ADULT PERCEPTIONS OF UTILIZING A MOBILE HEALTH APPLICATION FOR SELF-MANAGEMENT OF TYPE 2 DIABETES

PERCEPTIONS OF MOBILE HEALTH APPLICATIONS

by

Chandra Vivian Sorrelle

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by Chandra V. Sorrelle, titled Adult Perceptions of Utilizing a Mobile Health Application for Self-Management of Type 2 Diabetes and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Nursing Practice.

Renee Gregg, DNP, FNP-C — Date: 11-13-18

David Trinidad, DNP, ACNP-C — Date: 11-13-18

Angela Brown, DNP, MSN, RN, ANP-BC, FNP-BC, CDE — Date: 11-13-18

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copies of the dissertation to the Graduate College.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

Dissertation Chair Name: Renee Gregg, DNP, FNP-C — Date: 11-13-18

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DEDICATION

In dedication to my family, particularly my daughter, Ava, my little snuggle bug, whose patience and sacrifices made this possible. To my parents, Doug and Cheryl, who have always valued higher education and pushed me to succeed; my mother, Robbie, who pulled double duty as Grandmother and Mother to my daughter while I was studying and in clinical; and to my sister, Jennifer, who continues to inspire me with her intellect and passion….I've been trying my whole life to just keep up with you.

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ABSTRACT

Background: Type two diabetes mellitus (T2DM) is a devastating, chronic disease that effects millions of people in the world (Fitzner, Heckinger, Tulas, & McKoy, 2014). Self-management is significantly important to those with this diagnosis. Proper self-management will help improve quality of life and many of the complications due to diabetes (Ahola & Groop, 2012).

Objective: To determine if the use of a free mobile health app can improve the perceived self-management of T2DM.

Methods: The QI project consisted of participants completing a 14-question pre-test survey and then utilizing a free mobile health application, Tactio Health, for four weeks to help with their self-management of their T2DM. The participants received a text message at week two and week three reminding them to fill out the post-test survey to gage their perceived perception of their self-management after incorporating the use of the mobile health app. At week four, participants were sent a link to the post-test survey. Four individuals agreed to participate and completed the pre-test survey.

Results: Recruiting for this QI project was severely crippled when approval from the Institutional Review Board (IRB) was not granted at the community hospital that would have served as the principal recruiting site. Over four months were devoted to trying to secure approval that was never granted. This led to a change in implementation site that was not nearly as saturated with the target population meant for this project. Ultimately, recruitment took place at a community center where many individuals encountered did not meet the inclusion criteria. Another limitation, compounded by the last-minute change in implementation site, was a small sample size. Four individuals were recruited at the community center. Such a small sample size does not

allow for any clinical significance to be determined. An additional limitation was the 100% attrition rate. None of the participants completed the post-test survey, which would have demonstrated whether the perception of self-management stayed the same, declined or improved. However, there were similarities and differences noted based on the pre-test survey. For example, 75% of participants strongly agreed managing their diabetes at home is extremely important. 75% check their blood sugar as often as their provider wants them to and 75% strongly agree that poor control of their diabetes will lead to complications. Only 25% of participants currently utilized a mobile health app specifically for the management of their diabetes, but 100% strongly agreed a mobile health app would be very helpful. This infers there is a role for a mobile health app in the management of T2DM.

Conclusions: Inability to receive IRB approval from the community hospital, change in recruitment site, lack of recruitment time, small sample size, and the 100% attrition rate were all significant barriers to the success of this QI project. However, valuable information was still gleaned from the pre-test survey. Future projects, with a much larger sample size, need to be completed to further assess the role of mobile health apps in the perceived self-management of T2DM.

INTRODUCTION

Diabetes mellitus (DM) is a chronic disease that effects millions of people worldwide. It is estimated that 30.3 million people, or 9.4% of the population, in the United States had diabetes in 2015. Of those 30 million people, 4 million were between the ages of 18 to 44, 17 million were 45 to 64 and 25.2 million were over 65 years of age. And about 95% of those with diabetes were diagnosed with type 2 (Centers for Disease Control and Prevention [CDC], 2017). Hyperglycemia, impairment of insulin secretion and insulin resistance characterize type 2 diabetes mellitus (T2DM) (McCulloch & Robertson, 2016). People with T2DM have varying degrees of insulin resistance and deficiency, which are contributory to the development of T2DM (McCulloch & Robertson, 2016). Beta cells secrete insulin and glucose, facilitated by the glucose transporter 2 (GLUT-2), and transports the insulin into the cell. A high-fat diet has been suggested to alter GLUT-2 and predispose a person to diabetes (McCulloch & Robertson, 2016). Insulin resistance, a strong predictor of T2DM, is thought to be related to substances released by adipose tissue. Additionally, clinical features of T2DM can ascend from environmental and genetic stimuli, which makes it increasingly difficult to differentiate the precise cause in every patient (McCulloch & Robertson, 2016). Impaired insulin processing "…suggest that the processing of proinsulin to insulin in the beta cells is impaired in type 2 diabetes or that there is insufficient time for granules to mature properly so that they release more proinsulin" (McCulock & Robertson, 2016). Amylin, an islet amyloid polypeptide, is stored in beta cells and is secreted with insulin. In patients with T2DM amylin is present in high concentrations and decreases glucose uptake and impedes insulin secretion (McCulloch & Robertson, 2016). All these factors cause the pancreas to secrete more and more insulin until it can no longer keep up,

and blood sugar increases (CDC, 2017). A simple blood test, known as an A1C, can confirm a diagnosis of T2DM. The normal result for an A1C is below 5.7% and 6.5% or above confirms type 2 diabetes (CDC, 2017). People who are over the age of 45 are the most at risk for developing T2DM (CDC, 2017). Additional risk factors include, obesity, parent or sibling with T2DM, sedentary life style, or previous gestational diabetes (CDC, 2017). Despite fervent efforts to bring awareness to this overwhelming, metabolic disorder, T2DM continues to increase in prevalence all over the world and is on track to become the 7th leading cause of death by the year 2030 (Saffari, Ghanizadeh, & Koenig, 2014).

Background Knowledge

The difference between type 1 and type 2 diabetes was first distinguished roughly 80 years ago and was determined to be the result of genetics, the environment and various behavioral risk factors (Olokoba, Obateru, & Olokoba, 2012). There is no denying the strong genetic disposition of T2DM, however, there have been epidemiological studies demonstrating solid evidence that proposes that T2DM can be prevented in several cases with simple lifestyle changes. Nevertheless, in 2015, the United States ranked third in the number of diabetic patients and this upward trend shows no sign of slowing down. In fact, it is hypothesized that the global predictions of T2DM are grossly underestimated. By 2015, the estimates for diabetes mellitus made by the World Health Organization for the year 2030 had already been surpassed (Zheng, Ley, & Hu, 2018).

Complications of T2DM are numerous and debilitating; ranging from peripheral neuropathy, cardiovascular and renal disease, retinopathy, stroke, and amputation. The risk of developing microvascular and macrovascular conditions is 10-20 times and 2-4 times higher,

respectively in those with DM (Zheng, Ley, & Hu, 2018). These complications have a reciprocal effect on healthcare costs. In 2013, the American Diabetes Association released research approximating the total costs of diabetes to be as high as $245 billion in 2012 (2013). This figure is significantly higher than the $174 billion estimated in 2007 and illustrates a 41 percent increase in only five years (American Diabetes Association [ADA], 2013). As the number of people diagnosed with T2DM continues to rise steeply, so does the financial burden that it places on healthcare costs. One in ten dollars are spent on the *complications* of diabetes and one in five dollars are spent on providing care to patients with diabetes (ADA, 2013). Moreover, healthcare expenditures are 2.3 times higher for those with diabetes (ADA, 2013). Treating diabetes is very costly, but the crucial point to take away from these figures is that healthcare expenditure for DM is radically rising because of the increasing prevalence of this chronic disease and insufficient self-management (ADA, 2013).

To curb the costs and complications of T2DM it is imperative that healthcare providers educate patients on the importance of self-management. Diabetes self-management education (DSME) is supported by evidence to be fundamental in effectively managing this chronic disease. According to the Centers for Disease Control and Prevention, “Self-management education are clinically proven to reduce symptoms and improve quality of life” (2017). Additionally, it has proven that individuals with T2DM, who receive and have access to, DSME incur less healthcare costs than those who do not receive education (Fitzner, Heckinger, Tulas, Specker & McKoy, 2014). Therefore, DSME is more cost effective than other interventions (Fitzner et al., 2014). Understanding that DSME is imperative to successfully manage T2DM will give healthcare providers a platform in which to base interventions.

Local Problem

According to the Behavioral Risk Factor Surveillance System (BRFSS), conducted in 2012, 10.6% of those living in Arizona were diagnosed with diabetes. This percentage is 0.4% higher than the national average (Arizona Department of Health Services, 2012). In 1994, only 3.5% of Arizonans were diagnosed with diabetes and that number has steadily risen over the past 20 years (Arizona Department of Health Services, 2012). In 2011, the BRFSS demonstrated that the highest rates of diabetes were among those that were between the ages of 45 to 64 and 65 to 74; 13.2% and 23.0% respectively (CDC, 2015). In addition to providing figures on the number of individuals in Arizona with diabetes, the BRFSS also gathered data on the dollars spent to manage and treat DM. In 2012, there were over 7000 visits to the emergency department (ED) and/or inpatient hospitalizations directly linked to diabetes. The total number of days spent in either the ED or as an inpatient were 22,414. The average length of stay fluctuated between 2.4 to 3.8 days. These visits totaled over $179 million in healthcare costs (Arizona Department of Health Services, 2012).

The rate of diabetes in Arizona is climbing at alarming rates and the aforementioned statistics serve as further warning that healthcare providers must act in order to prevent T2DM from becoming the worldwide pandemic that it is poised to be. Diabetes is a multifaceted disease that demands continuous care and attention. The effective management of blood sugar will reduce and circumvent expensive and fatal complications that arise from poor self-management. However, there are less than 20,000 diabetes educators employed and available to provide this life saving education (Fitzner, Heckinger, Tulas, & McKoy, 2014). The need for DSME is far

greater than 20,000 educators can offer. This is precisely why a newer, innovative method of delivering DSME, such as a mobile health application, must be utilized.

Purpose

The purpose of this Doctor of Nursing Practice (DNP) project was to discover if the introduction of a free mobile health app, to individuals with T2DM, could improve perceptions of self-management. Assessing thoughts, attitudes and usefulness of a mobile health app will guide future practice and interventions. If mobile health apps are found to be supportive for self-management, providers will be able to prescribe not only medications, but a helpful and educational tool to improve patient outcomes. A mobile health app will encourage a healthier lifestyle by providing healthy snack options, exercises, and education. A health app providing feedback based on the information entered by each individual will reach those who are in rural areas and have limited access to traditional face-to-face diabetes education. Information at their fingertips would be a tremendous help to those who are unable to attend classes or keep appointments with primary care providers. A survey conducted in 2015, revealed that 72% of adults own a smartphone and 62% of those individuals looked up health information on their phones. The rate of smartphone users continues to climb, by 2020, it is projected that 80% of the global population will own a smartphone (Kao & Liebovitz, 2017).

Health care providers have known for many years that self-management is crucial to preventing the complications associated with T2DM. Patients must proactively manage their disease by eating healthy, exercising, and diligently monitoring their blood sugar (Park, Burford, Nolan, & Hanlen, 2016). Because the cost of treating diabetes and complications continue to rise, it can be inferred that current DSME tools are not enough. There is a great need for providers to

utilize a DSME tool that will encourage compliance and improve self-care. The potential for mobile health apps to do just that is exciting and promising.

Stakeholders include patients, families, health care providers, and the diabetes educator. Other possible stakeholders with a vested interest would be the Arizona Department of Human Services, the American Diabetes Association, the community and payers (Moran, Burson, & Conrad, 2014). However, patients and families are the two most important stakeholders that must be engaged in this project for it to be successful.

The specific aim of this project was to improve the participants perceived self-management of their disease. The greatest outcome that could have been achieved at the close of this project would have been the belief of participants that the use of the mobile health app increased confidence in their daily management of T2DM and made education less complicated and easily accessible. This positive outcome would have then led health care providers and diabetes educators, to make a small change in their process of care. The diabetes educator could introduce the use of a mobile health app to those in an inpatient setting and the hospitalist would continue to reinforce the utilization of the health app during inpatient hospitalization. This would help ensure that when the patient discharged home he/she would have the self-confidence and knowledge needed to continue using the app. Primary health care providers (PCP) would also play an important role. PCPs could introduce the use of a mobile health app during routine office visits.

Study Question

In adults with T2DM, does the use of a free mobile health application improve their perceived self-management?

FRAMEWORK & SYNTHESIS OF EVIDENCE

Theoretical Framework

Diabetes is a chronic condition that demands tremendous responsibility on the part of the patient. Day-to-day management is crucial in preventing diabetes related complications and researchers have continuously reported that self-management is suboptimal (Ahola & Groop, 2012). A portion of this stems from health beliefs, which influence attitudes and behavior. It has been demonstrated that the perceived risk from the patient's perspective often varies greatly from that of the practitioner (Ahola & Groop, 2012). For this reason, the principle theory that guided this DNP project was the Health Belief Model (HBM). The HBM is a guide for evaluating health behaviors and beliefs, for this project it guided the use of a mobile health app in improving self-management. Acquiring further knowledge on the beliefs/attitudes about a specific patient-focused intervention will assist practitioners in providing T2DM patients with a better tool for self-management. A mobile health app will align with busy lifestyles and provide social support. Social support is a significant aspect of diabetes management and is associated with an increase in perceived self-efficacy and self-management behaviors (Ahola & Groop, 2012).

The HBM was developed in the 1950's by social psychologists who worked in Public Health Service to explain why people did not partake in programs intended to prevent and detect disease (Champion & Skinner, 2008). The HBM model is composed of six main constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy (Champion & Skinner, 2008). Perceived susceptibility is an individuals' belief about getting a certain disease or illness. Perceived severity is the persons' view on the

significance of the disease or illness. Perceived benefits and barriers are the positive benefits and the possible negative features to acting. Cues to action are the reasons the individual chooses to rise to the challenge, and self-efficacy is the confidence that one can accomplish the behavior necessary to achieve the desired outcome (Champion & Skinner, 2008). Each construct provides information to help practitioners understand what motivates a person with diabetes to adopt, or reject, self-management behaviors.

Concepts

Lack of self-management has been identified as the most crucial explanation for death in diabetics (Baquedano, Santos, Martins, & Zanetti, 2010). Important self-management behaviors that help stave off complications of diabetes are medication adherence, exercise, maintaining a healthy diet, and glucose monitoring (Dehghani-Tafti et al., 2015). Self-management is a dynamic process requiring strict adherence, constant vigilance, and a healthcare team to support the process (Karimy, Araban, Zareban, Taher, & Abedi, 2016). Providers support this effort by promoting healthy, life-sustaining, self-management behaviors by offering education and support programs, however, accountability ultimately falls to the patient. Due to this, providers and patients face substantial challenges when attempting to change the lifestyle and behaviors of diabetic patients (Nie et al, 2018).

A key component to motivating a diabetic patient is understanding their perception of illness. The perception of illness includes beliefs about what caused the illness, length of illness, symptoms, control over the illness, and consequences of it (Nie et al, 2018). Several studies have been conducted that support the significance of illness perception and the effect that it has on self-management behaviors of diabetic patients (Abubakari et all, 2011; Grant & Steadman,

2016; McElfish et al., 2016; Stiffler, Cullen & Luna, 2014). For example, a person with DMT2 who has a BMI of 30kg/m2, blood pressure of 151/81 and a hemoglobin A1c (HbA1c) of 9% may not view this as poor self-management that could lead to devastating consequences. Yet, a practitioner may perceive this as a relatively substantial risk for developing complications in the future (Ahola & Groop, 2012). This determinant of self-management aligns well with the HBMs first construct of perceived susceptibility.

The second construct in the HBM is perceived severity/threat. Carpenter (2012), found while diabetes poses a significant health risk, it is thought of as more of a challenge than a threat to many people living with T2DM (2012). This knowledge can help further explain why self-management continues to be lacking in those with T2DM. Health beliefs have been strongly correlated with adherence to disease management (Carpenter, 2012). Therefore, it can be postulated that individuals who do not view diabetes as a significant illness, capable of shortening their lifespan and diminishing their quality of life, will have sub-optimal self-management behaviors. Evidence has revealed that, in developed countries, self-management adherence is less than 50%, which has a linear effect on the incidence of complications (Voigt et al., 2015). It is imperative for practitioners to educate individuals upon diagnosis about the seriousness of the disease and the complications that will likely follow if self-management isn't a top priority. This education must take place before the patients adopt harmful health behaviors. Disease severity/threat should be a collaborative conversation that discusses the potential consequences of sub-optimal self-management and life expectancy (Aloha & Groop, 2012).

The third construct in the HBM is perceived benefits defined as the positive outcomes resulting from certain behaviors. It has been noted that there is a substantial connection between

the perceived benefits and self-management behaviors exhibited by T2DM patients (Karimy et al., 2015). In fact, those patients who understood the benefits of self-management were more adherent to their regimen and developed positive self-care behaviors (Karimy et al, 2015). If practitioners immediately begin the conversation about the benefits of self-management, positive behaviors may be implemented earlier in their T2DM patients, thus reducing long-term complications.

Perceived barriers are the fourth construct in the HBM model and can be numerous for some individuals (Grant & Steadman, 2016). Grant and Steadman (2016) concluded that reducing barriers to critical self-management education/tools is essential to creating health behaviors that will have a positive impact. Some of the barriers noted by diabetic patients are the health care system, communication, coping mechanisms, and managing diabetes within their social roles. The health care system presents an issue because office visits tend to be brief and do not allow satisfactory time to ask questions and address all the self-management issues (Grant & Steadman, 2016). Kruse et al. (2013), determined that an average of 5.2 minutes was allotted for discussing medications, glucose testing, values and foot problems (2013). In addition to the quick appointments, patients with diabetes also have limited access to dieticians to learn about a healthy diet and review food choices. There are also inadequate amounts of health care providers causing patients to travel further for appointments; exacerbating the problem. This, consequentially, leads to patients scheduling fewer follow up appointments which can lead to diabetic complications going undetected (Grant & Steadman, 2016). Diabetic patients describe having an initial reaction of denial and fear to their diagnosis which often results in complications (Jones et al., 2014). Another emotion defined by patients is the feeling of betrayal

by their bodies and this causes them to lose confidence in their ability to sufficiently care for themselves (Grant & Steadman, 2016). These feelings can lead to the patients ignoring the advice of practitioners; resulting in further complications (Grant & Steadman, 2016).

Difficulty in implementing proper self-management can stem from the demands of a busy lifestyle and contribute to disregarding self-care behaviors. When patients are a parent, caregiver or primary breadwinner, it is often difficult to find time to pursue further information and educational opportunities for their diabetes. People with T2DM also cite food and culture as a weighty barrier to self-management (Grant & Steadman, 2016). Recommendations on a healthy diet are often disregarded because culture is not taken into consideration when giving generic handouts to diabetic patients (Grant & Steadman, 2016). What does this mean to healthcare professionals? Practitioners must have knowledge of the barriers that exist for every individual patient. This will help practitioners to select appropriate interventions and not simply give generic information that may not be useful or suitable. The culture of each patient must be taken into consideration to engage and motivate diabetics to participate in self-management activities. It has been demonstrated that health care professionals who tailor their education to include cultural beliefs have a positive impact on health outcomes (Grant & Steadman, 2016).

The fifth construct, Cues to action, can be defined as the external and internal forces that drive a person with T2DM to engage in self-management behaviors that will preserve their quality of life. External forces are family and healthcare provider support and developing an understanding of the disease process and complications that will arise if proper control is not taken. External forces are important; however, it is the internal motivation that will provide the fortitude to actively manage their T2DM (Aloha & Groop, 2012). It is imperative that diabetics

find the motivation to adhere to a healthy diet and exercise program to help prevent complications later in life. Practitioners can help accomplish this by setting small goals for their patients (Ahola & Groop, 2012). Once initial goals have been achieved the patient will become more confident and more stringent goals can be set. Achieving goals will lead patients to a feeling of self-efficacy; the sixth and final construct in the HBM.

Self-efficacy is the individual's belief in his/her ability to properly care for themselves. A confident person will be more prone to initiate additional health behaviors and successfully navigate through obstacles as they present themselves. Practitioners are in a position to assist patients in achieving this confidence by providing them with the knowledge and tools to be successful. One such tool could be the use of a free mobile health app. A mobile health app gives those with T2DM the freedom to move around, enjoy their busy lifestyles, participate in social events and always have a link to vital self-management information.

Exploring the utilization of a free mobile health app, with the HBM to guide the process, can help practitioners discover if a diabetic app can improve the self-management of individuals with T2DM. The HBM was the perfect framework to guide this DNP project because it is a structured system rooted in understanding how to create changes in behavior. Additionally, the HBM was the ideal outline to discover if a mobile health app intervention would improve adherence to self-management behaviors.

Synthesis of Evidence

Millions of Americans are affected by T2DM and the increasing prevalence of this chronic, debilitating disease continues to strain the health system (Chavez et al., 2017). The intensity of self-management and daily care required to avoid diabetes-associated complications,

coupled with the lack of time patients have to spend with providers, is exacerbating the issue (Chavez et al., 2017). Mobile technology (e.g. smartphones) provides an opportunity for a novel approach to a longstanding problem (Chavez et al., 2017). Over 75% of American adults, regardless of socioeconomic status, have access to a smart-phone, and more than half of those individuals currently use their smart phone to acquire health information (Chavez, et al., 2017). Mobile technology has already revolutionized people's lives and mobile health apps have the potential to continue this trend by providing lower cost, 24-hour access to high-quality care (Kao & Liebovitz, 2017). Evidence-based care at your fingertips will have an enormous impact on patient empowerment, self-management, and patient education of chronic diseases, such as T2DM (Kao & Liebovitz, 2017).

To gain a better understanding of the barriers to daily self-care and the feasibility of utilizing a mobile health app numerous literature reviews were performed using PubMed and Cumulative Index of Nursing and Allied Health Literature (CINAHL). The subsequent key words were used: diabetes type 2, diabetes mellitus, adults, self-management, mhealth, mobile health, mobile technology, barriers, and perceptions. Inclusion criteria for articles included: English language, adult population, published within the past 7 years, human species and full text articles. The search terms diabetes mellitus generated thousands of results. Articles were quickly excluded if they did not relate to self-management. When applying the search term self-management, the number of populated articles dropped to 673. This number was further narrowed with the additional search terms mobile technology, mhealth, barriers and/or perceptions. Multiple combinations of these terms were used in the databases. Boolean operator was used to combine terms. For example, PubMed was searched using the terms mobile health

(title/abstract) and diabetes type 2 (title/abstract). The reference list of identified articles was also scrutinized to find other pertinent articles. For the purpose of this project, 11 articles were retained (see Table 1).

Aziz et al. (2015) and Tan et al. (2015) scrutinized the self-care management of individuals with T2DM. These literature reviews found that diabetes education and management programs were far more successful when they included lifestyle-focused interventions. However, traditional diabetes self-management programs require patients to follow a stringent treatment plan (Tan, Cheng, & Wang, 2015). Therefore, a new approach that aligns seamlessly with the beliefs and lifestyles of those with T2DM is needed. Additionally, it was discovered by Aziz et al (2015) and Tan et al. (2015), self-efficacy is a vital aspect of successful diabetes self-management. Saffari et al. (2014) found in their systematic review and meta-analysis that the use of mobile technology for education and self- management was an effective tool to maintain metabolic control. It was also noted that interactive interventions, such as mhealth, help keep diabetes patients motivated to perform self-management behaviors (Saffari et al., 2014).

Dehghani-Tafti et al. (2015) and Karimy et al. (2016) explored the determinants of self-care behavior in type 2 diabetic patients using a cross sectional study. Both studies determined that degree of self-care behaviors is a key component in preventing long term complications of diabetes. Dehghani-Tafti et al. (2015) noted inspection of shoes to be the least likely self-care behavior, while taking medication regularly as the most likely self-care behavior. Karimy et al. (2016) echoed similar results as Aziz et al. (2015) confirming that self-efficacy remains a significant predictor of positive self-management behaviors.

Other studies chosen from the literature review demonstrated the potential of mobile health technology to positively impact diabetes education and self-management. For example, Heitkemper et al. (2017) created a mobile diabetes detective intervention allowing patients to log their blood glucose values throughout the day. The program then averaged their blood glucose and provided participants with information on the specific times of day that glycemic control is most difficult for them. The participants could then browse the information and choose specific interventions to help modify their behaviors (Heitkemper et al., 2017). This process of recognition and then action provides diabetic patients with invaluable lessons on glycemic control (Heitkemper et al., 2017). Wayne et al. (2015) conducted a randomized control study that demonstrated mobile technology support accelerated improvement in glucose regulation. Furthermore, it has been discovered that the more intense the intervention, such as programs that produce automated messages generated by patient entries, produce greater HbA1c control (Wayne et al., 2015).

There is a lack of research regarding the benefits of utilizing mobile health technology and/or mobile applications to improve self-management of T2DM. However, studies discussing diabetes and self-management all have one sentiment in common; self-management is the most influential predictor of future complications and blood glucose levels that are uncontrolled remain the basic problem in diabetes patients (Wang et al., 2017). “So, the aim of the diabetes management is to control the glycemia and to prevent the complications (Surucu et al., 2017). A mobile diabetes health app is the engine that can drive the movement toward technology driven interventions. Traditional diabetes education is fundamental in the battle against diabetes related complications and mobile health apps are an important addition to the arsenal. Presently, those

with T2DM receive around two hours of education annually (Petersen & Hempler, 2017). Two hours of education is not enough for all individuals to learn and apply the essential knowledge required to successfully manage their diabetes. Dehkordi and Abdoli (2017) conducted a study addressing the experience of 15 participants attending a traditional diabetes class. Comments made by participants were "…the concepts of the classes get out of our mind too early," "I need new and more specific information" and "…some of the topics were just repeated in different sessions" (Dehkordi & Abdoli, 2017). This study demonstrates the inherent problem of traditional diabetes education; classes are not tailored to the audience and it is difficult for participants to retain information learned. Another tactic must be employed to improve diabetes self-management. Tremendous advances have been made with smartphone technology and this has given rise to new opportunities in diabetes education (Petersen & Hempler, 2017). A smartphone diabetes health app eliminates the need to memorize information and ensures new information is always at their fingertips.

METHODS

Design

This DNP quality improvement project utilized a quasi-experimental, single group, pre-test/post-test design to compare attitudes towards the usage of a mobile health app for the self-management of T2DM as well as the intent to use. Unlike true experiments, which randomly assign participants to groups, a quasi-experimental study, also known as a controlled trial without randomization, manipulates the entire group of participants (Polit & Beck, 2017). For this project, a convenience sample was utilized in an effort to achieve the intentions of this project. The mobile health app that was employed is Tactio Health (see Appendix C). A quasi-

experimental methodology was the suitable method for this project because the goal was to discover the perceptions of the health app and the intent to use. In addition, this methodology was chosen to assist the lead investigator in acquiring baseline data prior to the intervention (Polit & Beck, 2017). Before commencement of this project, approval was granted from the University of Arizona Institutional Review Board (IRB) to ensure participants were safe, risks were minimal, selection was equitable, and privacy and confidentiality was provided (Polit & Beck, 2017). Site approval was also received from the community center where recruitment of participants began.

To safeguard participants' rights, great care was taken to guarantee their privacy, safety, and freedom from coercion. All paper data was stored in a locked filing cabinet in a locked office. Computer data was encrypted, and password protected. To ensure full disclosure, all participants were given a copy of the Health Insurance Portability and Accountability Act of 1996 (HIPPA) and provided the opportunity to ask any questions and convey any concerns they had regarding their involvement in the project. Participants were treated impartially and with respect.

Setting

The setting of the project was initially intended to take place at two different locations; a community hospital and community center located in Goodyear, Arizona. However, due to time constraints and length of approval process at the community hospital, approval was never received for this project. Therefore, recruiting took place solely at the community center. During the implementation phase of this project the key stakeholders were the participants, family,

nutritionists, and providers. Resources that were helpful in this project were the flyers describing the project and the $5.00 Walmart gift card offered as an incentive to complete the project.

Participants

A convenience sampling of members of the community center was utilized for recruitment. Convenience sampling involves recruiting the most convenient individuals. (Polit & Beck, 2017). Inclusion criteria for this project were: (a) current diagnosis of T2DM, (b) English speaking, (c) own or had access to a smartphone daily, and (d) 18 years and older. Age and diagnosis of each participant was verified by the individual. Exclusion criteria included: (a) diabetes mellitus type 1, (b) non-English speaking, (c) younger than 18 years of age, and (d) did not own or have access to a smartphone. These criteria were chosen because the goal of this project was to introduce and/or encourage the utilization of a mobile health app for the self-management of T2DM. Additionally, the purpose of this project was to educate individuals with T2DM on the beneficial contributions a mobile health app could offer. Dehkordi and Abdoli (2017) found that diabetes self-management education and self-care behaviors are the cornerstone to improved health and quality of life. To that end, it is crucial for individuals with T2DM to have access to effective, widely accessible and inexpensive self-management options such as a mobile health app.

To attain the objectives of this project, initial recruitment at the community center took place by using flyers. After the director of the community center approved the flyer (see Appendix B) the lead investigator printed out 20 and delivered them to the front desk. Staff then posted them in designated areas determined by the director of the community center. It was then

up to individuals to contact the lead investigator by the specified deadline on the flyer (via email or phone) if interested in the project. The lead investigators contact information was listed on the flyer. However, after the recruitment flyers had been up for six weeks, not one person had volunteered for the project. In an effort to spark interest, the lead investigator went to the community center and personally handed out the flyers to people coming and going. This action prompted four individuals with T2DM to express interest in the project and fill out the 14-question pre-test survey on site. All four individuals then opted to forgo any education on the app and agreed to download it onto their phone when they got home. The only information that was given to participants on site was that the lead investigator, nor the rest of the team, would have access to the information they chose to enter into the mobile health app. Information received from participants was a phone number. Reminder text messages were sent at week 2 and week 3 and a post-test survey link at the end of week four.

The initial plan also included a convenience sampling of inpatients at a community hospital in Goodyear. The first step would have been to consult the diabetes educator (DE), due to her knowledge of all inpatients with T2DM, to determine conceivable participants. The DE would then approach potential participants first and obtain verbal consent to allow the lead investigator to receive their room number. When a list of prospective participants was compiled the lead investigator would have then gone to each patients' room to present the project. The goal was to recruit, at minimum, 10 participants, but no more than 25. After presenting the quality improvement project, explaining participant responsibilities, and answering any questions they had, everyone would have been asked if they would like to participate. Those agreeable to participate, would have been given a pre-test survey, in paper form, to complete. The lead

investigator would have stepped outside the room while the participant completed the 14-question survey. After 10 minutes the lead investigator would have re-entered the participants room to provide one-on-one training on the mobile app Tactio Health. The training would have included downloading the app to their personal smartphone, setting up their account and basic use of the app. Participants would have also been made aware that all the information entered into the Tactio Health app would remain confidential. However, as previously stated, project approval was never received from the community hospital, a convenience sampling was never obtained, and the above steps were never implemented. The only portion of this project that was designed to be completed in the inpatient setting was the initial meeting with the participants, completion of the pre-test survey and app download/training session. These elements would have been accomplished in one day.

Over the next four weeks the participants were, theoretically, supposed to incorporate the health app into their daily self-management routine at home. At the two- and three-week mark participants received a reminder text message to fill out the post-test survey when it was sent out. After four weeks all four participants were sent a final text to fill out the post-test survey. None of the four participants ever responded to the text messages sent at week two, week three or week four.

Data Collection

Data was going to be collected through a pre-test and post-test survey link utilizing Qualtrics or by paper copy. The pre-test was administered before the intervention (see Appendix E). The post-test was to be given after the intervention (see Appendix E). The pre-test, and post-test questionnaires were developed by the investigator of this project and were peer reviewed for

validity by DNP prepared Family Nurse Practitioners who currently work with diabetics. Identifiable data was encrypted, and password protected. Pre-test surveys were kept in a locked filing cabinet in a locked office. Raw data contained on paper and computer will be destroyed no later than December 2018. Paper data will be shredded, and computer data will be erased.

The pre-test survey contained questions relating to current self-management, concern for health status, health app knowledge, current diabetes knowledge, education and access to information. The post-test consisted of the same questions as the pre-test with the addition of questions pertaining to participants' perception of the utility of the health app and the intent to use in the future. The pre-test and post-test questions were written in the form of a zero to ten-point Likert scale. Each possible answer denoted the degree of agreement or disagreement and was given an assigned score (Polit & Beck, 2017). The pre-test was administered using a paper copy at the community center. The post-test was going to be delivered via text message utilizing a link to Qualtrics. However, none of the participants responded to any of the text messages during the implementation phase of the project.

Plans for Data Analysis

For this project, data was going to be entered into SPSS statistical software where total scores would have been calculated for the pre-test and post-test total. This would have been accomplished by summing the scores on all individual questions. Descriptive statistics would have then been used to determine if self-management and knowledge improved after the intervention. The mean, standard deviation, median, minimum and maximum would have been compared by scores (for both individual questions and total score). If enough participants would have been recruited a paired t-test would have been conducted using an alpha threshold of 0.05

to assess the difference in total scores in terms of statistical significance and a non-parametric Wilcoxon sign-rank test would have been conducted if distributions were asymmetric (Rothers, personal communication, April 5, 2018). Due to only having four participants, none of which completed the pre and post-test survey, assessment was limited to simple comparisons of similarities and differences in the responses received in the pre-test survey.

DISCUSSION

Conclusion

The use of a mobile health app, Tactio Health, to improve the perceived self-management of T2DM was attempted to be assessed in adults. A total of four individuals initially agreed to participate in the QI project. However, none completed the post-test survey. For this reason, the only information that can be surmised is from similarities and/or differences noted in the pre-test surveys. For example, 75% of the participants strongly agreed that managing their diabetes is very important to them and 75% strongly agreed they check their blood sugar as often as their provider instructs them. Interestingly, the 25% who strongly disagreed about diabetes management at home being important to them and strongly disagreed to checking their blood sugar as frequently as instructed, is also the participant that strongly disagreed to having enough information about managing their diabetes at home. These figures may imply lack of information and education about T2DM contributes to noncompliance with blood sugar checks and understanding of diabetes related complications. Additionally, only 25% strongly agreed they know about health apps that can be downloaded onto their phone to help manage their diabetes, but 100% of participants strongly agreed a health app would be very advantageous in managing their diabetes. This particular finding inspired the lead investigator to believe a mobile health app

for the self-management of diabetes would be beneficial, but an N=4 is not sufficient to demonstrate clinical significance, even if the post-test surveys did indicate improved perception of self-management. Another interesting finding from the pre-test survey was 75% of participants strongly disagreed diabetes would lead to health problems no matter what they did. This is an encouraging percentage because it may indicate 75% of participants understand self-management is a significant component of diabetes care.

100% of participants strongly agreed the education they have received about diabetes is helpful, but 25% strongly agreed they do not always have access to information they need when at home. This is an area a mobile health app could improve; information at your fingertips at any time of day or night. Only 25% of participants strongly agreed to currently using a mobile health app to assist with self-management of T2DM, however, 75% strongly agreed having access to information any time they needed it would be very helpful. The other 25% neither agreed nor disagreed.

Limitations and Lessons Learned

As with any QI project, limitations presented themselves prior to and during implementation. An excessively, problematic IRB approval process at the community hospital which led to a change in implementation site, insufficient recruitment time, shortage of willing participants, and lack of motivation to complete the post-test survey were four such limitations. The most detrimental limitation was the inability to receive IRB approval from the community hospital. Multiple attempts were made to obtain IRB approval without success.

Initial contact with the community hospital began May 9, 2018 with a phone call and email. Numerous emails were exchanged from May 2018 all the way through to October 1, 2018.

Unfortunately, a QI project by a DNP student was new territory and those in the research department were unsure who could make the decision to approve it. Several names were given as possible points of contact, but these individuals were also unsure of the procedure. The Chief Nursing Officer was involved in the early part of the process (early June 2018) and he enlisted the help of others, but still no one knew how to proceed.

Banner was contacted, in mid-June 2018, to request IRB approval for the DNP project because the community hospital process was challenging. It was presumed because the University of Arizona is affiliated with Banner Health, IRB approval would be certain. However, after exchanging several emails from June 13, 2018 to June 19, 2018 the lead investigator was informed only Banner employees were permitted to implement their QI projects at a Banner facility. This was another unfortunate disappointment.

While work was still being done to secure approval at the community hospital, attention was also turned to finding another implementation site. At the suggestion of the project chair, the local community center was contacted on June 27, 2018. The director of the community center reviewed the QI project and flyer (see Appendix B) used for recruitment and approval was received from the community center for implementation on July 7, 2018. In the interim, preliminary approval was also received from the community hospital on June 30, 2018. At that point, the preliminary approval was given to allow the QI project to be submitted for IRB approval through the University of Arizona to prevent further delay in the process at the university level. Once approval was received from the university the lead investigator was instructed the community hospital would follow suit.

Approval from the University of Arizona IRB came through on August 1, 2018 and the CNO of the community hospital was contacted via text message on August 3, 2018 and the rest of the individuals working on the approval process were contacted via email on August 7, 2018. From that point, 18 emails and numerous phone calls were made to boost efforts in granting approval. Nevertheless, no headway was made in the approval process. After over four months of correspondence with the CNO, research department, and various individuals, nothing had been accomplished by the community hospital. The lead investigator was led in circles and spent an exuberant amount of time focused on this critical part of the QI process to no avail. Approval was never granted, and all efforts had to be abandoned because there was no longer a sufficient amount of time to implement the project. This was a devastating outcome because it was believed that multiple individuals met inclusion criteria for the project.

Another limitation to this project was the insufficient amount of recruitment time at the community center. Months were wasted trying to get approval from the community hospital (that ultimately never came), which delayed submission to the UA IRB, which then significantly shortened the timeframe for recruitment. Flyers were only posted for six weeks. This was a mistake to not allow for more time for people to see the flyers. The hospital location should have been aborted much earlier in the project in order to focus on the community center and allow for more time for people to see the flyers. The lack of recruitment time then led to the small sample size; N=4. Four participants are not a large enough number to demonstrate clinical significance.

The final limitation to this project was the 100% attrition rate. None of the four participants took the final post-test survey. The reminder text messages were sent out at week two and week three. The final message with the link to the post-test survey was sent at the end of

week four. Unfortunately, all messages were unanswered at the end of the four weeks. It is unknown whether the participants ever even downloaded the Tactio Health app. Perhaps it would have been wise to insist the participants download the app after taking the pre-test survey to ensure they had it. This small measure may have increased the probability of the app utilization and post-test survey completion. These are factors to consider if reproduction of this project is attempted in the future.

Although this quality improvement project was unsuccessful in demonstrating clinical significance it is important to continue to evaluate the use of a mobile health app for self-management of T2DM. Diabetes is one of the most overwhelming, chronic health problems in the world (Dehkordi & Abdoli, 2017). WHO (2017) has even termed it as the silent epidemic due to the rising prevalence and insidious onset. Blindness, kidney failure, heart attacks, stroke, limb amputation, ulcers and infection are but a few known complications of diabetes. To prevent the onset of diabetes related complications it is paramount for diabetics to actively monitor their condition and engage in self-management activities (Wang et al., 2017). The time is now for providers to engage and motivate those with T2DM to actively participate in their self-management by utilizing a mobile health app. Regardless of the small sample size and 100% attrition rate of this QI project, the lead investigator continues to believe that mobile health technology gives providers a tool to bridge the gap between traditional diabetes education and patients' self-management (Park et al., 2016). The lack of success of this project stems from the staggeringly inadequate sample size and not the usefulness of utilizing a mobile health app for the management of T2DM. Individuals with T2DM require an intervention worthy of the 21st century to facilitate diabetes education and self-management optimizing resources. And a mobile

health app is the innovative technology that can assist with this process (Fitzner et al., 2014). The knowledge gleaned from this DNP QI project will assist in creating a future project that will yield more participants and a sufficient amount of data to demonstrate clinical significance.

Allowing more time for recruitment and having more than one recruitment site are two lessons learned from this QI project. Depending solely on one recruitment site was a mistake, because when it fell through there was not adequate time to locate another with the potential to yield as many participants. This one miscalculation cost the QI project an adequate sample size. If another QI project is implemented involving the use of a mobile health app, another recommendation should be to have participants download the app at the time of the participation agreement. Proper introduction and education will help enforce and encourage the use of the mobile health app from the beginning. The 100% attrition rate could have possibly been attributed to lack of familiarization to the app. A training session should be part of the recruitment process. These modifications should help support improved outcomes in future projects.

OTHER INFORMATION

Projected Budget

This DNP project had a negligible projected budget of $70. The investigator anticipated costs for the subsequent items: paper for printing the pre-test questionnaire and flyers; possible travel to the participants location(s) to retrieve pre-test and/or post-test survey and the $5.00 Walmart gift card that was supposed to be given to every participant upon completion of the

post-test survey (see Appendix F). However, actual expenditures totaled only $20. Due to a 100% attrition rate, the $50 allotted for the $5.00 Walmart gift cards were never purchased.

APPENDIX A:

CONSENT FORM

University of Arizona
Consent to Participate in Research

Project Title: In Adults with T2DM, does the use of a free mobile health application improve their perceived self-management?

Principal Investigator: Chandra Sorrelle

You are being asked to participate in a Doctor of Nursing Practice Project. Your participation in this quality improvement project is voluntary and you do not have to participate. This document contains important information about this project and what to expect if you decide to participate. Please consider the information carefully. Feel free to ask questions before making your decision to participate.

You are being asked to participate in a project that will assess the perception of self-management when using a free mobile health application. The length of the project will be approximately 4 weeks and it will be completed from your home.

When you agree to participate in the project, the first step will be to fill out a pretest survey consisting of 14 questions that will be sent via email or text message link from Qualtrics. Once you have completed the survey, the free mobile health application, Tactio Health, will be explained to you via the method of your choice (phone, email, text message) and, if needed, you will be given assistance to download the app onto your personal phone.

When Tactio Health has been downloaded you can begin using the app in your daily life. Participants should access the app at least once a day but are encouraged to utilize the app throughout the day and be an active user. There is a Coach component to the software that generates feedback based on the entries you make throughout the day. Types of data that you may enter are height/weight, blood sugar, medical conditions, nutritional and exercise habits, mood, activity, blood pressure, pulse, sleep and more. The more data you enter the more feedback you will receive. A few examples of feedback you may receive are positive affirmations, suggestions for healthy snacks and being active, alerts to check your blood sugar and when to seek medical care.

There are no expected risks to you as a result of participating in this study. You will participate from home, work, or wherever you are and will not need to make special trips to any location or change your current routine. No current treatment or medication regimens will be changed. You will not benefit directly from participating in this project either.

After incorporating the use of the health app into your daily life for 4 weeks you will be sent another link to take a post test survey. After completing the post test survey, you can choose to either continue using the app or delete it from your personal phone.

The Tactio Health app has a privacy policy that can be found at tactiohealth.com and states that any personal information entered into the app will not be used or disclosed to anyone unless required by law. All information is stored within the software and is not shared with anyone, including the members of this DNP project.

Personal identifiable information that will be collected are phone number, your name and email address if that is how you wish to receive the surveys. Phone number will be utilized to send the pre/post-test survey to you and your name will be provided only for signing the consent form.

Your name, phone number nor email will be used in any report. Any possible identifiable research data on the computer will be encrypted, and password protected.

Your responses will be assigned a code number. The list connecting your name to this code will be kept in an encrypted and password protected file. Only the project team will have access to the file. When the project is completed, and the data have been analyzed, the list will be destroyed.

The information that you give in the project will be anonymous. Your name, phone number nor email address will be linked to your answers.

Information collected will not be used or shared for future projects. However, if you want to see the results of the project you can provide your email and results will be sent to you upon completion of the project.

The information that you provide in the project will be handled confidentially. You will use your personal cell phone to access Tactio Health and personal information entered into Tactio Health will be stored by the apps software (on your personal phone) and the project team will not have access to it. Paper consent forms will be kept in a locked filing cabinet in a locked office and data on the computer will be in an encrypted folder and password protected. However, there may be circumstances where this information must be released or shared as required by law. The University of Arizona Institutional Review Board may review the project records for monitoring purposes.

For questions, concerns, or complaints about the project, or if you would like project results, you may contact _***Chandra Sorrelle 701-541-2144***.

For questions about your rights as a participant in this project or to discuss other project-related concerns or complaints with someone who is not part of the project team, you may contact the

Human Subjects Protection Program at 520-626-6721 or online at http://rgw.arizona.edu/compliance/human-subjects-protection-program.

Signing the consent form

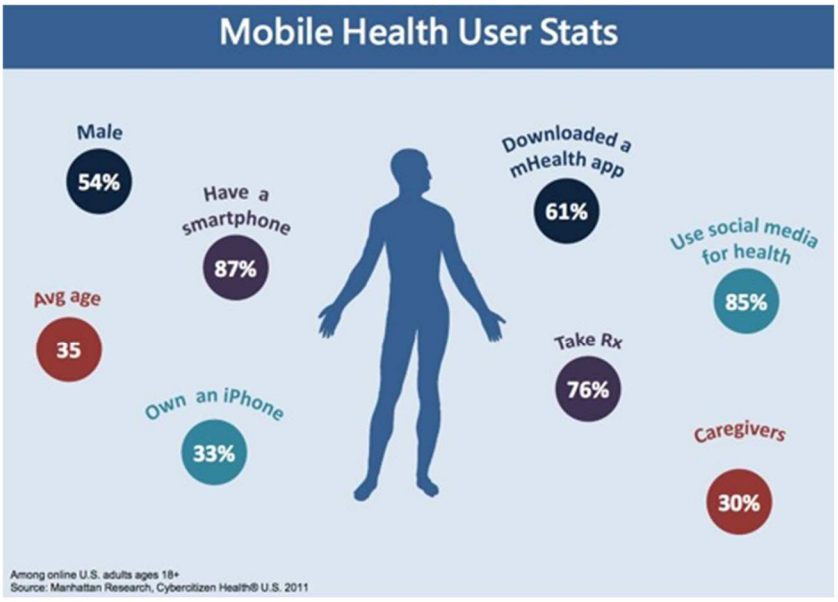
I have read (or someone has read to me) this form, and I am aware that I am being asked to participate in a quality improvement project. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this project.

I am not giving up any legal rights by signing this form. I will be given a copy of this form**.**

Printed name of subject	**Signature of subject**	**Date**

APPENDIX B:

RECRUITMENT FLYER



20 SEPT 2018

PRE/POST SURVEY

Does the use of a mobile health application improve perceptions of type 2 diabetes self-management?

If you would like to participate in this project or would like more information, please contact Chandra. You will not need to go anywhere or change your current medication regimen. Take a short 14 question survey via email and simply use the free mobile health app for 4 weeks and then complete a post-test survey and receive a $5 Walmart Gift Card. It's easy!!

THE UNIVERSITY OF ARIZONA

FREE $5 Walmart gift card for participating in a nursing project!!!

Do you have Type 2 Diabetes and are 18 years or older? Own a smartphone?

Try a FREE mobile health app from the comfort of your home

Just take a pre/post test survey!

No change to your daily routine!

Please contact Chandra

701-541-2144 call or text

csorrelle@email.arizona.edu

APPENDIX C:

TACTIO HEALTH APP

Tactio Health App

Tactio Health is a free mobile health app developed by Tactio Health Group Inc. This mobile health app helps track and manage a wide range of data pertaining to health. It is compatible with iPhone and Android, offers science-based feedback from coaches regarding healthy behaviors and chronic disease control, such as T2DM, and computes health risks for T2DM, cardiovascular and metabolic syndrome as information is entered by the user.

Tactio Health has four icons at the bottom of the screen that are seen when opening the app. They are the Dashboard, which automatically displays full screen, Logbook, Coach, and Settings. The Dashboard displays whatever health indicators the individual chooses (eg activity, glucose, blood pressure). If BS is chosen it denotes, by color, whether blood sugar (BS) is within a normal range or if it is high or low. If you tap on the BS it will take you to another screen that will explain the BS and provide feedback to help lower or raise it and whether a provider should be consulted. The Logbook displays the most recent blood sugar levels and the Coach icon will display all the helpful coaching tips that populate throughout the day based on information logged by the user. The Settings icon allows the user to update his/her profile, change the language, add a passcode/ touch ID lock and change the information that appears on the Dashboard.

APPENDIX D:

INTRODUCTION SCRIPT

Introduction Script

Lead Investigator (LI)

Project Participant (PP)

LI: Hello. My name is Chandra and I am a nurse practitioner student. Do you mind if I talk to you for a few minutes about a project I'm doing for school and ask you a couple questions?

PP: Go ahead.

LI: You are over the age of 18, correct?

PP: Yes.

LI: Do you have diabetes type 2?

PP: Yes.

LI: Do you own a smartphone or android? Or do you have access to one on a daily basis?

PP: Yes.

LI: The reason I ask is because the project I am doing for school involves introducing 10 people to a free mobile health application designed to help with self-management at home. The title of my project is: Adult Perceptions of Utilizing a Free Mobile Health Application for the Self-management of Type 2 Diabetes Mellitus. The question I want to answer thru this project is: Does the use of a mobile health app improve the perception of self-management? Do you currently use a health app for your diabetes?

PP: No.

LI: For my project, if you agreed to participate, you would be required to take a pre-test survey asking you a few questions about your diabetes and how you care for it at

home. This would be done today. I would then show you how to download Tactio Health and you would use it at home for 4 weeks and then take a post-test survey that I would send to you via text message. So, the only personal information that I would need from you is your cell phone number, which I would have you write on the top of your pre-test survey. This would be the only identifying information and I will keep it in a locked filing cabinet in a locked office. Do you think you would like to participate?

PP: I will participate.

LI: What questions do you have for me regarding this project?

PP: (Will ask his/her questions)

LI: If you have any more questions at any time just ask. My phone number is listed in the consent form and it is there for you to use, ok?

PP: Ok.

LI: Alright, before we go any further I need you to read this consent form and then sign it. Basically, by signing this consent you are saying that you agree to participate in this project, you've had the opportunity to ask questions and they've been answered to your satisfaction and you are voluntarily participating.

PP: Okay.

LI: Ok, now that you have signed the consent form I am going to have you take the pre-test survey. It shouldn't take you long. It is 13 questions and it will only take you about 5 minutes to complete, but feel free to take as long as you want. I will step outside while you fill it out and will be back in about 15 minutes if that works for you.

PP: That will be fine.

15 minutes later……

LI: Hi! Are you finished with the survey?

PP: Yesei

LI: Great! I will take your survey from you and put it in this folder. The next step is to download Tactio Health. That is the health app that I want you to start using as soon as we get it downloaded. And it is very important that you continue to use it once you go home.

PP: Got it.

LI: Lets get started! Do you know how to look for an app?

PP: Yes.

LI: Okay, go to the App Store, click on the Search icon and type in Tactio Health. It should be either the first or second app choice.

PP: Okay.

LI: That's it! Click on GET and we'll wait a few minutes for it to download.

PP: Ok, it's finished downloading.

LI: Go ahead and click on OPEN. The first screen you will see will prompt you to set the language, but it defaults to English. Then click on Sign Up down on the bottom, right.

PP: Okay.

LI: I will look away and you can enter your email address and password.

PP: Finished.

LI: Click Send and then you will get a request to let the app send you notifications. Click on Allow. Next, you'll see a WELCOME screen and you will have to complete your profile. Click on Start down on the bottom, right.

PP: Ok.

LI: There are 24 steps, but they are simple things like your name, gender, date of birth, height, weight, pregnancy status, and health conditions. This is where you would make sure to list diabetes type 2. So, go ahead and work your way thru those steps and I can help walk you thru it if you get stuck.

PP: Ok

LI: When you get to step 23 let me know.

PP: Ok, I'm there.

LI: This is where you can choose what will show up on your Dashboard. The Dashboard is your main screen; what you'll see first whenever you log into the app. You can customize it any way you would like and you can put a lot of "tiles" on your Dashboard. Tiles are things like blood glucose (BS), blood pressure (BP), weight ect. And you can always go back and add more, change it around, remove some. Whatever you think will help you at home.

PP: Ok, finished.

LI: Click Done. Now you are looking at your Dashboard as you have customized it. On the bottom of the Dashboard you can see four icons that will allow you to navigate. The icons are DASHBOARD, LOGBOOK, COACH, and SETTINGS. Click on LOGBOOK when you want to add data. Swipe left on the information you would like to edit. It gives you the ability to edit or delete it. If you click on the "+" sign you will see several more data pieces that you can provide information for (cholesterol, waist circumference, carb count ect). You have the ability to do as much or little as you want. The COACH button will display messages from a virtual coach that, as you enter data, will analyze it and then provide individualized feedback to you.

PP: Okay.

LI: The fourth icon is the SETTINGS button and that is where you can change your password, create touch ID, change your DASHBOARD tiles, language and other profile information. Any questions so far? Does this seem fairly simple to use?

PP: No questions. It does seem pretty easy.

LI: Just play around with it. Get familiar with it. Start entering data so you can get feedback and really see how the app works.

PP: Okay.

LI: At the 2 and 3 week mark I will send a reminder text message that you will be getting a post-test survey to fill out. And at the 4th week I will send a text message with the link to the survey to take. Once you have filled out the survey I will give you a $5.00 Walmart gift card that can be used toward healthcare supplies or anything else that you need. Any questions for me right now?

PP: No.

LI: Ok, remember you have my phone number on the consent form and you can feel free to call or text me with any questions. It was very nice to meet you and thank you for agreeing to participate in my project. Have a good day!

APPENDIX E:

PRE/POST-TEST SURVEY QUESTIONS

Pre-Test Survey Questions

1. **Managing my diabetes at home is very important to me.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

2. **I check my blood sugar as often as my doctor tells me to.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

3. **I am worried about my health because I don't have enough information about taking care of my diabetes at home.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

4. **Poor control of my diabetes will lead to health problems in the future.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

5. **I believe that diabetes will lead to health problems no matter what I do.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

6. **I feel like I have all the information I need to take care of my diabetes.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

7. **The education I have gotten about my diabetes is very helpful.**

   Strongly disagree Neither agree nor disagree Strongly Agree
   0 1 2 3 4 5 6 7 8 9 10

8. The amount and timing of diabetes education is good for me.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

9. I can't get the information I need to help me care for my diabetes at home.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

10. I know about health apps that can be downloaded onto my phone.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

11. I use a health app on my phone every day to help me care for my diabetes at home.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

12. A health app to help me monitor my diabetes would be very helpful.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

13. I am very comfortable using a health app on my phone.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

14. Being able to get information any time I need it will be very helpful.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

Additional Post-test Survey Questions

15. This health app helps me manage my diabetes.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

16. This health app is very important to help me care for my diabetes at home.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

17. Using a health app is a good way to track my blood sugar.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

18. This health app makes it easier to care for my diabetes at home.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

19. I am happy with how this health app helped me improve the care of my diabetes.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

20. I will continue to use this health app to manage my diabetes.

Strongly disagree Neither agree nor disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

APPENDIX F:

PROJECTED BUDGET

Projected Budget

Expense Items	Requested Amount
Travel	$10.00
Operations	
Materials and Supplies (Paper)	$10.00
Participant Payments	$50.00
Other	$0.00
Total	**$70.00**

APPENDIX G:

DIABETES EDUCATOR SCRIPT

DE: Diabetes Educator

PP: Potential Participant

DE: Hi, I'm the diabetes educator. How are you today?

PP: I'm fine.

DE: I am stopping by today to ask you a question. Would you allow me to give your name and room number to a nurse practitioner student? She is recruiting for a quality improvement project involving adults with T2DM. If you agree the student will stop by to tell you about the project and what is involved. You are under no obligation to participate in the project.

TABLE 1.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Wayne, N., Perez, D., Kaplan, D., & Ritvo, P. (2015). Health coaching reduces HbA1c in type 2 diabetic patients from a lower-socioeconomic status community: a randomized controlled trial. *Journal of Medical Internet Research*, 17(10), e224-e224.	To evaluate a health coach intervention with and without the use of mobile phones to support health behavior change in patients with type 2 diabetes.	RCT	**Sample:** 131 adults from 2 primary care health centers in Toronto, Canada ages 18-69 with type 2 diabetes and HbA1c level of >=7.3% Experimental Group (n=67) Control Group (n=64) **Setting:** Site #1: Black Creek Community Health Center Site #2: North York Family Health Team	**Data Collection:** Participants were evaluated at baseline, 3 months and 6 months (HbA1c, weight, waist circumference, BMI, satisfaction with life, depression, anxiety, positive and negative affect, and quality of life) **Data Analysis:** Data was entered by 2 independent research assistants twice. Baseline differences between the experimental and control group were compared using independent samples *t* tests for continuous variables and chi-square for dichotomous variables. Primary outcomes determined by independent samples *t* test and secondary outcomes determined using ANOVA. All data analyzed using SPSS 21.0 (IBM Corp, Armonk, NY, USA)	There was a significant between-group difference in HbA1c at the 3-month mark favoring the mobile phone assisted group. Observed weight and waist circumference also suggested benefits in the mobile phone group. Reductions in negative affect was also seen in the mobile phone group. Overall psychological improvement was seen in both the control and experimental group. **Attrition Rate:** 25% Of the 131 participants, 34 dropped out. 19 of them from the intervention group and 16 out of the control group

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Karimy, M., Araban, M., Zareban, I., Taher, M., & Abedi, A. (2015). Determinants of adherence to self-care behavior among women with type 2 diabetes: an explanation based on health belief model. *Medical Journal of the Islamic Republic of Iran*, 30(368), 1-8.	To investigate the predictors of adherence to self-care behavior among women with type 2 diabetes.	Cross-Sectional	**Sample:** 210 female patients aged 30 to 60 years selected through random sampling method. **Setting:** Hazrat Ali Asghar Hospital	**Data Collection:** Self-designed questionnaire based on the Health Belief Model, acquiring information about perceived susceptibility, severity, benefits, barriers, self-efficacy, and diabetes self-care behavior. **Data Analysis:** Data was analyzed by t-test, chi-square and regression analysis	Self-efficacy was found to be the strongest determinant of self-care. Perceived susceptibility failed to produce a significant increase for the variance. Self-care behaviors had a statistically significant positive association between self-care and perceived susceptibility, perceived severity, perceived benefits and self-efficacy

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Dehghani-Tafti, A., Mahmoodabad, S., Morowatisharifabad, M., Ardakani, M., Rezaeipandari, H., & Lotfi, M. (2015). Determinants of self-care in diabetic patients based on health belief model. *Global Journal of Health Science*, 7(5), 33-42.	To determine self-care predictors in diabetic patients based on health belief model.	Cross-sectional	**Sample:** 110 diabetic patients aged 26 to 75 years treated with either oral or insulin medication and diagnosed at least one year ago. **Setting:** Records registered with Health Services Network of Ardakan City	**Data Collection:** Questionnaire designed by a researcher with the first section consisting of 21 questions on demographics and general characteristics. Second part consisted of 68 questions to measure HBM constructs. **Data Analysis:** Collected data was analyzed using SPSS statistical software. Pearson correlation coefficient test was utilized to determine associations between HBM constructs and self-care behaviors. Linear regression analysis was used for deciding the prediction power of HBM constructs in explaining the variances of self-care behaviors.	Self-efficacy was the strongest predictor of self-care behaviors. There was no significant difference between self-care behaviors by sex, but there was a significant difference between some of HBM constructs and level of participant's education. The unique contribution of barriers, benefits, severity, and social support on self-care were not statistically significant.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Saffari, M., Ghanizadeh, G., & Koenig, H. (2014). Health education via mobile text messaging for glycemic control in adults with type 2 diabetes: a systematic review and meta-analysis. *Primary Care Diabetes*, 275-285.	To systematically review the impact of education through mobile text messaging on glycemic control.	Systematic Review with Meta-analysis	**Sample:** Five electronic databases were searched to access English studies involving a randomized controlled trial design that used text-messaging educational interventions in patient with type 2 diabetes during an 11-year period. N=10 studies **Setting:** Pubmed, Ovid MEDLINE, EBSCO, Science Direct, and ProQuest	**Data Collection:** An extraction form based on the study objectives was created. Two reviewers performed data extraction. The first reviewer completed the extraction form and the second reviewer checked the data entered in terms of accuracy. **Data Analysis:** Analysis was conducted using the Comprehensive Meta-Analysis Software Version 2.0. Standard difference in means and Hedges's g were used as measures of effect size to assess the impact of education on glycemic control.	Findings support the thought that health education through mobile text-messaging may help to improve glycemic control in patients with type 2 diabetes. The Hedges's g revealed almost a 50% decrease in HbA1c in the experimental groups versus the control groups. Another finding was that younger patients have a greater reduction in HbA1c than in patients over 55 years of age. However, HbA1c in both age groups was still significant.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Park, S., Burford, S., Nolan, C., & Hanlen, L. (2016). The role of digital engagement in the self-management of type 2 diabetes. *Health Communication*, 31(12), 1557-1565.	1. What are the factors that influence type 2 diabetes patients' engagement in mHealth programs? 2. How is digital literacy related to type 2 diabetes patients' engagement with mHealth programs? 3. How can we encourage users with low digital literacy to participate in mHealth programs, and to improve their self-management?	Pilot Program	**Sample:** 28 Participants who are type 2 diabetics ranging in age from 30 to 79 years. 16 participants were males and 12 were females. **Setting:** Participants were recruited from Ochre Health Medical Centre located in Canberra, Australia.	**Data Collection:** Data was collected twice via a survey; first at 2 months of participation and again at 5 months. Open ended and closed ended questions were asked. **Data Analysis:** Thematic analysis was conducted on the open-ended responses and SPSS 21 was used to conduct descriptive analysis. Mean difference tests were conducted using independent sample *t*-tests when appropriate.	Online surveys revealed that digital engagement is crucial to the patients' participation in mHealth activities and digital support training was essential to the patients' sustainable use of the devices and applications for health care. Longer term observation is needed to discern the factors that influence sustainable use due to novelty effects that come to play when introducing participants to technologies.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Peng, W., Kanthawala, S., Yuan, S., & Hussain, S. A qualitative study of user perceptions of mobile health apps. *BMC Public Health*, 16(1158), 1-11.	The purpose of the study was to examine and qualitatively determine the design and content elements of health apps that facilitate or impede usage from the users' perspective.	Qualitative	**Sample:** A total of 44 individuals who owned a smartphone; 39 in six focus groups and 5 in interviews participated in the study. Participants were recruited from a midwestern university and from a local plaza. College Students=17 University affiliated non-Student=22 Local Plaza=5 **Setting:** Focus groups took place in a conference room and ran for 40 to 90 minutes. Interviews were conducted at participants workplace, home or nearby café.	**Data Collection:** An initial survey on demographics was completed and all focus groups and interviews were audio recorded. Questions asked were about overall app usage, knowledge about health apps and their usage, and reasons for liking or disliking apps, including health apps. Non-student participants were given a free meal and $20 gift card. Student participants were given a free meal and an extra course credit. Interviewees were given a $40 gift card as incentive. **Data Analysis:** Verbatim transcripts were coded using the software NVivo. Inductive thematic analysis was adopted to analyze the data. Focus group and interview transcriptions were analyzed as a whole. Each recording was coded separately by at least two authors.	57% of participants had health apps Nine other themes were identified: 1.Barriers health apps: A. Low Awareness of health apps B. Lack of App literacy C. Cost 2.Barriers to continued use: A. Lack of time and effort B. Lack of motivation and discipline C. Apps take up storage space, drain battery 3.Motivators: A. Social competition B. Intangible rewards C. Tangible rewards D. Hedonic factor E. Internal dedication

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
					& motivation 4.Information & Personalized Guidance: A. Ability to receive information B. Personalized information C. Personalized coaching 5.Tracking for Awareness & Progress 6.Credibility 7.Goal Setting 8.Reminders 9.Sharing Personal Information: 1. Social networking features

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Dehkordi, L. & Abdoli, S. (2017). Diabetes self-management education; experience of people with diabetes. *Journal of Caring Sciences*, 6(2), 111-118.	To explore the experiences of people with diabetes from a local diabetes self-management education (DSME) program.	Descriptive Phenomenological Approach	**Sample:** 15 individuals with diabetes type 1 or type 2 that were attending the DSME program at a well-known endocrinology center. Males=6 Females=9 **Setting:** DSME program consisted of 7 two-hour sessions for both type 1 and type 2 diabetes. All participants completed the program between September 2011 and June 2012.	**Data Collection:** 18 interviews were conducted (three participants needed additional interviews) with the average length of time being 30 minutes **Data Analysis:** Data was immediately transcribed verbatim and analyzed based on Colaizzi's seven steps method	Findings highlighted three main themes regarding experience with DSME including: 1. Content of diabetes education 2. Teaching methods 3. Learning environment Study concluded that current DSME programs at this facility do not meet the needs of the people with diabetes.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Aziz, Z., Absetz, P., Oldroyd, J., Pronk, N., & Oldenburg, B. (2015). A systematic review of real-world diabetes prevention programs: learnings from the last 15 years. *Implementation Science*, 10(172), 1-17.	Findings of a systematic review that focuses on identifying the critical success factors for implementing diabetes prevention programs in real-world settings.	Systematic Review	**Sample:** 38 studies were utilized in this review. Inclusion criteria: Published in the last 15 years Contained evaluation of a lifestyle-focused program Adults aged 18 years and older English Language Publications Full text	**Data Collection:** Evaluation of diabetes mellitus type 2 program was conducted using the PIPE Impact Metric **Data Analysis:** Coding system included two steps: (1) initial scoring and (2) coding the scores as low, medium and high or not able to calculate	Lifestyle-focused diabetes prevention programs that have a high degree of contact have more potential to achieve effective outcomes High penetration into the target population with invitations to engage prospective participants in the program do not necessarily result in high participation

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Surucu, H., Kizilci, S., Ergor, G. (2017). The impacts of diabetes education on self-care agency, self-care activities and HbA1c levels of patients with type 2 diabetes: a randomized controlled study. *International Journal of Caring Sciences*, 10(1), 479-489.	The study aims to investigate the effects of diabetes education based on the self-care deficit nursing theory on the self-care agency, self-care activities, and HbA1c levels of patients with type 2 diabetes.	RCT Double Blind	**Sample:** 139 participants, with type 2 diabetes diagnosed at least 6 months ago and are 18 years of age or older. Control Group=69 Intervention Group=70 **Setting:** University Hospital in Izmir, Turkey	**Data Collection:** Data was collected between March 2012 and October 2012. A pretest was given to the control and intervention group and the intervention group underwent supportive-educative nursing interventions. Posttest was administered to the control and intervention group. Pretest and Posttest was administered via phone. **Data Analysis:** Data was analyzed using SPSS for Windows 15.0. The chi-square test and t-test were also performed to determine homogeneity and significance of the difference between two means respectively	A statistically significant difference was observed in the self-care agency between the two groups ($p<0.05$), but there was no significant difference in HbA1c and self-care activities. Pretest and posttest scores demonstrated that the intervention group scores after interventions for self-care agency and self-care activity were significantly higher, and HbA1c was significantly lower than the scores at pre-intervention ($p<0.05$) Control group scores showed no difference at the initial and 6th month of the study ($p>0.05$)

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Wang, W., Seah, B., Jiang, Y., Lopez, V., Tan, C., Lim, S., Ren, H., & Khoo, Y. (2017). A randomized controlled trial on a nurse-led smartphone-based self-management programme for people with poorly controlled type 2 diabetes: a study protocol. *Journal of Advanced Nursing*, 74, 190-200.	Study participants will be randomly allocated into an existing nurse-led diabetes service (NDS) group (control group) and a newly developed nurse-led smartphone-based self-management programme (NSSMP) group (experimental group). The authors hypothesized that compared with participants in the NDS group, participants in the NSSMP group will have significantly: 1. Higher levels of self-efficacy 2. Increased levels of diabetes self-care activities 3. Higher perceived health related quality of life (HRQoL) 4. Reduced HbA1c and acute diabetes complications 5. Lower usages of health services	RCT	**Sample:** A total of 128 outpatient adults with poorly controlled type 2 diabetes who are 21 years of age or older and have a recent HbA1c of >8% were recruited. Experimental Group=64 Control Group=64 **Setting:** Conference room in diabetes clinic in a Singapore hospital	**Data Collection:** Demographic and baseline data will be obtained on site by an RN. Experimental group will participate in the 6-month NSSMP and control group will receive standard diabetes care offered by the clinic **Data Analysis:** All data entry and analysis performed using IBM SPSS 24.0. Intention to treat analysis will be used to manage missing data. Baseline data and pretest scores will be compared between groups using chi-square analysis or independent t test to determine sample equivalence. Parametric tests will be employed as well as repeated measures analysis of covariance. Levene's test will be used to examine the homogeneity of the interaction effects	Findings are still pending. However, if the NSSMP is demonstrated to be effective in this study, the smartphone app developed in this project can be provided to all people with DMT2 and their family members/caregivers as a self-help education resource at home.

Author/Article	Research Question/Hypothesis	Study Design	Sample and Setting	Methods for Data Collection and Data Analysis	Findings
Heitkemper, E., Mamykina, L., Tobin, J., Cassells, A., & Smaldone, A. (2017). Baseline characteristics and technology training of underserved adults with type 2 diabetes in the mobile diabetes detective (MoDD) randomized controlled trial. *The Diabetes Educator*, 43(6), 576-588.	The purpose of this study is to describe the characteristics and technology training needs of underserved adults with type 2 diabetes mellitus (T2DM) who participated in a health information technology (HIT) diabetes self-management education (DSME) intervention.	RCT	**Sample:** 220 subjects with poorly controlled DMT2 who are 18-years or older. **Setting:** Conducted in eight FQHCs located in the New York City metropolitan area that are part of Clinical Directors Network primary care practice-based research network.	**Data Collection:** Data was collected either in person using paper surveys at the FQHC or via telephone interview All subjects received $15 at the baseline visit and $35 at the 12-month visit to encourage study completion. For study related text message fees all participants received $10. **Data Analysis:** All data were entered into REDCap. Data were analyzed using descriptive statistics and bivariate analyses using X2, Fisher exact, and Student t test. SAS 9.3 statistical software was used for all data analysis.	Technology ownership was high: 94% owned a cell phone; 71% owned a smartphone Training and support needs were greater than anticipated. Diabetes educators should assess technology abilities prior to implementing health information technology diabetes self-management education in underserved adults.

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