey instrument. We just ask that you please cite our Center as follows: The project described was supported by Grant Number P30DK020572 (MDRC) from the National Institute of Diabetes and Digestive and Kidney Diseases.

Thank you,

Pam Campbell
Michigan Diabetes Research Center
Michigan Center for Diabetes Translational Research
University of Michigan Medical School
1000 Wall Street
RM# 6100 Brehm Tower
Ann Arbor, Michigan 48105
Tel: 734-763-5730
Fax: 734-647-2307

Remember to cite the Michigan Diabetes Research Center (MDRC) and/or the Michigan Center for Diabetes Translational Research (MCDTR) in publications:

"The project described was supported by Grant Number P30DK020572 (MDRC) from the National Institute of Diabetes and Digestive and Kidney Diseases" OR the project described was supported by Grant Number P30DK092926 (MCDTR) from the National Institute of Diabetes and Digestive and Kidney Diseases."

APPENDIX I
Diabetes Empowerment Scale- Short Form (DES-SF)

University of Michigan Diabetes Research and Training Center

Diabetes Empowerment Scale-Short Form (DES-SF)

The 8 items below constitute the DES-SF. The scale is scored by averaging the scores of all completed items (Strongly Disagree =1, Strongly Agree = 5) des

Check the box that gives the best answer for you.

In general, I believe that I:

1. ...know what part(s) of taking care of my diabetes that I am **dissatisfied** with.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
2. …am able to turn my diabetes goals into a workable plan.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
3. ...can try out different ways of overcoming barriers to my diabetes goals.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
4. ...can find ways to feel better about **having** diabetes.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree

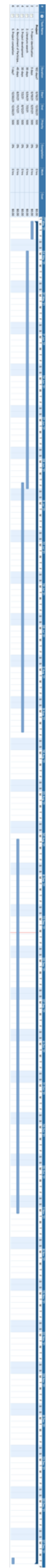
DES-SF; Diabetes Research and Training Center

DES_SF_AU1.0_eng-USori.doc

University of Michigan Diabetes Research and Training Center

5. ...know the **positive** ways I cope with diabetes-related stress.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
6. ...can ask for support for having and caring for my diabetes when I need it.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
7. ...know what helps me stay motivated to care for my diabetes.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree
8. ...know enough about myself as a person to make diabetes care choices that are right for me.	☐1 Strongly Disagree	☐2 Somewhat Disagree	☐3 Neutral	☐4 Somewhat Agree	☐5 Strongly Agree

APPENDIX J
Gantt Chart



Roche Diabetes

APPENDIX K
mySugr© Informational Handout

Download the mySugr app and send blood glucose readings to your phone

mySugr

1. Get the app! Search for “mySugr” in your app store and download the app. Then open the app on your device.

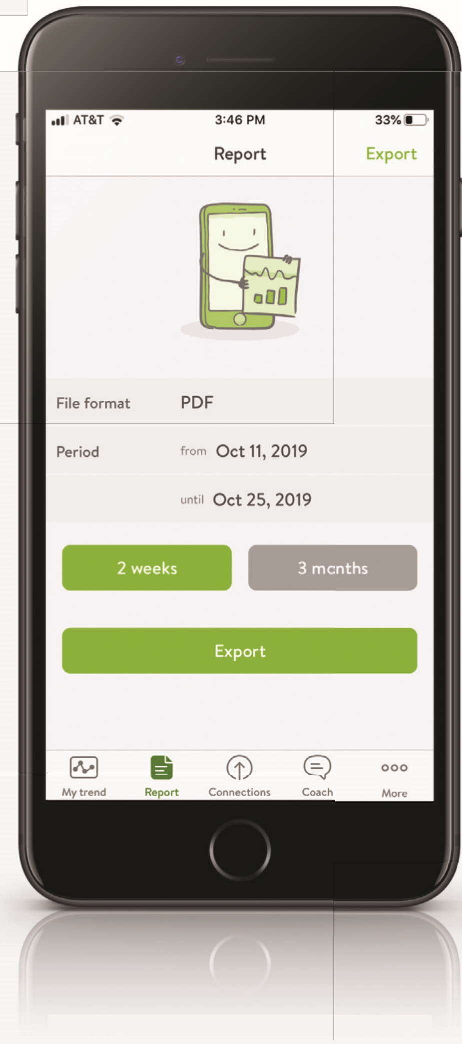
   Download on the App Store | GET IT ON Google Play

2. Enter and verify your email address and create a password.
3. Tap “Connections” at the bottom of the home screen.
4. Tap “Accu-Chek® Guide Me”.
5. Tap the green “Connect now” button.
6. On the Accu-Chek Guide Me meter, long press both (<) and (>) buttons at the same time for 3-5 seconds until the Bluetooth symbol shows, and 2 interlocked circles are flashing.
7. Tap the meter found under Available Devices.
8. Turn the meter over and find the PIN number at the bottom.
9. On your phone, tap the green “Next: enter PIN code” button.
10. When the pop-up appears, enter the PIN code you’ve located on the back of your meter at the bottom and tap “Pair”.
11. You should now have a “Successfully Connected” message on your screen, and if you’ve already taken any BG measurements, they’ll be imported into the app automatically.
12. Tap “Done” to take you back to the Connections page.

Share a PDF Report with your Healthcare Professional

Once you've transferred your first blood glucose from the Accu-Chek Guide Me meter to the mySugr app...

1. Open the mySugr app.
2. Tap "Report" at the bottom of the screen.
3. Select the Period by taping the "from" and "until" date, or use one of the preset times.
4. Select Export, this will generate a PDF Report.
5. Tap the "Share" button in the top right corner and select "Mail".
6. This will open a new email message using the email address used on this device with the PDF attached.
7. Next, tap "To:" and enter your email address to send the PDF to your own personal email address.
8. Open your email on your computer and download the PDF from your inbox and save to a specific location. Then you can attach the PDF to your My HealtheVet® secure portal with your Healthcare Professional.



mySugr

Hi Kelsey!

I hope you are doing well. 😊 I apologize for the delay in getting back you, but I do have good news! I did run this by my team and they said it was okay to use in your project. Thank you so much for checking in with us.

I hope it goes well. If you need anything else, feel free to reach out. Have a lovely weekend! 💚
Best,

Jasmine | **Customer Support Hero**

"Make Diabetes Suck Less"

mySugr GmbH | Trattnerhof 1/5 OG, A-1010 Vienna, Austria
Commercial registry number | FN 376086 v
Court of jurisdiction | Commercial Court Vienna
VAT number | ATU67061939

APPENDIX L
Evidence Table

Citation (APA)	Purpose	Sample	Design	Measurement	Results/Findings	LOE
Minooee, S. (2020). *Self-Management/Self-care: Interventions Strategies.* [Evidence summary]. Joanna Briggs Institute EBP Database. https://joannabriggs.org/	Search for best available evidence regarding enhancing self-management or self-care for individual with chronic disease	1 integrative review, 3 RCTs, 4 systematic reviews, 1 descriptive study, 1 cross sectional study, 1 qualitative study	Evidence summary	Self-care/ self-management in different groups of patients with chronic illnesses	• The most common strategies were regular medical reviews with practitioners and distribution of educational material including videos, exercise, and computer programs • Self-care behaviors were lower in patients uncontrolled chronic disease • Mobile phone messaging interventions may provide benefit in supporting self-management of long-term illness • Educational sessions and self-care management plans in combination should be used to assist with self-care processes (Minooee, 2020).	Level I
Wu, Y., Yao, X., Vespasiani, G., Nicolucci, A., Dong, Y., Kwong, J., Li., L., Sun, X., Tian, H., & Li, S. (2017). Mobile app-based interventions to support diabetes self-management: A	Develop and validate a taxonomy of apps for diabetes self-management, perform a meta-analysis investigating	12 RCTs involving app-based interventions involving 974 outpatients with diabetes	Systematic review	Evaluation of 96 diabetes mobile apps with 5 management modules (monitoring, medication management, lifestyle	• The use of mobile app-based interventions was associated with clinically significant HbA1C reduction of 0.48% (95% CI, 0.19%-0.78%, I2= 76%, P<.001) compared with standard of care alone	Level I

systematic review of randomized controlled trials to identify functions associated with glycemic efficacy. JMIR Mhealth Uhealth, 5(3), e35. https://doi.org/10.2196/mhealth.6522	the effects of mobile app-based interventions on glycemic control in adults with diabetes, explore the contribution of different functions to the glycemic efficacy of entire app-based interventions using the taxonomy and subgroup analysis (Wu, 2017).			modifications, complication prevention, psychosocial care)	• Larger HbA1C reductions noted for patients with T2DM (MD 0.67%, 95% CI 0.30%-1.03%, I2= 47%, P=.11). • Having a structured display was associated with larger HbA1C reduction • Interventions using manual entry showed an associated lower HbA1C reduction without statistical significance • "Direct data transmission between users and mobile devices using wire or wireless connections was associated with a trend towards reduced HbA1C"	
Manuel, B. (2020). *Diabetes management: Using ehealth in a rural or remote setting.* [Evidence Summary]. Joanna Briggs Institute EBP Database. https://joannabriggs.org/	Determine best evidence for remote management of T2DM	5 systematic reviews, 2 RCTs, 1 expert opinion	Evidence summary	Effectiveness of computer or mobile phone-based programs for monitoring and management of diabetes	• Mobile phone-based interventions have a larger beneficial effect on glycemic control for T2DM patient's vs computer based • Mobile phone use in monitoring and managing T2DM improved HbA1C levels and self-management behaviors • Best practice recommendation: "mobile-based support programs	Level I

					should be considered in management of diabetic patients where available" (Manuel, 2020). • Best practice recommendation: "telephone follow-up should be utilized in diabetes management, particularly in T2DM" (Manuel, 2020).	
Alexandre, K., Campbell, J., Bugnon, M., Henry, C., Schaub, C., Serex, M., Elmers, J., Desrichard, O., & Peytremann-Bridevaux, I. (2021). Factors influencing diabetes self-management in adults: An umbrella review of systematic reviews. *JBI systematic review, 19(5),* 1003-1118. https://10.11124/JBIES-20-00020	Identify and describe factors that influence diabetes self-management by summarizing the known evidence	114 systematic reviews	Systematic review	Factors influencing adult diabetes self-management in general or on individual self-care behaviors (taking medications, self-monitoring blood glucose, healthy eating, regular exercise, smoking cessation)	• The most frequent factors influencing self-care behavior (SCB) is relationship with healthcare professionals (communication & shared decision making), knowledge about disease and medication, social support, and availability of services • Positive influencing factors: social support from friends and family, interventions led by health professionals, knowledge about the disease/ medication/ behaviors associated with DSM, and strong community environment • Paying attention to both individual DSM behaviors (medication taking) and overall DSM behaviors	Level I

					(several self-care behaviors at once) may be beneficial • Knowledge about the disease, motivation, and self-efficacy, should all constitute essential parts of any intervention to promote adult DSM • To best support DSM, health professionals must be interested in understanding DSM in broader context including personal, interpersonal, and environmental characteristics	
Lizarondo, L. (2021). *Glycemic control in diabetes: Telehealth* [Evidence Summary]. Joanna Briggs Institute EBP Database. https://joannabriggs.org/	Best available evidence for the effectiveness of telehealth for type 2 diabetes management	7 systematic reviews	Evidence summary	HbA1c levels	• Pooled results indicated a small but statistically significant difference between intervention and comparator groups, in favor of the intervention. The impact of HbA1c was greater in the mobile phone subgroup compared to other types • Mobile/ smartphone with self-management apps: pooled results demonstrated a significant reduction in HbA1c in patients who received intervention compared to standard diabetes care. When apps with feedback	Level I

					and without feedback were compared, the reduction in HbA1c was not statistically significant for those who did not receive feedback • "patients with type 2 diabetes should be offered telehealth as an option for monitoring their condition and accessing self-management education. The most optimal type/approach, functions, intensity and frequency remains unclear and should be informed by clinical expertise and individual patient presentation"	
Pal, K., Eastwood, S. V., Michie, S., Farmer, A. J., Barnard, M. L., Peacock, R., Wood, B., Inniss, J. D. & Murray, E. (2013). Computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus (Review). *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002	"Assess the effects on health status and health-related quality of life of computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus" (p. 1).	16 RCTs- including adult patients over the age of 18 with type 2 diabetes mellitus	Systematic review	Impact of computer-based interventions on HbA1C levels, health-related quality of life, and change of knowledge level for type 2 diabetes mellitus vs. standard diabetes care	• There is a small, statistically significant difference in outcomes between intervention and comparison groups of 2.3 mmol/mol or mean difference (MD) -0.2% (95% CI -0.4 to -0.1) for HbA1C level for pooled computer intervention groups • HbA1C impact was larger in mobile phone subgroups of -5.5 mmol/mol or -0.5% (95% CI -0.7 to -0.3) and no	Level I

/14651858.CD008776 .pub2					heterogeneity. Computer based groups had smaller effect sizes and was not statistically significant: -1.5 mmol/mol or -0.1% (95% CI -0.3 to 0.1). • Looking at mobile phone-based interventions, all of these interventions provided feedback on performance and provided prompts or cues for desired behavior change around blood glucose self-monitoring. This subgroup was associated with larger improvement in HbA1C than other interventions • Five studies examined health-related quality of life but there was no evidence to show any significant improvement with computer-based interventions	
The management of type 2 diabetes mellitus in primary care work group (2017). *VA/DoD clinical practice guideline for management of type 2 diabetes mellitus in*	Discuss best practice guidelines for the management of type 2 diabetes mellitus	RCTs published between 2009-March 2016	Clinical practice guideline	N/A	• Recommended to offer one or more types of bidirectional interventions (computer, telephone, or other electronic means) involving licensed independent practitioners to patients selected by their primary care provider	Level I

primary care. Department of Veterans Affairs, Department of Defense. https://web.archive.org/web/20180610080058/https://www.healthquality.va.gov/guidelines/CD/diabetes/VADoDDMCPGFinal508.pdf					as an adjunct to usual care • "Improvements were seen in HbA1C when patients had the ability to upload glucose monitoring device data for review by the RN case manager or provider. Dedication of this resource to high-risk elevated HbA1C populations may help control outcomes where utilized" (p. 27). • Recommended to set a HbA1C target range based on absolute risk reduction of significant microvascular complications, life expectancy, patient preferences and social determinants of health	
Aminuddin, H. B., Jaio, N., Jiang, Y., Hong, J., & Wang, W. (2019). Effectiveness of smartphone-based self-management interventions on self-efficacy, self-care activities, health-related quality of life and clinical outcomes in patients with type 2 diabetes: A systematic	Determine effectiveness of smartphone-based mobile applications on HbA1C, self-care activities, and self-efficacy	22 RCTs	Systematic review & meta-analysis	HbA1c, self-care activities, self-efficacy	• Pooled studies that used smartphone interventions were found to be significant in improving self-efficacy with a large effect size (d= 0.39; 95% CI 0.16 to 0.61; P<0.001) • Pooled studies evaluating self-care activities using smartphone applications were found to be statistically significant (d=	Level I

review and meta-analysis. International Journal of Nursing Studies, 116, 1-10. https://doi.org/10.1016/j.ijnurstu.2019.02.003					0.90; 95% CI 0.24 to 1.57; P<0.001) • The effect of smartphone-based interventions on reduction of HbA1C was statistically significant (pooled MD= -0.55; 95% CI -0.60 to -0.40; P<0.001) • Participants with HbA1C of <8% at baseline showed larger improvements in self-efficacy • "Smartphone-based interventions have the advantage of being easy to use and widely accessible, and thus can keep patients engaged longer, increasing effectiveness on self-care activities" (p. 8)	
Wang, Y., Li, M., Zhao, X., Pan, X., Lu, M., Lu, J., & Hu, Y. (2019). Effects of continuous care for patients with type 2 diabetes using mobile health application: A randomized controlled trial. *Int J Health Plann Management, 34*, 1025-1035.	Determine clinical effect of continuous care for patients with type 2 diabetes using mobile health application	120 patients with type 2 diabetes (intervention: n=60, control: n=60)	RCT	HbA1c levels, blood glucose levels, self-care abilities	• Self-management was found to be higher in the test group than in the control group after 6-month period (P>.05) • "The use of the mobile health application system can promote knowledge of self-monitoring of blood sugar, eating habits report, blood sugar control, and monitoring	Level II

https://doi.org/10.1002/hpm.2872					frequency and accuracy" (p. 1032) • Blood glucose and HbA1C levels were statistically significant and lower in the test group compared to the control group (P < .05) • "This study revealed that continuous care based on mobile service platform significantly lowered patients' blood glucose levels" (p. 1032) • "Continuous care provided through a mobile phone application for patients with type 2 diabetes significantly improved patient cognition levels and self-management abilities, thereby reducing patients' blood glucose levels" (p. 1034).	
Yoshida, Y., Boren, S., Soares, J., Popescu, M., Nielson, S. D., & Simoes, E. J. (2018). Effect of health information technologies on glycemic control among patients with type 2 diabetes. *Current Diabetes*	Present findings of the effect of health information technologies (HITs) on glycemic control among patients with type 2 diabetes	34 RCTs included in the meta-analysis	Meta-analysis	HbA1c levels based on mobile, computer-based, e-mail, and internet interventions	• The standardized mean reduction in HbA1C resulting from HITs was -0.57 (95% CI -0.71, -0.43) with values ranging from -2.10 to -0.01. • The pooled standardized decreases in Hba1c for mobile-based applications was -0.67 (-0.90, -0.45)	Level I

Reports, 18, 130. https://doi.org/10.1007/s11892-018-1105-2					• "Findings from this meta-analysis suggest that HITs lead to improvement in glycemic control, both clinically and statistically" (p. 5) • "Among all technology features under review, we found mobile phone-based and SMS/text approaches to be particularly effective in improving glycemic profile" (p. 8)	
Wu, X., Guo, X., & Zhang, Z. (2019). The efficacy of mobile phone apps for lifestyle modification in diabetes: Systematic review and meta-analysis. *JMIR Mhealth Uhealth, 7(1),* 1-23. https://doi.org/10.2196/12297	Summarize and synthesize evidence of mobile phone apps for lifestyle changes in subtypes of diabetes	23 RCTs	Systematic review & meta-analysis	Primary outcome: HbA1c Secondary outcomes: behavioral changes with diet & exercise	• Overall difference for short-term effect in HbA1c between app intervention and control groups -0.48 (95% CI -0.69 to -0.28) which was significantly different from 0 (P<.01) • Overall difference for long-term effect subgroup HbA1c of -0.25 (95% CI -0.43 to -0.07), (P<.01) • Long-erm and short-term effects were both significant • "the results of our review indicate that there is strong evidence for efficacy of apps for lifestyle modification in T2DM" (p. 16).	Level I

Hou, C., Xu, Q., Diao, S., Hewitt, J., Li, J., & Carter, B. (2018). Mobile phone applications and self-management of diabetes: A systematic review and meta-analysis, meta-regression of 21 randomized trials and GRADE. Diabetes, Obesity and Metabolism: A Journal of Pharmacology and Therapeutics, 20, 2009-2013. https://doi.org/10.1111/dom.13307	Update the evidence of diabetes apps to improve glycemic control and self-management for diabetes	21 RCTs	Systematic review & meta-analysis	HbA1c levels, effect of HCP feedback on HbA1c level	• Diabetes apps were associated with mean reduction of 0.57% in hbA1c (95% CI, 0.32-0.82; P<.01) • Studies with no HCP feedback had a mean HbA1C reduction of 0.24% (95% CI, -0.02 to 0.49) whereas this increased in studies with low and high feedback to 0.33% (95% CI, 0.07-0.59) and 1.12% (95% CI, 0.91-1.32) • "Results overall reaffirmed that apps for T2DM help with self-management, but also demonstrated a HCP dose-response with HbA1C" (p. 2010).	Level I
Hou, C., Carter, B., Hewitt, J., Francisa, T., & Mayor, S. (2016). Do mobile phone applications improve glycemic control (HbA1c) in the self-management of diabetes? A systematic review, meta-analysis, and GRADE of 14 randomized trials. Diabetes Care, 39, 2089-2095.	Investigate effect of mobile health apps on glycemic control in self-management of diabetes	14 RCTs	Systematic review & meta-analysis	HbA1c levels	• Mean reduction in Hba1c was 0.49% (95% CI 0.30 to 0.68; P<0.01) • Studies of younger participants (less than or equal to 55y/o) reported larger and clinically significant reduction in HbA1C level of 1.03% compared with 0.41% in those with average age >55y/o but result was not found to be statistically significant (P=0.10)	Level I

https://doi.org/10.2337/dc16-0346					• "the results of meta-analysis lend support to the use of diabetes apps in diabetes self-management, especially for type 2 diabetes" (p. 2093).	
Cui, M., Wu, X., Mao, J., Wang, X., & Nie, M. (2016). T2DM self-management via smartphone applications: A systematic review and meta-analysis. PLoS ONE, 11(11), 1-15. https://doi.org/10.1371/journal.pone.0166718	Review RCTs to assess effect of mHealth apps on changes in HbA1C, blood glucose, blood pressure, serum lipids, and body weight in type 2 diabetes mellitus patients	13 RCTs	Systematic review & meta-analysis	HbA1c levels	• Mobile phone app strategies were associated with significant reduction in HbA1c by -0.40% (95% CI -0.69 to -0.11%; p=0.007) • mHelath with feedback: overall effect size for HbA1c was statistically significant -0.40% (95% CI -0.69 to -0.11%; p=0.008) • mHealth without feedback, effect size was larger but no longer statistically significant -0.46% (95% CI -1.19 to 0.26%; p=0.21). • mobile-phone/smartphone-based self-management apps appear to have moderate benefit on glycemic control with a pooled effect on HbA1C reduction of -0.40% • patients with milder disease with baseline levels of HbA1c lower	Level I

					than 8% appeared to benefit more from mHealth apps compared to those with higher baseline HbA1c	