MOBILE-BASED TECHNOLOGY APP USED TO IMPROVE SELF-CARE MANAGEMENT

OF PATIENTS WITH TYPE 2 DIABETES MELLITUS

A Scholarly Project

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By

Fred Allen Smith Jr.

Liberty University

Lynchburg, VA

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ABSTRACT

Billions of dollars are spent on diabetes in healthcare each year. Patients with lower socio-economic-status tend to have poor glycemic control, higher associated diabetic complications, and higher associated mortality rates. In underserved patients with Type 2 Diabetes, does utilization of a Diabetes app, compared to previous self-care management and clinic education, lower the Hemoglobin A1c over a 3-month period? A 3-month scholarly project was conducted in a small rural town in Virginia with an average median income around $17,000. N=21 participants were selected for the scholarly project. Inclusive criteria consisted of adults aged 19-70 years with a diagnosis of type 2 diabetes for more than 6 months. Participants were required to have access to iOS/Android cellular devices. Additionally, participants were requested to complete pre and post self-care management and demographics questionnaires, and utilize the Diabetes app daily during the 3 month intervention window. After the 3-month intervention window, particpants had an overall decrease in hemoglobin A1c by (2.34%, $p = .004$). Further evidence demonstrated a direct improvement in self-care management techniques ratings based on *average*, *good*, and *great* with an overall mean increase of 14.3% after the intervention window. Particpants who scored *poor* and *bad* had an overall mean decrease of 21.38% after the intervention period. Mobile-based technology serves to help patients achieve their target glycemic goals, reduce mortality and morbidity, and promotes more versatile methods of healthcare delivery compared to traditional interventions and educational methods such as oral glycemic agents, diabetic class education, and insulin administration to manage T2DM.

Keywords: Mobile-based technology, underserved patient populations, diabetes

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

American Association of Diabetic Educators (AADE)

American Diabetes Association (ADA)

Collaborative Institutional Training Initiative (CITI)

Doctor of Nursing Practice (DNP)

Federally Qualified Health Center (FQHC)

Health Resource Service Administration (HRSA)

Interactive Diet Activity Tracker (iDAT)

Type 2 Diabetes Mellitus (T2DM)

SECTION ONE: INTRODUCTION

Each year, 327 billion dollars are spent on diabetes in healthcare (American Diabetes Association [ADA], 2018). Currently, over 30 million people live with Diabetes Mellitus Type 2 (T2DM) in the United States (ADA, 2018). Unfortunately, patients suffering from diabetes often are non-compliant with recommended medical therapies. Adherence is defined as a person's ability to take medication, follow recommended dietary modifications, lifestyle modifications, and retain close communication between the provider and patient (Perez, Alvarez, Dilla, & Guillen, 2013). Despite supportive evidence that demonstrates increased compliance and longevity of patients suffering from T2DM with medication compliance, around 50% of patients with T2DM are non-complaint with associated medical therapies (Perez et al., 2013). As a result, hyperglycemia and increased mortality leads to billions of dollars in healthcare services spent each year (Perez et al., 2013).

Poverty is not only associated with a higher incident of diabetes, it is also associated with decreased access to diabetic management (Hsu et al., 2012). Patients with low socio-economic-status tend to have poor glycemic control, higher associated diabetes complications, and higher mortality rates (Hsu et al., 2012). Various barriers to optimizing care of patients suffering from T2DM in low-income areas include lack of transportation, limited healthcare access, and medical costs associated with medical supplies (Hsu et al., 2012). People of low socio-economic status are more than 50% less likely to receive recommended diabetic checkups (Hsu et al., 2012).

What can be done to solve this problem in the underserved population? How can we decrease the unequal disparities associated with T2DM in poor communities compared to middle and high-income class communities? Two of the most commonly associated barriers to effective management of T2DM are a lack of communication between the patient and provider and failed

follow-up appointments. Is there a way to help correct this problem? We currently live in a technological era. In particular, smartphone and devices with mobile app capabilities can be used to help patients manage chronic illnesses. The vast majority of Americans own cell phones, accounting for approximately 96% of the United States population ("Cell Phone Facts," 2019). Of people with cell phones 81% have smartphone capabilities ("Cell Phone Facts," 2019). Whitehead and Seaton (2016) reviewed several studies supporting the usage of mobile apps to improve symptom management and compliance through self-care management interventions. The purpose of this scholarly project was to determine if the utilization of the Diabetes app would decrease the hemoglobin A1c and improve the self-care management techniques in patients diagnosed with T2DM in the underserved patient population.

Background

Working with the underserved population can serve as a difficult challenge. The underserved population often have several barriers to face with healthcare. Pulmonary, cardiovascular, learning disabilities, and poor quality of life are common health disparities within the underserved population (Hooker, 2013). Diabetes management in the underserved patient population is disproportionately managed compared to higher socioeconomic classes. In fact, compliance and treatment failure rates are higher within the underserved patient population (Hooker, 2013). This unfortunate fact applies to those who suffer from T2DM. What if there was a way to help bridge this gap in healthcare and avoid this barrier to optimizing care? Technological advancements have provided revolutionary advancements in medicine. How can mobile-based technology be utilized to facilitate better healthcare management for the underserved patient population?

T2DM requires extensive self-care management techniques for effective disease management (Beverly, Worley, Court, Prokopakis, & Ivanov, 2016). Fundamentally, effective communication between patients and providers must consist of continuous care (Beverly et al., 2016). Recent studies reflect that diabetic self-care communication is directly related to patient satisfaction, medication compliance, and associated with improved patient outcomes and patient satisfaction (Beverly et al., 2016). Providers often report one of the biggest barriers to effective communication with patients is time limitations (Beverly et al., 2016). Interestingly, a recent study concluded that patients felt shame, guilt, and even embarrassment to report they did not feel connected with their providers during and after chronic care appointments due to time constraints (Beverly et al., 2016). However, one benefit of utilizing the Diabetes app was to break down barriers and optimize effective patient provider communication while improving participants self-care management techniques for T2DM.

Utilization of the Diabetes app served to improve communication between patients and providers outside of traditional chronic care visits. An educational hub for patients in the underserved patient population. It consisted of dietary food options, various exercise regimens, blood sugar log, diabetic education congruent with the American Diabetes Association (ADA), and self-care techniques for diabetes management. Increased self-care management techniques should improve patients' hemoglobin A1c outside of traditional T2DM chronic care management. Recent studies supported that even small improvements in patient–provider communication positively influence self-care adherence for patients with T2DM (Patel, Datye, & Jesser, 2018).

Lately, technology has transformed the way healthcare is delivered to patients with T2DM. Technological advancements in the management of T2DM include accurate data

collection and tracking, online glucose monitoring, improved glucometers, improvement of

diabetic insulin pumps, improvement of access to health information, streaming information

monitors, and a complete expansion of innovative therapies available for patients in the forms of

oral glycemic agents and various insulins. Technology has served as an excellent reservoir for

improving self-care management techniques in patients with T2DM. Technology improves the

self-care management techniques of patients by enabling patients to perform self-blood glucose

monitoring, dietary adherence recommendations, medication adherence, and user platform

discussion forums. The utilization of mobile-based app technology improves barriers to

healthcare access, enhances patient education, and increases patient exposure to self-care

management techniques. Healthcare providers should incorporate the utilization of mobile-based

technology to effectively manage T2DM.

Problem Statement

Research supports that the underserved patient population suffers increased mortality and

morbidity by more than 50% compared to middle- and high-income groups who suffer from

T2DM (Duke, Colaguri, & Colaguri, 2015). Often, the underserved patient population reports a

lack of transportation, limited healthcare access, and a lack of self-care management techniques

as barriers to effectively managing their chronic illnesses. This rural clinic located in Virginia

experiences many of these barriers resulting in decreased self-care management compliance and

unchanged hemoglobin A1c levels.

Purpose of the Project

The purpose of this scholarly project was to determine if utilization of the Diabetes app

would decrease the hemoglobin A1c in patients diagnosed with T2DM in the underserved patient

population and enhance their self-care management techniques. Additionally, the project aimed

to provide the underserved patient population with full-time access to various educational

resources to improve self-care management techniques.

Clinical Question

In underserved patients with T2DM, does utilization of a Diabetes App, compared to

previous self-care management and clinic education, lower the hemoglobin A1c over a three-

month period?

SECTION TWO: LITERATURE REVIEW

The purpose of this literature review was to provide insight into the health disparities within the underserved population with T2DM. This literature review explored the benefits of utilizing mobile apps to improve self-care management of patients with T2DM resulting in decreased hemoglobin A1c. Qualitative and quantitative research provided evidence to support the utilization of mobile apps associated with the clinical management of T2DM. This literature review evaluated the influence of mobile-based technology and patient self-care management techniques of T2DM.

Search Strategy

A literature review was conducted to gather data pertaining to the large healthcare disparity among diabetics within the underserved patient population. Goals of the search set out to optimize the most relevant data supporting the utilization of mobile-based technology and diabetic management. A comprehensive database search was conducted using CINAHL, Pubmed, Medline, and EBSCOhost, and ProQuest. The following keywords and phrases were utilized during the search: *mobile app help manage diabetes*, *mobile technology effectively manage chronic illnesses*, *mobile technology decreases hemoglobin A1c*, *barriers in underserved patient populations diabetes management*, *barriers underserved population healthcare*, and *mobile app devices assist healthcare providers to optimize care*. Parameters of the literature search included peer-reviewed studies, clinical case studies, and clinical trials written in the English language within the past 5 years. The total number of articles reviewed before application of parameters applied was 40. After inclusion criteria was applied there were 20 remaining articles. Careful attention was taken during this literature search to avoid biased work, ineffective data, and research studies that contained conflicts of interest.

Critical Appraisal

Each article was examined for the level of evidence according to Melnyk's system of hierarchy (Research Guides, 2015). The articles included in this scholarly project's literature review included three cross sectional design studies, five randomized controlled trials, seven non-randomized control trials, and five systematic reviews. The remaining articles varied from levels of evidence I-IV, including quasi-experimental and randomized control trials. The quality of each study is provided in Appendix A.

Systematic reviews. A systematic review was conducted in 2016 to evaluate the utilization of mobile phones and tablets for self-care management in long term conditions. An extensive web search was conducted via PubMed, Embase, EBSCO database, Cochrane library, and the Joanna Briggs Institute Library (Whitehead & Seaton, 2016). The search consisted of randomized control trials consisting of mobile-based technology that utilized mobile apps and tablets for self-care management for T2DM, chronic lung disease, and cardiovascular disease between 2005-2016 (Whitehead & Seaton, 2016). Nine studies were evaluated and reviewed for this study. Six of those studies demonstrated statistical relevance and improvement in overall clinical outcomes (Whitehead & Seaton, 2016). Three apps included interventions via the utilization of mobile apps and demonstrated statistically significant improvement (Whitehead & Seaton, 2016). Most interventions involved chronic care management of T2DM (5/9) studies (Whitehead & Seaton, 2016). The duration of most interventions ranged from six weeks to one year, with follow-up data from the various studies ranging from three months to one year (Whitehead & Seaton, 2016). The number of study participants ranged from 48 to 288 individuals in the nine studies reviewed (Whitehead & Seaton, 2016).

Findings from the systematic review supported the utilization of mobile apps to improve symptom management and self-care management interventions (Whitehead & Seaton, 2016). Utilization of mobile apps, such as iHealth, amongst those with chronic health issues displayed more significant improvement in symptom management (Whitehead & Seaton, 2016). Whitehead and Seaton (2016) encouraged further study evaluation to optimize the utilization of mobile apps incorporated in chronic disease care management. Mobile app interventions provide innovative ways to optimize the treatment of chronic care conditions (Whitehead & Seaton, 2016).

Randomized control trials. Recently, a randomized control trial by Garg, Shah, Aturk, Benson, and Benergeon in 2017 supported the utilization of mobile-based technology in the treatment of patients with diabetes. This randomized control trial consisted of N=100 compared to a control group using self-monitoring blood glucose with Accu Check Nano synched with iPhone. All subjects had similar clinic and phone visits for three months, with an extension of three months for those utilizing the app. Participants within the study were required to have at least eight visits during the designated study period (Garg et al., 2017). The goal of Garg et al.'s research was to find out if utilization of the Accu Check Nano app would help decrease fear of hypoglycemia, worry, and behavior sub-scores.

Garg et al. (2017) conducted a-six-month study utilizing the two groups with and without the utilization of the Accu Check Nano synched app. At baseline, both groups had similar glycosylated hemoglobin A1c values. However, at six months the intervention group had a significant decrease in the hemoglobin A1c compared to the control group, who did not use the Accu Check Nano app. (-.16 vs. -.51, p = 0.04) (Garg et al., 2017). Hypoglycemia fear and

behavior scores of the control group were higher compared to the intervention group with no

increased risk of hypoglycemia (-1.4 ± 10.0 vs. -3.9 ± 12.5, p= 0.32) (Garg et al., 2017).

Limitations to Garg et al.'s (2017) study consisted of a short-term period (six months) in

one facility. In addition, the focus was geared toward only hypoglycemia risk without analyzing

other blood glucose variabilities (Garg et al., 2017). A strength of Garg et al.'s study was the

additional data produced that support the utilization of mobile app technology incorporated with

traditional diabetic management. Overall results from Garg et al.'s trial indicated that utilization

of the app with self-glucose monitoring improved diabetic management over a short period of

time.

In 2016, Goyal et al. conducted another randomized controlled trial that demonstrated the

ability of mobile app technology to improve diabetic self-management. The purpose of Goyal et

al.'s study was to see if utilization of a mobile app could facilitate and improve self-monitoring,

self-knowledge skills, and elicit positive behavior changes through effective self-management

skills of diabetes. The mobile app consisted of various functions geared toward improving better

self-care management of patients with diabetes. Functions included a daily step counter, dietary

menus, and incentive game with rewards. Each function within the mobile app supported ways

the patient could increase their self-improvement behaviors aimed towards better management of

the chronic disease. A strength of the mobile app was the structure it provided for participants.

Self-monitoring glucose reminders for N = 483 reduced their hemoglobin A1c on average

by 1.2%, compared to the control group utilizing traditional diabetic education methods of (0.4

to 0.6) (Goyal et al., 2016). In this study utilization of a game feature within the app improved

self-glucose measurements by an estimated 49.6% over a 12-week pilot. (Goyal et al., 2016). A

limitation of Goyal et al.'s (2016) study was the long-term sustainability of providing incentives

to patients. Goyal et al.'s study reinforced that mobile apps serve as a wonderful complementary tool with traditional diabetic education and improvement of self-care management techniques for patients with T2DM.

        Non-randomized control trials. In a non-randomized control trial in Singapore, Goh, Tan, Chaun, and Uma (2015) developed an app called interactive diet and activity tracker (iDAT) for use among patients with T2DM in various primary care settings. The objective was to predict trajectories of app usage for disease management and to improve self-care management of patients with T2DM (Goh et al., 2015). Goh et al. selected 84 participants who had not previously had exposure to the iDAT app. Goh et al. divided participants into three groups: minimal users (78.6%) with no previous iDAT usage; intermittent waning users (11.9%) with occasional weekly usage during the first four weeks; and consistent users (9.5%) with weekly usage. Goh et al. studied participants for app usage during an eight-week period. Most participants were android users, accounting for approximately 70% (Goh et al., 2015). Interestingly, most users reported strong utilization of their smartphone, with 87% reporting using their smartphone more than five times per day (Goh et al., 2015).

        After educational sessions on how to operate the iDAT app, users gave the app an average rating score of 6 out of 9 on a 9-point scale (Goh et al., 2015). Participants who had higher associated app usage reported increased levels of exercise. Results from Goh et al.'s (2015) study supported mobile app technology as an excellent complementary tool for providers to use to aid in the improvement of self-care management. Limitations to Goh et al.'s study included mobile app data only available on a weekly basis. In addition, utilization of this app only had a marginal usage rate of 3 to 4 out of every 10 users. Sample size for the study was limited and could not effectively represent enough data for larger generalization. A strength of

this study is the realistic feedback based on users' mobile device app usage for similar studies in the future (Goh et al., 2015). Goh et al. provided more realistic results of what could be seen with self-motivation when compared with other popular mobile device apps.

Cross-sectional studies. Two cross-sectional design studies revealed a significant correlation between self-knowledge of diabetes and improved hemoglobin A1c. Yang et al., (2016) conducted the first cross-sectional study in various regions of China (Western, Eastern, and Mainland) with a total of 5,957 participants. Yang et al. utilized an implemented pre and post survey to evaluate self-care improvement measures for T2DM post utilization over a 12-month period. After the 12-month period Yang et al. evaluated participants via the implemented post survey for diabetic knowledge regarding diet, exercise, blood glucose testing, foot care, and medication testing. Yang et al. concluded that patients with good understanding of T2DM improved to 72.1% from 46.8% prior to the implemented study.

Participants with good T2DM understanding had on average significantly lower fasting blood glucose (FBG) and two-hour postprandial blood glucose and were more likely to use self-monitoring blood glucose, exercise techniques, and medications than those who had a poorer understanding (Yang et al., 2016). Patients with better understanding had better associated outcomes ($P < 0.001$) (Yang et al., 2016). Strengths of Yang et al.'s study included a large sample population, a variety of patient demographics, and extensive study length. All presented data within the data had a P value less than $P < 0.005$ for significant relevance (Yang et al., 2016). Weaknesses of Yang et al.'s study included the number of language dialects among various regions and educational levels of sampled regions.

Synthesis

T2DM health disparities are common within various types of healthcare systems around

the globe. Common barriers to effective T2DM management can be linked to patient behaviors, access to healthcare, insufficient patient education, poor communication between providers and patients, and inconsistent patient education. In a study conducted in 2017, Vencio et al. collected data across various regions including Brazil, India, Japan, Spain, UK, and USA to identify barriers to effective self-care management of T2DM. Interestingly, Vencio et al. reported that diabetic education covered during traditional chronic care consultations across the various global regions was the same. Diabetic education included healthy dietary intake, frequent exercise regimen, and glycemic regulation regarding disease progression and management from most providers (Vencio et al., 2017). Out of 1000 providers surveyed during this study, a common reported issue amongst providers is that they wish they had more time at the beside with patients to discuss effective self-care disease management techniques (Vencio et al., 2017). Importantly, Vencio et al. provided substantial evidence that supports a disparity between what physicians report they included in educational sessions versus what patients can remember during and after those sessions for later recall. Vencio et al. noted education outside of traditional chronic care appointments is vital and should be explored to optimize outcomes of patients with T2DM.

   Utilization of mobile apps within clinical practice.   There is a direct relationship between the utilization of mobile apps and various positive effects on patients' self-care behaviors. Mobile-based app technology can be utilized in clinical practice to improve self-care management of patients with T2DM. For instance, Schmocker, Zwahlen, and Denecke (2018) implemented the usage of the diabetic app GlucoMan to help encourage self-care management of patients with diabetes. Schmocker et al. encouraged patients over a six-month period to utilize the app for blood glucose entry, diabetes information, and food tracking. The GlucoMan app was found to improve patients' ability to monitor their disease and empower better self-care

management of diabetes for their health (Schmocker et al., 2018). Furthermore, the GlucoMan app empowered patients to keep better track of their chronic illness.

Boyle, Grainger, Hall, and Krebs (2017) conducted research in New Zealand at an outpatient clinic examined utilization of a diabetic apps in clinical practice to help improve self-care management of patients with T2DM. Boyle et al. found that mobile app users were most interested in mobile app functions such as an insulin dose calculator, diabetic diary, blood glucose monitoring, and dietary carbohydrate. As evidenced by 200 implemented surveys, patients were interested in learning how to utilize mobile apps to manage their chronic conditions (Boyle et al., 2017).

Mobile app utilization in diabetic management. Studies were conducted to explore various ways to optimize care for patients with T2DM. Ye, Khan, and Boren (2018) conducted a study in China in which they reviewed various apps within the two biggest app platforms available (iTunes and Google Play). Ye et al. interviewed six diabetic educators to examine the efficiency of various app functionalities. Over 1050 mobile apps were reviewed for this study (Ye et al., 2018). Mobile apps were reviewed applying the following criteria: functionality within the clinical setting, user preferences, American Association of Diabetic Educators (AAED 7) criteria of healthy eating, physical activity, glucose monitoring, taking medication, problem solving, healthy coping, and reducing risks (Ye et al., 2018). After inclusive criteria was applied a remaining 310 mobile apps were selected for clinical usage in this study (Ye et al., 2018). Key features of these apps consisted of empowering healthy eating, mediation adherence, daily exercising, and disease monitoring (Ye et al., 2018). Exploration of the various apps found that mobile technology served as an excellent complementary service to optimize patient outcomes associated with T2DM. Recommendations for future diabetic apps encouraged the inclusion of

more evidence-based guidelines to increase further self-care management of diabetes (Ye et al.,

2018).

Mobile-based technology has the power to reach all age groups, various patient

demographics, and has endless potential for patients with T2DM. Arnold, Solz, Quade, and

Kirch (2014) conducted a systematic review examining 656 mobile apps' functionality to

determine if they could serve the needs of T2DM patients aged 50 years or older by expert app

usage. Arnold et al. noted a large variety of user capabilities within the various mobile apps. Of

user apps only 54.1% offered one simple function for end users, while 53% of the apps provided

a documentation function within the app (Arnold et al., 2014). The predominant language within

all examined apps was English (Arnold et al., 2014). Arnold et al. identified patients as the main

end user group for all the various apps. Interestingly, Arnold et al. identified no clear user

preference between free and paid apps.

Arnold et al. (2014) utilized a comprehension scale to grade various components within

the various apps. Scores generated from the comprehension scale represent app users' ability to

navigate and understand overall app functions. Scores on the comprehension scale are ranked

from 0-5 with 0 as not able to use at all, 1 as extremely difficult to navigate and use app, 2 as

somewhat difficult to utilize the app, 3 as fair amount of difficulty utilizing the app, 4 as good

functionality within the app, and 5 as exceptional ease of app utilization. On average, most apps

scored a 4.0 out of 5.0 on the comprehension scale (Arnold et al., 2014). Arnold et al. reported

diabetic apps were effective interventional tools to promote self-care management tools for users

at or over the age of 50 years. Furthermore, Arnold et al. suggested that the target population is

well represented utilizing the mobile-based app technology. Arnold et al.'s results encourage

providers to take a proactive stance in the incorporation of alternative complementary tools to help improve self-care management associated with T2DM.

   Utilization of mobile apps in underserved patient populations. Research reflects huge disparities in healthcare for patients residing in rural communities. In order to effectively address barriers for those at a disadvantage, healthcare providers must find ways to treat patients outside of traditional diabetic educational methods. In 2015, Shadid, Mahar, Shaikh, and Shaikh conducted a study in rural Pakistan consisting of 440 participants and a control group enrolled in a randomized control trial study). The purpose of the study was to establish if mobile app technology in a rural community for patients with T2DM would positively influence patient's hemoglobin A1c (Shadid et al., 2015). The mobile app sent reminders to patients every 15 days during the 4-month study period (Shadid et al., 2015). Shadid et al. revealed participants who utilized the mobile app had an increase from baseline in dietary planning from 17.3% to 43.6% post mobile app intervention compared to the control group of 13.6% to 15.9%. Additionally, participants showed a direct correlation with their hemoglobin A1c decrease of (RR= 2.71, 95% CI=1.18-6.40) during the 4-month period. All participants compared to the control group had a significant positive association with an improved hemoglobin A1c (Shadid et al., 2015). Results within this rural community reinforced the value of managing patients T2DM outside of traditional means who have lack of access to healthcare, limited transportation, and have mobile technology available.

  Mallow, Theeke, Barnes, Whetsel, and Mallow (2014) conducted an extensive integrated review of mobile health supporting the utilization of mobile app technology to improve T2DM care within rural community settings. A trigger for this integrated review was the critical need for an effective intervention to help patients with T2DM in rural communities who face

commonly associated barriers of rural healthcare (Mallow et al., 2014). Those barriers identified

include lack of access to healthcare, poor outcomes of patients within rural communities, and

lack of provider interventions (Mallow et al., 2014). Mallow et al.'s integrated review consisted

of evaluating all mobile technologies involved in the improvement of T2DM care. Mallow et al.

studied all relevant data within the inclusive criteria of the study from January to mid-August,

2013, for significant relevance surrounding mobile health technology in rural communities for

T2DM patients. Mallow et al. studied a total of 157 articles were reviewed, with 25 articles

meeting inclusive criteria. Results from the study supported the utilization of mobile app

technology to be effective at improving patients with T2DM outcomes, reducing costs to

patients, and an exceptional way to provide innovative treatment to communities with limited

resources (Mallow et al., 2014).

Conceptual Framework

The conceptual framework utilized for this scholarly project was the Iowa model (Titler

et al., 2001). This model is a commonly utilized framework for the implementation of evidence-

based practice. The Iowa model utilizes seven triggers to effectively promote best evidence-

based practice methods (Doody & Doody, 2012). The seven main components of the IOWA

model include: identify triggering issues, state the purpose, form a team, examine the evidence,

design the practice change, implement the practice change, evaluate and disseminate the results

(Doody & Doody, 2012). Permission was provided by the University of Iowa, Department of

Nursing to utilize the Iowa Model for this scholarly project (see Appendix B).

Identify triggering issues and state the purpose. No-show appointments are associated

with a higher risk of hospitalization for patient suffering from T2DM (Nuti et al., 2013). Often,

patients who "no-show" in primary care settings interrupt the ability of providers to provide

consistent treatment (Nuti et al., 2013). Nuti et al. (2013) found that diabetic patients who did

not show to appointments displayed an increase of 60% risk for admission to the emergency

room (ER).   The rural medical facility has a difficult time trying to keep diabetic education

appointments with patients due to high levels of no-show appointments.

       Another barrier to effective management of diabetic patients within the organization is

effectively getting patients within the organization to keep diabetic education appointments after

traditional chronic care checkups. A trigger for the scholarly project set to explore solutions that

aid in resolving various barriers to effective self-care management education for patients in the

underserved patient population suffering from T2DM. This project site is committed to

providing health services, promoting health, reducing health risk factors, and increasing access to

the uninsured and underserved patient population (Rural Health Clinic, 2018). This scholarly

project aligned with the clinics mission by seeking to improve patient access in the underserved

patient population, decreasing risk factors with unmanaged T2DM, and promoting health

through improved self-care management techniques through utilization of the diabetes app.

       Team development. Team development for this scholarly project began with

identification of key stakeholders for this scholarly project. This project team leader organized a

project team to effectively provide adequate resources to implement this scholarly project. This

team leader helped the team develop clear roles within the project, establish goals, establish

project team feedback, and develop a scholarly project timeline. The project team leader and

scholarly project chair worked collaboratively together to ensure the scholarly project utilized the

most evidenced-based practice during implementation of this scholarly project. The team leader

organized the team and oversaw all aspects of the project including implementation and

evaluation of this scholarly project. The scholarly project team members consisted of a scholarly

project chair DNP, FNP-C, student DNP, FNP-C, DNP, FNP-BC, MSN, FNP-C, four LPNs, six

front desk ancillary staff within the selected organization, and a DNP FNP-C to help analyze

statistical results.

Examine the evidence. Evidence retrieval for this scholarly project was conducted by a

systematic literature review for best evidence-based practices surrounding the care of T2DM

utilizing mobile app technology. The lead team member reviewed all literature and discussed

evidence with all associated scholarly project team members. Studies consisted of quasi

experiment, random controlled trials, non-random controlled trials, systematic reviews, and

cross-sectional design studies. The team leader utilized the latest SPSS software for effective

clinical relevance to analyze the evidence after the imposed intervention.

The team leader examined each article for the level of evidence according to Melnyk's

system of hierarchy (Research Guides, 2015). This scholarly project's literature review

consisted of Levels I to III and Level 5 evidence. Level I evidence consisted of randomized

control trials and systematic reviews conducted within primary care settings utilizing mobile

apps to improve self-care management of patients with T2DM. Level II evidence articles

consisted of non-randomized control trials and cohort studies. Level III evidence articles

consisted of three quasi experimental design studies supporting mobile-based app technology for

the management of T2DM self-care management. Level V evidence consisted of observational

studies that support the utilization of mobile app usage within the primary care setting.

Design the practice change. The team leader implemented the standard utilization of

mobile app technology within the clinic. Mobile app technology utilization was based on strong

supporting evidence that consistently demonstrated positive outcomes with the incorporated

utilization of the Diabetes app for diabetic education for patients with T2DM. Clinical

guidelines associated with the utilization of mobile-based app technology served the purpose to assist providers and promote better clinical decision-making skills for self-care management of T2DM. Evidence composed from the systematic literature review and similar studies helped guide and develop evidence-based practices currently being provided to patients of similar demographics and illnesses. Utilization of mobile-based apps within clinical practices has produced substantial evidence of the positive impacts on patient outcomes. In a growing technological era, mobile-based app technology can enhance the ability of providers to improve self-care management of T2DM. Furthermore, the benefits of mobile apps and diabetes management can break previous barriers associated with self-care management of T2DM within the underserved patient populations. This scholarly project aimed to provide substantial evidence that mobile app-based technology utilization incorporated into diabetic management can produce reproducible results and can be effective within the target population.

Practice change implementation. One of the biggest challenges throughout healthcare remains to be consistent effective implementation of the best evidence-based practices. The scholarly project team leader demonstrated in order to effectively implement new standards within an organization, there must be an understanding of organizational culture, a defined process, a plan for effective implementation, and a provided effective evaluation (Cullen & Adams, 2013). The scholarly project team leader utilized five steps to help with the implementation of this evidence-based practice utilizing mobile-based app technology for improved self-care management of T2DM. The five steps included: create awareness and interest within the organization; build knowledge and commitment from all key stakeholders; promote action and adoption via educational outreach and multidisciplinary team discussions; pursue integration; and sustain use via evaluated results (Cullen & Adams, 2013).

The scholarly project team leader started with the developmental process of the mobile app with a software company named Appy Pie. The Diabetes app served as a "one stop shop" education hub for patients with T2DM, available on both Android and iOS platforms. The app consisted of several recommended ADA dietary changes, a built-in blood sugar log, healthy exercise videos, a variety of meal plans, diabetic education in congruence with ADA recommendations, various self-care management techniques, and a frequently-asked-questions section.

This project team leader aimed to recruit 60 established rural health clinic patients who met inclusive criteria for the scholarly project. Concluding the study, participants with the highest mobile app utilization and lowest hemoglobin A1c decrease were entered in a raffle drawing to win a 19-inch television. Prior to implementation all participants were provided a pre and post diabetic questionnaire-based utilization of the mobile app and assessment of various self-care management techniques. All participants were requested to download the mobile app and utilize the Diabetes app daily during the three-month intervention period. During the three-month period participants received two push notifications daily and received new downloadable content weekly. All activity within the app was measured daily via google analytics for each specific end user. The purpose for the change in practice was designed to break barriers involving ineffective T2DM self-care management within the underserved patient population.

Evaluation and dissemination the results. Data-driven decision making and incorporation of feedback from all essential stakeholders drove the vitality of this scholarly project. Careful evaluation of *p* value, overall hemoglobin A1c response, and impact on self-care management influenced the level of significance and future usage of the mobile app. Personal feedback from participants allowed for further engagement needs for future app users,

barriers to utilization, and strengths associated with the mobile app. Data was compared to prior

hemoglobin A1c levels for comparison purposes with traditional diabetic education and self-

learning alone.

Results were distributed to participating scholarly project team members during the post-

implementation and evaluation meeting. Furthermore, at this meeting the team discussed various

aspects of the conducted project and set the building blocks for the dissemination plan associated

with this scholarly project. Other members and staff associated with the organization were

provided a summary book, with the potential for an article or poster presentation with scholarly

project results.

Summary

The purpose of this literature review was to discover evidence-based practice strategies

for management of T2DM in underserved and uninsured populations. Evidence indicated mobile

apps improve symptom management through improved self-care management (Whitehead &

Seaton, 2016). In the current advanced technological era, utilization of mobile apps grants

healthcare providers another effective tool to encourage self-management of chronic illnesses.

The critical appraisal of data provided strong evidence for utilization of mobile apps within

clinical practice, mobile app utilization in diabetic management, and utilization of mobile apps in

underserved populations. DNPs have the knowledge and skills to work in collaboration with

software designers to help develop these apps for specific chronic illnesses. Literature supported

the need for this scholarly project, which was to decrease the hemoglobin A1c in patients with

T2DM by utilizing a mobile app to improve self-care management.

SECTION THREE: METHODOLOGY

Design

The purpose of this scholarly project was to determine if the utilization of a Diabetes app would decrease the hemoglobin A1c and improve the self-care management of patients diagnosed with T2DM in the underserved patient population. The Diabetes app aimed to provide the underserved patient population full-time access to improved self-care management techniques and education to improve their hemoglobin A1c. This project served as an evidence-based performance project framed by the Iowa model for evidence-based performance. The project design was based on extensive evidence in the literature and congruent with the steps of the Iowa model. Triggering issues surrounding the care of T2DM patients in underserved communities were identified and a team was developed to review the literature and address this issue. The scholarly project team leader sought out to recruit 60 participants. However, only 30 participants were obtained during the three-month intervention window for daily utilization of the Diabetes app. Prior to receiving the app, patients received education on its usage. The project team leader utilized phone contact for this education, plus provided an in-app welcome video tutorial. Pre- and post-Diabetic app questionnaires (demographics, self-care) were distributed for baseline levels before and after the intervention. Additionally, participants received push notifications daily at 8am and 6pm. Prior to implementation of the Diabetes app, each participant had their hemoglobin A1c drawn pre- and post-app-utilization.

Measurable Outcomes

Goal 1: After completion of the three-month window with utilization of the Diabetes app, patients would demonstrate a decrease in their Hgb A1c. This measurement would be evidenced by comparing blood drawn pre- and post-Diabetic app utilization. Goal 2: After completion of

the three-month intervention of the Diabetes app, patients would demonstrate an increase in self-care management behaviors associated with their T2DM. This measurement would be evidenced by increased self-care management scores ranked by the Likert scores for all questions on the pre- and post-survey Diabetic Self-Questionnaire (Appendix C).

Setting

This scholarly project was conducted in a small rural town in Virgina. Census results revealed approximately 1600 people living in the selected study area (Bassett, Virginia [BV], n.d.). Approximately 72.94% of these people were White, 24.14% African American, 0.07% Asian American, and 1.79% other races (BV, n.d.). The average median income in Bassett was $28,359. Of the households 22.6% have children under the age of 18. About 17.8% of the population lived below the poverty line (BV, n.d.).

The health clinic is a community health center located in rural Virginia. It is a 10-room medical facility, with over 20 employees ranging from certified medical assistants, licensed practical nurses, translators, clinical supervisor, clinical director, registered nurses, five nurse practitioners, two physicians, and is equipped with an in-house lab including EKG capabilities, microscope, and performs various in clinic procedures. This family practice is dedicated to providing comprehensive, primary health services to medically underserved residents of Henry County regardless of their ability to pay. This health center receives grant funding program under the 24 U.S.C 254b and is deemed a public health service employer (Rural Health Clinic, 2018). The clinical director of the organization provided a letter of support for the study taking place at the site (see Appendix D).

Population and Sample

Participants of this study consisted of those who met inclusive criteria. The scholarly project team leader selected approximately 60 particpants within the inclusive criteria. The targeted audience for this scholarly project was adults aged 19-70 years of age with a diagnosis of T2DM for more than six months. Patients were required to have access to iOS or Android device app stores with online capabilities. Patients were required to be established patients of the clinic with a hemoglobin A1c greater than seven. In addition, participants were required to have been referred to the diabetic educator within the last 12 months and English speaking only. Exclusion criteria consisted of falling outside the designated age range, not having mobile device access, not having smartphone capablities (app store), not being a rural clinic patient, not speaking English, and having an hemoglobin A1c lower than seven or without a diabetic educator referral within the last 12 months.

Ethical Considerations

The scholarly project team leader and project chair completed extensive research ethics training to ensure protection of human subjects through the Collaborative Institutional Training Initiative (CITI Training) and were awarded a certificate of successful completion (see Appendix E). All aspects of the scholarly project were reviewed to ensure ethical standards were maintained throughout the implementation of the scholarly project. The team leader reviewed all aspects within the study to ensure the highest level of quality and integrity throughout the duration of the project. The scholarly project was approved by the project chair and received successful Liberty University Institutional Review Board (IRB) approval (see Appendix F). All study participants were under a direct voluntarily basis, and at any time reserved the right to un-enroll from the project.

The scholarly project team leader distributed and retrieved in person the informed consent forms during patients' acute and chronic care visits. Each participant's reading level was assessed to ensure adequate reading literacy associated with participating in this scholarly project. Scholarly project participants' personal information remained confidential and anonymous throughout utilization of the Diabetes app intervention period. All participants received an informed consent and non-disclosure statement for participating in the scholarly project (see Appendix G). According to the disclosure forms provided to patients at the time of signing the informed consent, information was only discussed with direct scholarly project team members. No personal information was shared with any other institutions or similar programs without direct consent from participants. All patient information was carefully stored in an Excel spreadsheet on an encrypted laptop. The scholarly project team leader reviewed all aspects of the scholarly project to ensure the safety of all study participants prior to implementation of the scholarly project. The scholarly project was not associated with any paid firms and or institutions and did not receive any compensation for completion of this project. Each study participant was assigned a coded number that was associated to them with generated data for confidentiality purposes.

Data Collection

Data collection consisted of various tools utilized within this scholarly project. Participants had their hemoglobin A1c drawn pre- and post-intervention during this scholarly project. Other data collection tools associated with this scholarly project consisted of: Diabetes app utilization (super user), diabetes self-care questionnaire with Likert ranking scoring (Appendix C), and a demographics questionnaire (Appendix H). Study participants' activity was tracked via google analytics for detailed app utilization (number of logins, individualized screen

time, app functions, and personalized data tracker). Each diabetic self-care questionnaire was distributed in addition to instructions within the Diabetes app. Demographic questionnaires required participants to provide age, race, annual household income, current diabetic medications, and years living with diabetes. The project team leader collected all completed questionnaires. Lab collection took place in a secured sterile environment, and samples were collected by Labcorp employees within the inhouse lab during normal chronic care appointments for enrolled participants. The project team leader collected all data utilizing the rural clinic E-clinical electronic health record system for each participant.

Tools

The implementation of this scholarly project consisted of several tools designed to improve the self-care management of T2DM in the underserved patient population. Participants were provided a 5-point Likert scale diabetes questionnaire and access for utilization of the Diabetes app. The 5-point Likert scale diabetes self-care questionnaire was distributed pre- and post-implementation of the scholarly project. Surveys evaluated each participant's progression and initial self-care management levels. The diabetes self-care questionnaire was a 10-question survey designed to evaluate self-care management techniques of patients with T2DM. Participants completed the questionnaire while in the office during their pre- and post-blood work obtained during the project time period.

The Likert scale is a proficient scale of variability used in self-reported attitudes and behaviors (Hartley & Maclean, 2006). Hartley & Maclean (2006) endorsed the Likert scale as consistently providing better response rates than traditional yes and no, either/or, and open-ended questions (Hartley & Maclean, 2006). Each question was scored 1 through 5 consisting of: 1 strongly disagree; 2 disagree; 3 neutral; 4 agree; and 5 strongly agree. Overall scores were

totaled and placed into various categories based on raw scores. Raw scores of participants were placed into the following categories utilizing a score bank sheet. Scoring of the questionnaire was ranked per the following: 46-50 great; 41-45 good; 30-40 average; 20-29 poor; and 0-19 or below bad. Appendix I presents the scale score ranking form. Scores were based on the amount of self-care management techniques each study participant had at the time of completion before and after Diabetes app usage. Literature supported patients with higher levels of self-care management techniques have better chronic care disease management. This idea served as a driving force behind this scholarly project to improve various self-care management techniques.

The following 10 items were utilized via the diabetic questionnaire utilizing the previous corresponding Likert point scale to answer each question. (a) I check my blood sugar level at home at least once a day. (b) I record my blood sugar level at least once per day. (c) I take my diabetes medication at home as prescribed by my doctor or nurse practitioner. (d) I follow the diabetic dietary recommendations given to me by my diabetic educator, physician, or nurse practitioner. (e) I choose foods to eat that makes it easy to achieve good blood sugars levels. (f) I plan my meals. (g) I use healthy diabetic recipes to prepare my meals. (h) I exercise 15 to 30 min minutes at least 3 times a week. (i) I keep all of the appointments recommended for my diabetes treatment. (j) I use a diabetic app to help educate me on diabetes and health issues associated with diabetes (see Appendix C). Hartley & Maclean (2014) reported utilization of the Likert scale consistently produced moderate to strong internal consistency, test-retest reliability, and concurrent validity. This questionnaire tool was developed for the scholarly project and clinical setting and was not validated.

The Diabetes app was the second tool utilized for this scholarly project. The mobile-based app consisted of several self-care management functions for enrolled users. Users had

access to seven main app widgets located on the Diabetes app home screen, plus an additional

information widget. App widget one consisted of a welcome video that provided patients an

overview of the scholarly project, project team leader introduction, goals during the three-month

intervention period, and a detailed screen by screen display of mobile app features and functions

shown directly by the project team leader (see Figure 1).
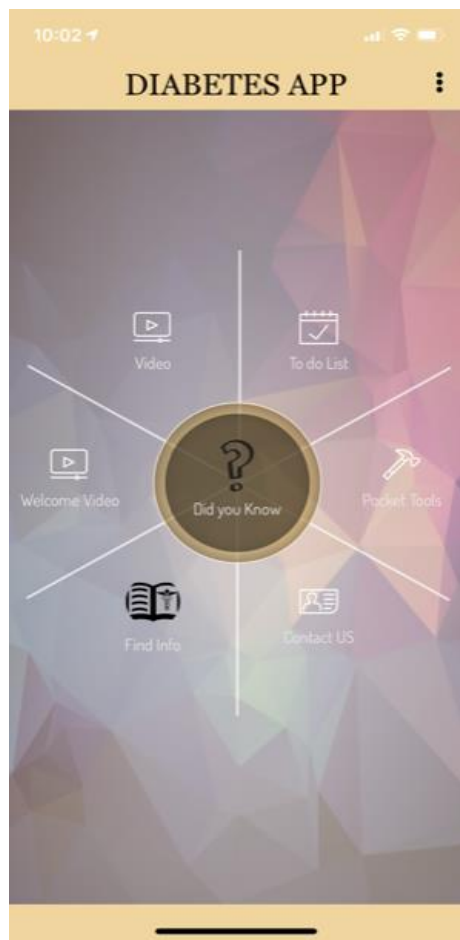
Figure 1. Welcome video and diabetes home screen.

App widget two consisted of pocket tools (daily blood sugar log, carb counter, and step

counter) within the mobile app. This widget provided patients the ability to track their blood

sugar daily and have easier access to stored information for future acute or chronic care visits for

healthcare providers. This widget also allowed patients to review blood sugar trends, manage

carbohydrate intake for convenience food tracking, and step counter to monitor daily activity

levels (see Figure 2).
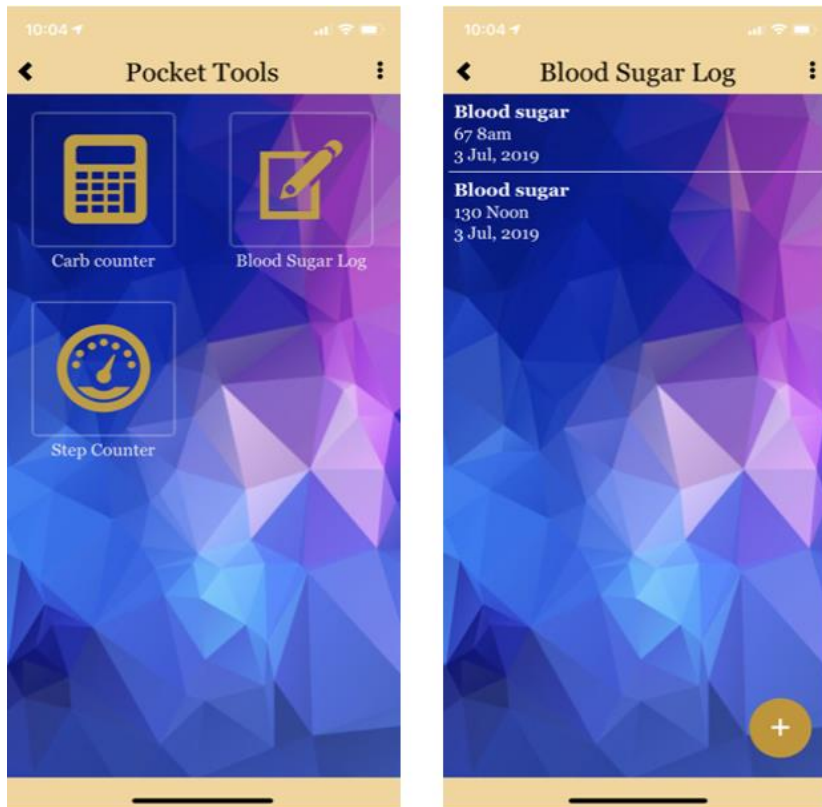
Figure 2. Pocket tools.

App widget three consisted of a structured to do list. Users were asked to complete as

many tasks on the daily to do list as possible during the three-month intervention window. The

following tasks were assigned every day during the three-month intervention window. Did you

check your blood sugar today? Did you take your diabetes medication today? Did I eat things

that help me achieve my blood sugar goals today? Did I have the opportunity to exercise today,

did I check my messages on the Diabetes app today, and did you give yourself credit for the

small things today? (making better choices when eating, exercising, taking your medication etc.)

(see Figure 3).
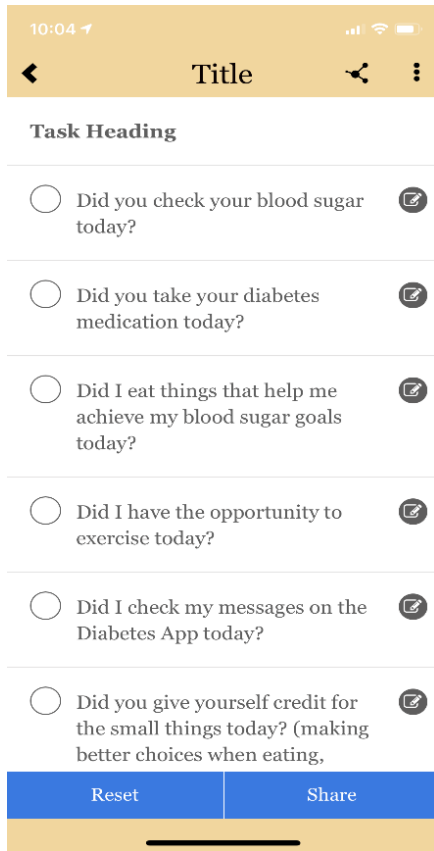
Figure 3. To do list.

App widget four consisted of various educational YouTube videos (testimonials, diabetic

education, exercise videos, and various dietary meal plans and recipes). Healthy meal options

were directly in accordance with the American Diabetes Association (ADA). Dietary options

consisted of developed meal options catered to lower socioeconomic patient population. These

items were from stores such as Walmart, ALDI, and Family Dollar. Original meal plans covered

breakfast, lunch, and dinner. At the launch of the app, 21 meals were uploaded via various video

resources. New additional recipes and snacks were added each week consisting of snacks,

breakfast, lunch, and dinner options. All meal plans created and added by the project team

leader were developed in collaboration with the diabetic educator and congruent with dietary

practice guidelines associated with the ADA (see Figure 4).
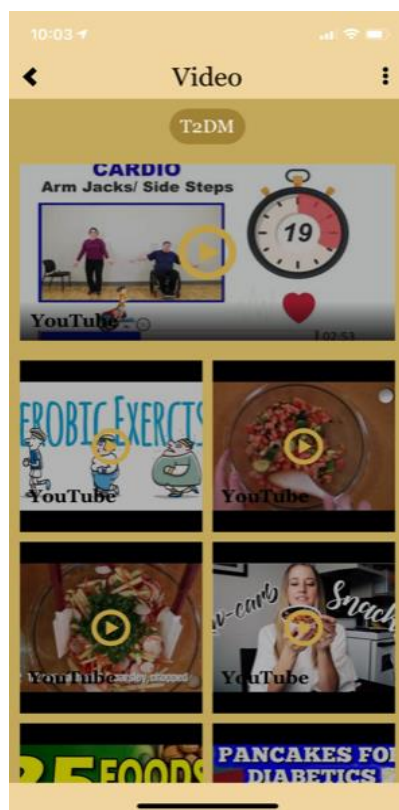
Figure 4. Videos.

App widget five, *Did You Know*, served as the main information hub associated with the

mobile app. This widget included information from the ADA on improving self-care

management techniques and frequent high-risk topics associated with T2DM. These self-care

management techniques consisted of basic T2DM information on frequently asked questions,

general medication information, exercise requirements, carbohydrate basics, medication

education, frequent problems with T2DM, a clearly defined carb counting formula for dietary

labeling, what to do on a sick day, foot care, eye care, hypoglycemia, hyperglycemia, injections,

checking blood glucose, heart disease facts, smoking impact, and weight loss (see Figure 5).
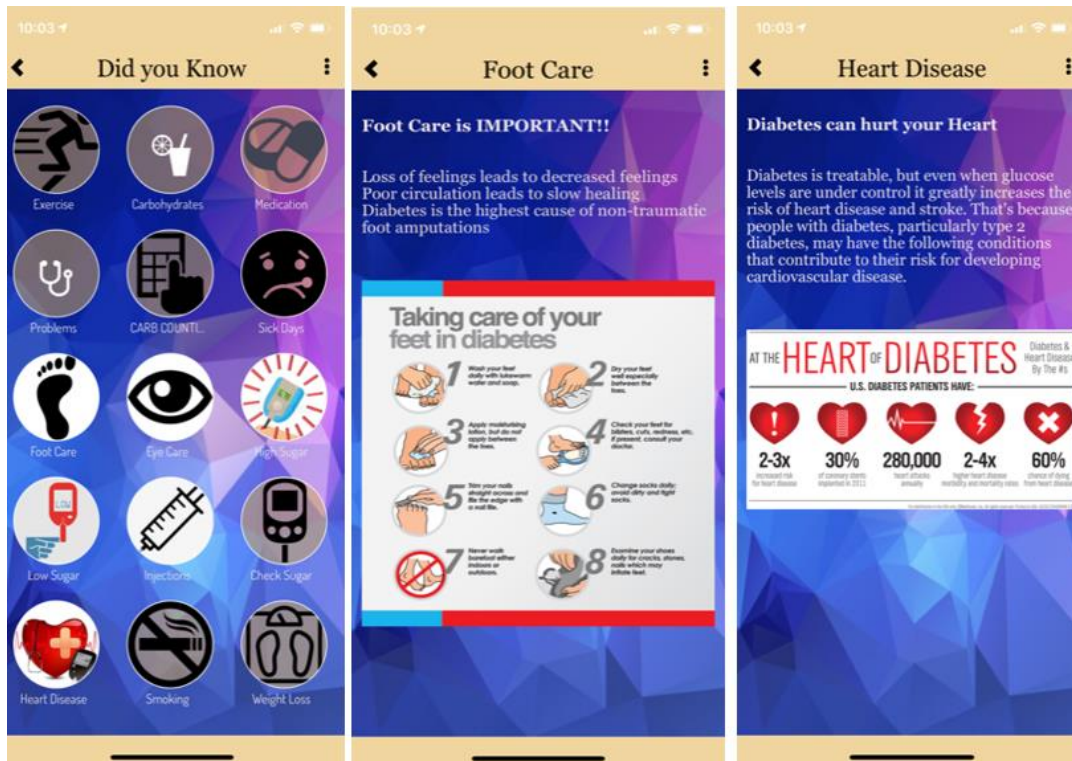
Figure 5. Did you know.

App widget six consisted of a *Contact Us* function. Users were provided the direct

ability to contact the project team leader or project team chair with any concerns or questions via

phone call, text, or email. App widget seven consisted of a *Find Info* function. This widget

provided registered users a list of all included resources and documented references for content

provided within the mobile app (see Figure 6). The goal was to encourage participants to

explore the variety of resources available to help aid in effective management of those with

T2DM. Mobile app utilization for the management of self-care management techniques is

appropriate and provides benefits, as presented in the review of literature. For easy mobile

installation, each participant, at the time of consent, received mobile app instructions for the

Diabetes app (see Appendix J).
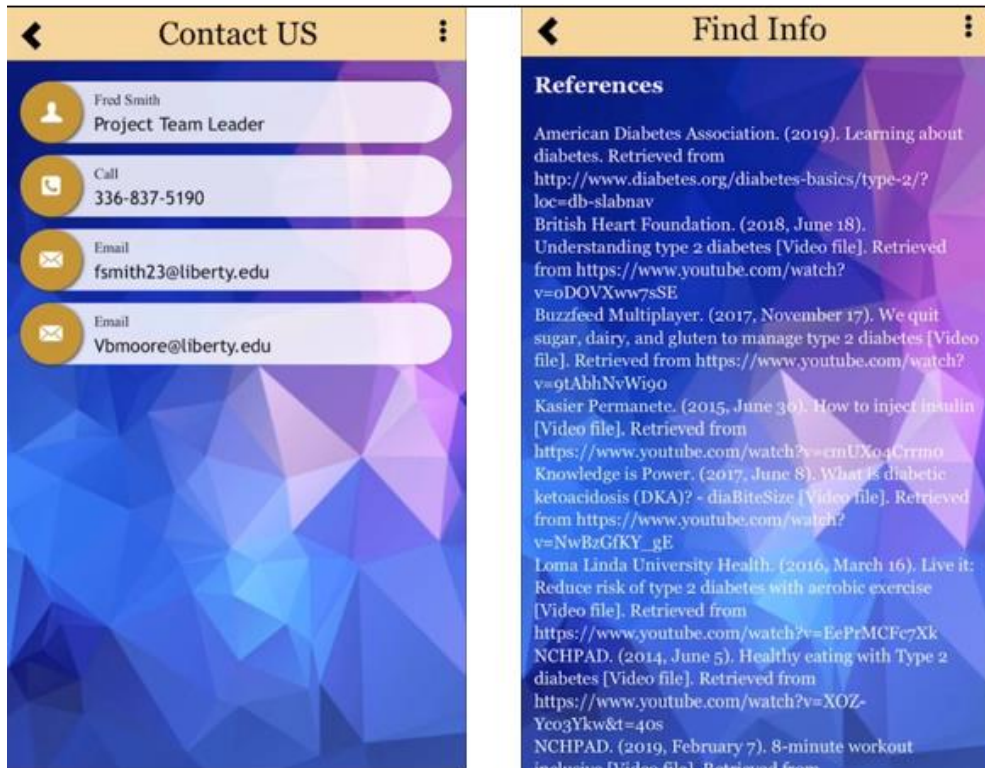
Figure 6. Contact us & find info.

Intervention

Scholarly project development started with the identification of current barriers to effective self-care management for patients with T2DM in the underserved patient population. The scholarly project team leader developed a scholarly project team to help develop an intervention to overcome barriers associated with ineffective self-care management techniques in the underserved patient population. Goals associated with the Diabetes app aimed to improve self-care management of patients with T2DM in the underserved patient population and decrease overall hemoglobin A1c. A careful literature review was conducted to construct the top app functions commonly associated with T2DM. Next, the scholarly project team leader worked closely with Appy Pie software developers to develop a customizable app geared toward

improving the self-care management of patients with T2DM based on most evidence-based

practices.

Approximately 60 participants (non-random) were screened who met inclusive criteria of

the scholarly project. Of those who met inclusive criteria, 30 were unavailable to participate in

the scholarly project or did not express interest within the required timeframe. Out of the

remaining 30 participants, nine participants dropped out the study before completion of the

study. Their various reasons included failing to turn in necessary requested questionnaires to

establish baseline data to obtain access to the mobile-based app, withdrawal after prescreening

conversation, and lack of consistent cellular service at the time. The remaining 21 participants

successfully completed all pre- and post-questionnaires, demographic forms, and utilization of

the Diabetes app during the required three-month intervention period.

The team leader of this scholarly project obtained in person consent from participants.

Nursing staff were educated about the study; however, nursing staff did not have much contact

with participants unless they came in for acute visits between their regular chronic care diabetic

visits. The team leader also placed at the nurse's station a Diabetes mobile app instructional

handout for any participants who came in for acute visits and needed additional resources or

presented with questions. A pre- and post- 10-question questionnaire utilizing the Likert scale

was administered to all 21 participants in the scholarly project. The scholarly project was

implemented over a three-month period. Participants during the three-month intervention

window received two push notifications each day to their cellphones (8 am and 6 pm) consisting

of various messages pertaining to better self-care management techniques associated with

T2DM. These messages consisted of content like the following examples. (a) Hey, let's get up

and get active today! (b) Did you check your blood sugar today? (c) Did you remember to take

your diabetic medication today? (d) Check out these newly added healthy recipes inside the

diabetes app today to help with cravings and help keep blood sugars down. (d) Come check out

the diabetes app today for new content, and various health tips to aid in effective T2DM

management. (Did you know?…etc) (see Figure 7).

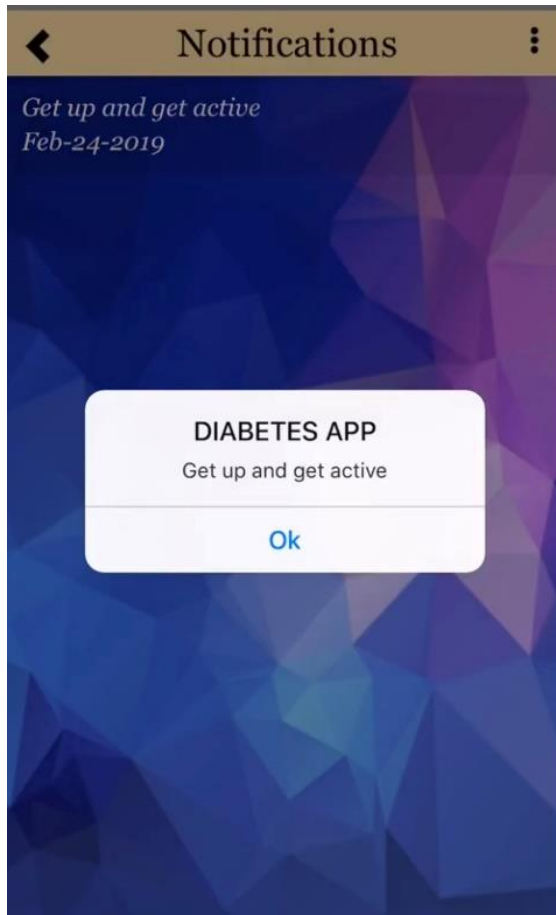*Figure 7*. Notifications.

Following the scholarly project intervention period, participants returned to the clinic to

have their hemoglobin A1c redrawn and received the same 10-question Likert scale diabetes

questionnaire after Diabetes app utilization. Dissemination was conducted after implementation

and evaluation of the scholarly project results. After an extensive meeting, the clinic leadership

team concluded there was a significant improvement in hemoglobin A1c and self-care

management techniques in patients who utilized the Diabetes app. Each participant received a

thank you letter for project participation. The scholarly project participant with the highest

correlating combined Diabetes app utilization, earliest project enrollment, and overall lowest

decreased hemoglobin A1c won the 19-inch LCD television. The winner of the 19-inch

television had an overall hemoglobin A1c decrease of 2.8%, enrolled in the project within 2

days, and had an increase in overall self-care management techniques by 34%!

Timeline

The scholarly project team leader spent 12 months on the project. This timeline included

the planning, pre-implementation, implementation, and evaluation periods of this scholarly

project. Please refer to Appendix K for a detailed table of the timeline of this scholarly project.

Feasibility Analysis

Various steps were taken by the scholarly project team leader to ensure the most cost-

effective and efficient measures were utilized while implementing the scholarly project.

Resources needed for this scholarly project included: various personnel within the clinic, various

resources and technology, and a strategic financial analysis of all mobile-based app technology.

Personnel at the clinic had a marginal role during this scholarly project. Personnel consisted of

ancillary staff and LPNs within the organization. Staff were only used to direct study patients

who may have come in for acute visits during the study period. Project resources were readily

available at the clinic for project participants during the project period and consisted of pre-made

Diabetes app booklets. The project team leader was available via email and phone for all study

participants with an anticipated 24-hours' window response rates. Most staff participation

associated with this scholarly project were utilized in a capacity that did not require

compensation from the project team leader. Any other staff within the clinic were compensated accordingly in line with their hourly rates associated with their employment within the organization.

Resources needed to draw pre- and post- hemoglobin A1c levels consisted of utilizing the Labcorp within the selected facility, E-clinical health work network system to store all patient information, and various handouts (consent, instructional guide, pre and post-survey questionnaire, demographics questionnaire). All personnel associated with Labcorp are contracted and paid by the clinic and obtained labs associated with participants during their regularly scheduled chronic care visits. A 19-inch Vizio television was purchased for $45.00. The Diabetic app start-up costs required a one-time fee of $10.00, with a monthly access fee of $15.00 per month. Feasibility of the scholarly project was extremely reasonable compared to incurred costs of patients who have persistent uncontrolled T2DM and associated hospital admissions and other associated health complications. Overall resources and ancillary staff involvement associated with the utilization of the Diabetes app were previously assigned job functions within the rural clinic. Financial analysis revealed total incurred costs associated with this scholarly project at $95.00. This is a marginal price compared to the billions of dollars spent each year in our healthcare system.

Data Analysis

Data analysis consisted of utilizing SPSS software to analyze established measurable outcomes for the scholarly project. SPSS software was utilized to identify correlations and relationships between Diabetes app utilization and the direct impact on self-care management techniques and hemoglobin A1c. Correlations were generated in the form of participants' overall hemoglobin average means, standard deviations, maximum, minimum, overall percentages,

paired t-test, *p*-values, and Pearson correlation values to help evaluate and establish the level of

significance for the scholarly project. User activity was recorded during the three-month

intervention period and tracked utilizing google analytics. Google analytics provided both real-

time data and overall time of users' day to day mobile app usage. Generated data consisted of

providing response times to push notifications, widget usage, and the amount of screen time per

user utilizing the app. This information was generated and projected in reports via bar graphs,

actual minutes, and percentages for each individual number of clicks per widget for each end

user participating in the scholarly project. The pre-and post-survey information was analyzed

using SPSS software to determine differences in patient's self-care management after the three-

month intervention. Data was formulated and integrated to identify trends and success for the

evidence-based practice scholarly project.

SECTION FOUR: RESULTS

Out of 60 participants recruited 30 turned in all the required forms for participation in the scholarly project. Of those, 21 participants successfully completed the demographics questionnaire (Appendix H) and self-care management questionnaire (Appendix C) pre- and post-Diabetes app utilization during the intervention period, and had required blood work drawn for hemoglobin A1c evaluation before and after Diabetes app utilization. Nine participants dropped out of the scholarly project, because they failed to complete pre- and post-study bloodwork for hemoglobin A1c evaluation, voluntary withdrawal, or were unable to complete the self-care management questionnaires required for baseline data collection before or after the study period window.

Utilization of mobile-based technology for this scholarly project demonstrated significant results in both improving the self-care management and decreasing hemoglobin A1c of study participants in a rural underserved patient population. Demographics of the scholarly project group reflected a yearly mean income of 17,986 dollars. N = 21 had a mean age of 43 years old, (min = 19, max = 70). The mean age of participants since diabetic diagnosis was 11 years (min = 1, max = 30). Participants in this scholarly project presented with the following education levels: some college 14.2%, high school or diploma equivalent 42.9%, and did not finish high school 42.9%. See Table 1 for characteristics and Table 2 for education and ethnicities of participants.

Table 1

Characteristics

Items	Means	SD	Min/Max	N
Age	45.19	15.33	19/70	21
Years with Diabetes	11.28	6.73	1/30	21
Yearly Income	18,399	8318.69	1000/37,000	21
Number of Diabetic Medications	1.95	1.02	0/4	21

Notes: SD= Standard Deviation, N=number of participants

Table 2

Education and Ethnicity

Education	Frequency	Percent	N
Some College	3	14.3	21
High School or Diploma Equivalent	9	38.1	21
Did not complete high school	9	47.6	21
Graduate Degree	0	0	21
Ethnicity			
Caucasian	9	42.9	21
African American or Black	8	38.1	21
Hispanic or Latino	4	19	21
Other	0	0	21
Sex			
Male	5	23.8	21
Female	16	76.2	21

Notes: All applicants had the option to leave any information undisclosed

Higher education of participants was associated with a lower incidence of uncontrolled chronic disease management historically in various models aimed to improve the hemoglobin A1c values. Participants reflected lower hemoglobin A1c control congruent with lower educational levels associated with not completing high school versus high school diploma and completing some college (see Table 3). In this project, N = 21 with gender represented as 28.2% male and 76.2% female. Approximately 42.9% of participants did not complete high school, 42.9% completed high school or high school equivalent, and 14.2% of participants completed some college. Data revealed lower educational levels were associated with less effective chronic care disease management evidenced by less hemoglobin A1c management. Poor hemoglobin A1c management is directly associated with increased health risk factors and increased mortality associated with prolonged uncontrolled management of T2DM.

Table 3

Educational Level Group and Average Hemoglobin A1c

Items	Mean A1c	N
Some College	7.9	21
High School Diploma or Equivalent	8.24	21
Did Not Complete High School	9.3	21

Descriptive Statistics

Overall utilization of the Diabetes app during the three-month intervention window demonstrated an improvement in overall hemoglobin A1c and self-care management techniques. Futhermore, evidence demonstrated a direct improvement in self-care management techniques based on *average, good*, and *great* overall ratings on initial self-care management techniques

increased to 14.3% from 12.6% (+1.7%) after Diabetes app utilization. Participants who scored

poor and *bad* based on the Likert ranking score questionnaire had an initial mean of 30.9%

down to 9.52% (-21.38%) for self-care management techniques in the previously mentioned

categories after Diabetes app utilization. Users also demonstrated an overall mean decrease of

2.34% hemoglobin A1c and overall decreased minimum and maximum hemoglobin A1c values

of (min = -1, max = -3.3) with app utilization.

Measurable Outcome 1.

Goal 1: After completion of the three-month Diabetes app intervention, patients would

demonstrate a decrease in their Hemoglobin A1c, evidenced by blood work drawn pre- and post-

app utilization during the designated three-month intervention window. Participants presented a

significant hemoglobin A1c drop after utilization of the Diabetes app during the three-month

intervention window with an overall hemoglobin A1c mean decrease from prior to utilization of

the Diabetes app by 2.34% during the overall total three months' evaluation (see Table 4).

Table 4

Pre- and Post-Diabetes App Utilization

Items	Mean A1c%	SD	P-value	Min/Max	N
Pre-Diabetes App Hemoglobin A1c	9.65	1.04	.004	7.20/11.90	21
Post-Diabetes App Hemoglobin A1c	7.31	.600	.004	6.20/8.60	21

Notes: Mean A1c = Hemoglobin A1c, SD = Standard Deviation, Min/Max = Minimum

Hemoglobin A1c, Max Hemoglobin A1c, N = Sample Participant size

Measurable Outcome 2.

Goal 2: After completion of the three-month intervention of the diabetes app, patients would demonstrate an increase in self-care management behaviors associated with their T2DM. The accomplishment of this goal was demonstrated by an increase in the overall average Likert ranking scores based on the Diabetes self-care questionnaire compared to the pre- and post-Diabetes app utilization (see Table 5) for Likert ranking scores.

Table 5

Pre- Intervention Likert Ranking Scores with Correlating Hemoglobin A1c

Items	Mean Hemoglobin A1c	Number of participants in category	Percent of select categories	P-Values	Difference	N
46-50 Great	0	0	0	.015	0	21
41-45 Good	7.12	2	9.5	.012	0	21
30-40 Average	8.13	6	28.5	.016	0	21
20-29 Poor	9.15	7	33.3	.017	0	21
0-19 Bad	10.75	6	28.5	.018	0	21

Post Diabetes App- Intervention Likert Ranking Scores with Correlating Hemoglobin A1c

Items	Mean Hemoglobin A1c	Number of participants in category	Percent of select categories	P-Values	Difference	N
46-50 Great	6.25	2	9.52	.006	+9.52%	21
41-45 Good	6.8	4	19.04	.004	+9.54%	21
30-40 Average	7.58	11	52.38	.004	+23.88%	21
20-29 Poor	8.45	3	14.28	.003	-19.02%	21
0-19 Bad	8.60	1	4.76	.002	-23.74%	21

Notes: N=Number of participants, Difference= Pre and Post Diabetes app utilization

Utilization of the Diabetes app demonstrated a positive correlation between app usage utilization and improved self-care management. Users in the *poor* and *bad* categories demonstrated a significant overall improvement. All users had their activity tracked via google analytics. Google analytics provided generated data associated with everyone's app usage. Usage was provided on each user's daily app screen time, response time to push notifications, most used app functions, and top widget selections. Participants with the highest amount of screen time and Diabetes app interaction had a higher decrease in overall hemoglobin A1c during the three-month intervention window (see Table 6).

Table 6

Google Analytics and Corresponding Average Hemoglobin A1c

Daily Usage	Percent of Users	Mean Hemoglobin A1c decrease	N
3.5 or more hours per week with at least 14 widget functions per week	(8) 38.09%	1.1 %	21
2 to 3.4 hours per week with at least 10 widget functions per week	(6) 28.57%	.92 %	21
1 to 3.3 hours per week with at least 5 widget functions per week	(4) 19.04%	.68 %	21
0.5-3.1 hours per week with at least 2 widget functions per week	(3) 14.28%	.54%	21

Notes: N = Sample size of participants Items: All participants were rounded in the closest group when placing into categories for weekly measurements.

SECTION FIVE: DISCUSSION

Implications for Practice

We have a rapidly evolving healthcare system with progressively more complex disease processes than ever before. Healthcare must find innovative methods to optimize patient outcomes with T2DM. Thus far, healthcare is losing the battle to effective T2DM management at the exponential rate of billions of dollars each year. In a technological era, utilization of the Diabetes app provided evidence that endorse further innovative ways to challenge barriers associated with ineffective self-care management of patients with T2DM in the underserved patient population. This scholarly project demonstrated mobile-based technology needs to be incorporated into clinical practice guidelines associated with management of T2DM.

Updated clinical guidelines incorporating the utilization of mobile-based technology will optimize the delivery of healthcare management for patients in the underserved patient population. Mobile-based technology will serve to help patients achieve their target glycemic goals and reduce mortality and morbidity. Additionally, incorporation of mobile-based technology into clinical practice guidelines will directly improve access to healthcare for those in underserved patient populations, offer creative ways to help engage patients to manage their T2DM, and expand the ability of diabetic educators and providers to reach patients and increase overall engagement.

Highest functionality associated with the Diabetes app gave healthcare providers clear defined advantages over traditional diabetic educational methods and self-learning alone. Streamlining real-time blood sugars promotes the ability for healthcare providers to make faster recognition of patients' glycemic control levels and aid in proper adjustments to help reduce prolonged hypo or hyperglycemic events leading to uncontrolled hemoglobin A1c levels

between three, six, and even 12-month intervals of chronic care visits. Videos within the

Diabetes app provided users additional educational resources for later recall outside of traditional

15 to 20-minute chronic care visits and 30 to 60-minute diabetic education class sessions. Video

media within the Diabetes app also provided users an innovate advantage for positive

reinforcement and quick access to recall critical self-care management techniques by personal

testimonials, exercise videos, and dietary meals to help facilitate better lifestyle choices.

      Another great function of the Diabetes app was the use of self-care management icons

with a variety of information about T2DM and daily to-do list. Diabetes is one of the largest

healthcare disparities within the United States with rapidly increasing costs, changes with

medication administration, and continual rapid evolvement of oral glycemic agents and insulin

medications advancements each year. The heartbeat of effective T2DM is self-care management

techniques. If creative ways to improve self-care management techniques are not incorporated

into clinical guidelines, ineffective management of T2DM will always serve as a tremendous

challenge and burden within the healthcare system. This scholarly project had no conflict of

interest identified during the administration. Additionally, no biases were associated with the

implementation of this study.

Limitations

      This scholarly project was conducted for the sole purpose of improving the self-care

management and decreasing the hemoglobin A1c of those with T2DM in the underserved patient

population. Project limitations associated with this scholarly project included a limited

timeframe to implement this study for the scholarly project team leader. Time limitations

directly influenced the available number of participants recruited for the scholarly project.

Furthermore, the inability to attract Hispanic patients served as a limitation due to a language

barrier, and those with limited phone access or non-smartphone app capabilities.

Sustainability

Sustainability is one of the most challenging considerations when developing changes in

how future healthcare is delivered. The project site, as a rural low-income clinic, is designated

as a Federally Qualified Healthcare Center (FQHC). The clinic can challenge the longevity of

imposed practice guidelines with limitations on resources such as finances, staffing, and

challenging patient populations. Adherence of healthcare providers to newly introduced mobile-

based technology is another important aspect to consider when implementing changes in clinical

practice guidelines. The rural health clinic must consider how to keep patients engaged with

newly introduced mobile-based technology. Resources should be considered and immediate,

short term, and long-term goals established. Additionally, the clinic must consider the

incorporation of the Diabetes app into current existing clinical practice guidelines for T2DM

management, the finances required to sustain mobile-based technology efforts, and the driving

force needed to continue developing the Diabetes app congruent with T2DM overall national

guideline changes. Long-term goals must include materials; staff for developing, implementing,

and continuing new guideline procedures; materials for participants; and staff and healthcare

provider education.

Healthcare staff adoption is another critical aspect in the success of this newly suggested

clinical guideline. Professional adherence is known to decrease as much as by 50% in relation to

personal bias, lack of understanding, and perceived quality of the guideline (Amet et al., 2015).

Therefore, strong efforts must be taken to ensure all healthcare providers are provided adequate education to effectively utilize the Diabetes app as a new clinical guideline for T2DM management. Maintaining the immediate, short-term, and long-term goals rather than focusing on short-term actions and short-term effect have been demonstrated from various research to improve clinical guideline changes as much as 35% (Amet et al., 2015).

How can mobile-based technology like the Diabetes app become a daily part of participants' lives each day with T2DM? The most popular mobile-based technology around offers user convenience and efficiency, provides a large spectrum of capabilities with reliability, and is generally user friendly. Dependability is important for the Diabetes app in order to meet several of the previously mentioned user preferences to sustain participant engagement with a mobile-based app to aid with their chronic disease management.

Utilizing the diabetic educator and healthcare providers' input from users is very sustainable within the organization. The rural health clinic diabetic educator is a full-time staff member with a great vantage point to identify needs and barriers that struggling patients with T2DM face each day. Two forms of feedback will be generated through diabetic education sessions and traditional chronic care visits conducted by healthcare providers. Longevity of this scholarly project solely lies on the efforts and collaboration between the diabetic educator and healthcare providers. Upkeep of the mobile-based technology is easy with advanced Software developers like Appy Pie. The complexity and variations associated with the development of mobile apps is simplified for input users to easily update and add new content. The same effort required to upkeep and maintain standard guidelines for T2DM within the clinic can be applied to updating the Diabetes app. However, these efforts serve to be a much more innovative way to reach more patients effectively than traditional methods. Prioritizing methods with a constant

evolving healthcare system should make efforts easier towards implementing methods that encourage patients to become more a part of their chronic disease management.

Dissemination Plan

Evidence demonstrated by this scholarly project endorses the utilization of mobile-based technology (Diabetes app), which effectively helped manage T2DM patients in the underserved patient population. The scholarly project achieved two measurable outcomes over the three-month intervention window after Diabetes app utilization. First, the Diabetes app demonstrated a decrease in overall end users' hemoglobin A1c, directly related to daily app usage. Second, the Diabetes app directly improved the self-care management of T2DM in the underserved patient population. Evidence supported a positive correlation with increased app usage and higher self-care management scores after baseline and during the intervention window.

The scholarly project was developed for multiple applications in a variety of clinical and non-clinical settings. The primary targeted audience for this scholarly project were those in the underserved patient population. Beyond the target audience group the development behind the Diabetes app served a much bigger purpose to help fight the seventh leading cause of death in the United States. The Diabetes app was developed to be an innovative tool that could be used by underserved patients, healthcare providers, healthcare centers, educators, and family and friends. Partners associated with the Diabetes app consisted of a variety of sources in the community.

The project study site receives federally funding from Health Resource Service Administration (HRSA). HRSA has gone through extra lengths to improve the overall standards of T2DM management across all FQHC receiving federally qualified funding as of 2018. Most recent operational site visits require FQHC to establish a diabetic performance analysis goal over

a year, with quarterly progress reports aimed towards improving patients' hemoglobin A1c levels greater than nine throughout all health centers. The Diabetes app and utilization of mobile-based technology will be shared as a part of various clinic initiatives to help obtain better controlled hemoglobin A1c values. Information will be utilized and placed on the universal FQHC website to serve as a resource for other FQHC to utilize within their organizations. Furthermore, the scholarly project team leader started several initiatives to disseminate the results beyond traditional scholarly project publication. The team leader has started progressive efforts towards developing a manuscript to meet submission requirements to the Diabetes Care scholarly publication. The project team leader has also taken efforts to produce the data and research on various chronic care disease blogs, social media (Facebook), and ADA's *In It Together* blog.

All submission research will be written to meet requirements of the submitting platform requirements to match the reader audience. The Diabetes Care will follow requirements required for scholarly publications, specifically providing a breakdown of the scholarly project in a structured and formal methodical manner with associated medical terminology. However, social media (Facebook) and ADA *In It Together* will be more informal presentations with the intent to provide a more personable approach to utilization of the Diabetes app for those with T2DM. Like the origin and development of this mobile app, the goal was to endorse a user-friendly platform app to encourage patients to manage their T2DM. This scholarly project team leader had several opportunities to evaluate the effectiveness of this dissemination plan through various sources. The HRSA website is an area for FQHC to provide posted feedback on similar protocols, policies, and new clinical guidelines. Facebook and the ADA blog will provide real-time responses from members to provide and engage users with new available resources. The start of this dissemination plan relied on effective implementation within the clinic to

demonstrate the Diabetes app as an effective tool compared to traditional diabetic educational methods.

Conclusion

We have a rapidly evolving healthcare system with progressively more complex disease processes than ever before. Healthcare must find innovative methods to optimize patient outcomes with T2DM in the underserved patient population. Thus far, healthcare is losing the battle to effective T2DM management at the exponential rate of billions of dollars each year. In a technological era, utilization of the Diabetes app provided substantial evidence that endorsed further innovative ways to challenge barriers associated with ineffective self-care management of patients with T2DM in the underserved patient population.

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Appendices

Appendix A

Evidence Table

Article Reference.	Study Purpose	Sample (Characteristics of the Sample: Demographics, etc.)	Methods	Study Results	Level of Evidence (Use Melnyk Framework)	Study Limitations	Would Use as Evidence to Support a Change? (Yes or No) Provide Rationale.
Alexander, M., Christopher, B., Shatz, M., Schick, T., Neauman, T., Kribbs, A., ... Stefan, B. (2016). A mobile application improves therapy-adherence rates in elderly patients undergoing rehabilitation: A crossover design study comparing documentation via iPad with paper-based control. *Medicine*, *95*(36), 4446. doi:10.1097/MD.0000000000004446	This study focused on whether mobile application could support therapy management for patients with chronic conditions and improve therapy adherence (Alexander et al., 2016).	N= 24 patient study.	Non-randomization trial.	The mobile app for medication adherence increased objectively and subjectively medicine adherence (Alexander et al., 2016).	Level III: Quasi Experimental	Medication intake needed to be confirmed via iPad. Adherence was reported from patients does not confirm adhering to medication regimen, and short length of study (Alexander et al., 2016).	Yes, this data is supportive of mobile technology increasing medication adherence.

Arnold, M., Solz, D., Quade, M., & Kirch, W. (2014). Mobile applications for diabetics: A systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. *JMIR Publications*, *16*(4), 104. doi:10.2196/jmir.2968	Examined whether the available applications serve the special needs of diabetes patients aged 50 or older by performing an expert-based usability evaluation (Arnold et al., 2014).	N=656 free apps N= 379 paid apps	Performed app review based on the information given in the Google Play Store, the Apple App Store, and the apps themselves. In addition, we carried out an expert-based usability evaluation based on a representative 10% sample of diabetes apps (Arnold et al., 2014).	With patient and physician input during the development of mobile apps for T2DM. Mobile apps can be a useful tool to assist in the management of T2DM.	Level I: Systematic Review	The systematic review was only on iOS and android platforms. Limiting the general number of available apps to research (Blackberry, google, Windows phone etc.) (Arnold et al., 2014).	Yes. Patients and physicians alike should be involved in the app development process to a greater extent. User performance of individuals aged 50 or higher was moderate to good (Arnold et al., 2014).
Boyle, L., Grainger, R., Hall, R., & Krebs, J. (2017). Use of and beliefs about mobile phone apps for diabetes self-management: Surveys of people in a hospital diabetes clinic and diabetes health professionals in New Zealand. *JMIR mHealth uHealth*, *5*(6), 85. doi:10.2196/mhealth.7263	The purpose of this study was to see if the usage of apps in New Zealand for DM self-management and evaluate desirable features of apps. Also, to evaluate providers recommending app usage (Boyle, Grainger, Hall, & Krebs, 2017)	12 months (N=539) assessed current app use and desirable features. A second survey of HPs attending a diabetes conference (n=286) assessed their confidence with app recommendations and perceived usefulness.	This cross-sectional study observational study	The most favored app functions were recorded blood glucose. It recommends further developing assessment process to give confidence in the quality and safety of diabetes apps (Boyle et al., 2017).	Level V: Observational Study	A large patient size was utilized, risk of over presentation by poor literate responders. Lack of access to keep up with app consistently.	A large patient size was utilized, risk of over presentation by poor literate responders. Lack of access to keep up with app consistently.
Cafazzo, J., Cassleman, M., Hamming, N., Katzman, D., & Palmert, M. (2012). Design of an mHealth app for the self-management of adolescent type 1 diabetes: A pilot study.	To design, develop, and pilot an mHealth intervention for the management of type 1 diabetes in adolescents	A pilot group of 20 adolescents aged 12-16 years, with a glycated hemoglobin (HbA(1c)) of between 8% and	Non-randomized control trial	This mHealth diabetes app with the use of gamification incentives showed an improvement in the frequency of	Level III: Quasi Experimental	Limitations of this study are based on each user's ability to effectively navigate the mobile app. Limited access to	Yes, this study demonstrates that that the utilization of a mobile app improves the overall health outcome of patients with DM.

JMIR, *14*(3), 70. doi:10.8898/10-93284	(Cafazzo, Cassleman, Hamming, Katzman, & Palmert, 2012).	10% was sampled.		blood glucose monitoring in adolescents with type 1 diabetes (Cafazzo et al., 2012).		smartphone, and small group sample (Cafazzo et al., 2012).	
Chavez, S., Fedele, D., Guo, Y., Bernier, A., Smith, M., Warnick, J., & Modave, F. (2017). Mobile apps for the management of diabetes. *Diabetes Care*, *40*(10), 145-146. doi:10.2337/dc17-0853	The purpose of this study was to assess whether popular apps for diabetes management enough quality to complement clinical care (Chavez et al., 2017).	A total of 120 apps. Before download, we eliminated duplicate apps (n = 11), apps in Spanish (n = 3), prank apps (n = 2), and a pet diabetes app (n = 1). 89 remained after for usage (Chavez et al., 2017).	A meta-analysis (systematic review)	This study suggested that additional work is needed to assess the clinical significance of apps for diabetes self-management, and that app developers should work closely with health care providers and patients when building such m Health tools (Chavez et al., 2017).	Level I: Systematic Review	This study only included free apps. In addition, the study did not account for behavior or health outcomes	Yes, this study provided a view at a great standardized tool to support the utilization of mobile app technology incorporated with diabetes management.
Desveaux, L., Shaw, J., Saragosa, M., Soobiah, C., Marani, H., Hensel, J., . . . Jeffs, L. (2018). A mobile app to improve self-management of individuals with type 2 diabetes: Qualitative realist evaluation. *Journal of Medical Internet Research*, *20*(3), 81. doi:10.2196/jmir.8712	The purpose of this study was aimed to evaluate a web-based solution for improving self-management of diabetes type two (Desveaux et al., 2018).	N=26 interviews (14 baseline and 12 follow-up) 16 participants had T2DM	Randomized wait control group	Self-efficacy, competing priorities, previous behavior, and beliefs about web solutions influence utilization of web activity. Web solutions could tailor to improve diabetes management with suboptimal management (Desveaux et al., 2018).	Level II: Experimental Design	Participation in this study was voluntary, which could result in selection bias. Limited ability of transferring data applicable to larger population with small study size (Desveaux et al., 2018).	Yes, this study utilizes enough data to support the potential for mobile app influence on DM management. Sample size significant enough to provide insight for future study.

Garg, S., Shah, V., Aturk, H., Benson, C., & Benergeon, J. (2017). Role of mobile technology to improve diabetes care in adults with type 1 diabetes: The remote-tid study iBGStar in type 1 diabetes management. *Diabetes Therapy, 8*(4), 811-819. doi:10.1007/s13300-017-0272-5	To further evaluate the effectiveness of mobile technology in relation to patient related outcomes (Garg, Shah, Aturk, Benson, & Benergeon, 2017)	N=100 N=50 iBGstar app N= control group	Randomized trial	The mobile app ibgstar app had the same amount of hemoglobin A1c decrease at three months. However, at 6 months the iBGstar had an increased decrease in hemoglobin A1c (Garg et al., 2017).	Level II: Experimental design	Short term only limited to six months. Only conducted within one facility and could not be used for generalization of results (Garg et al., 2017).	Yes, this data was strongly supported.
Goh, G., Tan, N., Chaun, M., & Uma, B. (2015). Short-term trajectories of use of a caloric-monitoring mobile phone app among patients with type 2 diabetes mellitus in a primary care setting. *JMIR Publications*, *17*(2), 33. doi:10.2196/jmir.3938	The objective of this study is to identify and describe short-term (8-week) trajectories of use of the iDAT app among patients with type 2 diabetes mellitus in a primary care setting in Singapore and identify patient characteristics associated with each trajectory (Goh, Tan, Chaun, & Uma, 2015).	A total of 84 patients with type 2 diabetes mellitus from a public primary care clinic in Singapore who had not previously used the iDAT app were enrolled	Non-randomized control study	This study provides insight into the nature and extent of usage of a caloric-monitoring app among patients with type 2 diabetes and managed in primary care. This study provided a vital framework for future mobile app management of DM (Goh et al., 2015).	Level III: Quasi Experimental	Smaller sample, with limited length of study time. Results limited to one facility, reduces generalization to the general population.	Yes, this study provides sound support for the utilization of mobile app technology in the management of patients diagnosed with DM. It offers a great tool to help patients with self-care management.
Goyal, S., Morita, P., Lewis, G., Yu, C., Seto, E., & Cafazzo, J. (2016). The systematic design of a behavioral mobile health application for the self-management of type 2 diabetes. *Canadian Journal of Diabetes,*	The present study asked if the addition of a tailored mobile coaching (TMC) system to current primary care for diabetes management resulted in better	Maintenance (I-M) group (n = 74) and Control-Intervention (C-I) group (n = 74).	Randomized, controlled, open-label trial, conducted from October 2014 to December 2015 in Kangbuk Samsung Hospital, Seoul, Korea, and	In this study, we evaluated the effect of TMC in diabetes care when added to the usual current diabetes management and investigated whether this	Level II: Experimental design	Medication compliance could not be confirmed. User comprehension of the TMC system was not considered.	Yes, strong data was presented in this well-controlled study for better glycemic control via mobile technology.

40(1), 95-104. doi:10.1016/j.jcjd.2015.06.007	glycemic control and other diabetes-related outcomes in adult patients with type 2 diabetes compared to standard diabetes management (Goyal et al., 2016).		consisted of 2 phases	effect was repeatable in other participants and maintained without active intervention. After 6 months, HbA1c levels were significantly decreased by 0.6%. This improvement was reproduced in the other group of participants and remained after removal of individualized message feedback (Goyal et al., 2016).			
Holmen, H. (2017). *Mobile health for diabetes self-management* (Unpublished doctoral dissertation). University of Oslo, Norway. Retrieved from https://www.duo.uio.no/bitstream/handle/10852/59412/PhD-Holmen-DUO.pdf?sequence=1	The present study asked if the addition of a tailored mobile coaching (TMC) system to current primary care for diabetes management resulted in better glycemic control and other diabetes-related outcomes in adult patients with type 2 diabetes compared to standard diabetes management (Holmen, 2017).	Maintenance (I-M) group (n = 74) and Control-Intervention (C-I) group (n = 74).	Randomized, controlled, open-label trial, conducted from October 2014 to December 2015 in Kangbuk Samsung Hospital, Seoul, Korea, and consisted of 2 phases (Holmen, 2017).	In this study, we evaluated the effect of TMC in diabetes care when added to the usual current diabetes management and investigated whether this effect was repeatable in other participants and maintained without active intervention. After 6 months, HbA1c levels were significantly decreased by 0.6%. This	Level II: Experimental Design	Medication compliance could not be confirmed. User comprehension of the TMC system was not considered.	Yes, strong data was presented in this well-controlled study for better glycemic control via mobile technology.

				improvement was reproduced in the other group of participants and remained after removal of individualized message feedback (Holmen, 2017).			
Irvine, B., Russell, H., Manocchia, M., Mino, D., Glassen, T. C., Morgan, R., . . . Ary, D. V. (2015). Mobile-web app to self-manage low back pain: Randomized controlled trial. *JMIR*, *17*(1), 1-10. doi:10.2196/jmir.3130	This study evaluated the efficacy of a mobile-Web intervention called "FitBack" to help users implement self-tailored strategies to manage and prevent NLBP occurrence (Irvine et al., 2015).	597 adults were recruited, screened, consented, and assessed online at baseline, at 2 months (T2), and at 4 months (T3).	NRCT	This research demonstrated that a theoretically based stand-alone mobile-Web intervention that tailors content to users preferences and interests can be an effective tool in self-management of low back pain (Irvine et al., 2015)	Level III: Quasi Experimental	User knowledge of technology (web application and app).	Yes, data supported from this study indicates several indications for various chronic illness.
Jo, I., Yoo, S., Lee, D., Park, C., & Kim, E. (2017). Diabetes management via a mobile application: A case report. *Clinical Nutrition Research*, *6*(1), 61-67. doi:10.7762/cnr.2017.6.1.61	The Healthy-note app was designed to enable patients to record and monitor self-management activities (SMBG, diet, exercise, and medication), providing the patient with a self-learning function (Jo, Yoo, Lee, Park, & Kim, 2017).	Two case study patients utilizing healthy note app.	Cohort Study	Mixed results. Patient one who was actively engaged in mobile app had a decrease in Hemoglobin A1c (Jo et al., 2017).	Level IV evidence: Cohort design	Small sample population Hard to generalize results with small sample.	No, limited data supportive to efficiently support the data provided by the two participants. However, this does spark the need for further research if results can be demonstrated again.

Lithgow, K., Edwards, A., & Rabi, D. (2017). Smartphone app Use for diabetes management: Evaluating patient perspectives. *JMIR Diabetes*, 2(1), 2. doi:10.2196/diabetes.6643	The purpose of the study was to gain insight into patient experiences related to the usage of smartphone usage for diabetes management (Lithgow, Edwards, & Rabi, 2017).	N=12 questionnaire survey of app usage diagnosed with T1DM. 7 men and 5 women.	Non-randomized, purposive sampling strategy.	Participants displayed the interest in having more apps with more features to help manage their diabetes. Current app technology must be geared towards catering to patient's needs (Lithgow et al., 2017).	Level III: Quasi experimental	Lack of generality and cannot be applied to larger population (Lithgow et al., 2017).	Yes, this study shows patients want more technological apps geared towards supporting self-management.
Mallow, J. A., Theeke, L. A., Barnes, E. R., Whetsel, T., & Mallow, B. K. (2014). Using mHealth tools to improve rural diabetes care guided by the chronic care model. *Online Journal Rural Health Care Nursing*, *14*(1), 43-65. doi:10.14574/ojrnhc.v14i1.27	The purpose of this study mHealth mobile technology be used effectively as an intervention improve chronic disease management (Mallow, Theeke, Barnes, Whetsel, & Mallow, 2014).	N= 23 articles that meet inclusive criteria.

256 articles screened | Systematic Review | Mobile app utilization in the underserved patient population can improve patient outcomes drastically. A recommendation to incorporate further mobile technology in the healthcare model is recommended (Mallow et al., 2014). | Level I: Systematic Review | Limitations of this study consist of studying mobile apps with only providers who endorse outside traditional care. It was hard to make generalization for effectiveness if the provider did not support app utilization. | Yes, this study supports the mobile technology as the future in healthcare. The results endorse cost effectiveness, improving healthcare access, and overall improving patient outcomes. |
| Schmocker, K. S., Zwahlen, F. S., & Denecke, K. (2018). Mobile app for simplifying life with diabetes: Technical description and usability study of GlucoMan. *JMIR Publications*, *3*(1), e6. doi:10.2196/diabetes.8160 | Develop a mobile app that provides secure collection data and stores vital diabetic information such as (blood sugars, hemoglobin A1c) with provider access to patient information. | N- 6 app users

2= T2DM
4= Non-T2DM | Non-randomized control trail | Data collection for patients with T2DM can be supported via the utilization of mobile apps. These mobile apps provide patients the ability to monitor relevant parameters set by their providers. | Level III: Quasi Experiment | Limitations of this study consist of limited study participants. Hard to apply study results for larger population. | Yes, despite limitations of this study, still supported that data can be safely streamed securely to providers via mobile apps. Providing a great tool for providers and convenience for app users. |
| Schreier, G., Eckman, H., Hayn, D., Kriener, K., Kastner, P., & Lovell, N. | The purpose of this study was to see if the mobile | N=403 patients enrolled in the program | Non-randomized control trial | The results obtained in this study of patients | Level III: Quasi Experimental | Limitations of this study were based on the user | Yes, cautiously. This study supported both |

(2013). Web versus app – compliance of patients in a telehealth diabetes management programming two different technologies. *Journal of Telemedicine & Telecare*, *18*(8), 476-480. doi:10.1258/jtt.2012.GTH 112	app could support physicians achieve sustainable lifestyle modifications, tailor therapy to individual needs, increased therapy adherence and safety (Schreier et al., 2013).	N=291 app controlled N=109 Web controlled		in a telehealth diabetes management program revealed a significantly higher compliance rate for patients using a mobile phone and NFC-based application user interface to acquire and transmit their health data than for patients predominantly submitting data via a web-browser (Schreier et al., 2013).		preference, and overall resources for each participant.	web and mobile apps improving self-care management of diabetes. Data was not supportive of app usage alone.
Shadid, A., Mahar, S. A., Shaikh, S., & Shaikh, Z. U. (2015). Mobile phone intervention to improve diabetes care in rural areas of Pakistan: A randomized controlled trial. *Journal College Physician Pakistan*, *25*(3), 166-171. doi:03.2015/JCPSP.1661 71	To determine the effect of mobile phone intervention on HbA1c in type-2 Diabetes Mellitus (DM) patients living in rural areas of Pakistan (Shadid, Mahar, Shaikh, & Shaikh., 2015).	N=400 N=200 controlled N=200 non-controlled group	Randomized Control Trial	Patients in intervention group showed improvement (p < 0.001) in following diet plan from 17.3% at baseline to 43.6% at endline, however, the control group showed insignificant increase (p=0.522) from 13.6% at baseline to 15.9% at endline. Intervention group (RR = 2.71, 95% CI = 1.18 - 6.40) showed significant	Level 3: Quasi Experimental	Patients were followed for 4 months. It is very difficult to change certain parameters like BMI in such short time duration. Only patients presenting to one hospital in Karachi and patients who were from two rural regions of Pakistan were studied due to defined catchment area of the hospital (Shadid et al., 2015).	Yes, despite the current limitations associated with the study. There was a significant amount of improvement with the utilization of mobile app intervention. Enough to endorse further studies that utilize mobile apps as complementary treatments for T2DM.

				positive association with normalization of HbA1c levels (Shadid et al., 2015)			
Shah, V. N., & Garg, S. K. (2015). Managing diabetes in the digital age. *Clinical Diabetes and Endocrinology*, *1*(16), 20-36. doi:10.1186/s40842-015-0016-2	A systematic review was conducted to review new digital technologies in diabetes self-care management and address potential challenges (Shah & Garg, 2015).	N=22 mobile apps All apps endorse selfcare management techniques for patients	Systematic Review	This study supports that overcoming barriers associated with mobile technology for self-care improvement of T2DM is promising (Shah & Garg, 2015).	Level I: Systematic Review	Limitations of this study consist of large healthcare systems that can not overcome barriers with incorporating mobile technology into healthcare (Shah & Garg, 2015).	Yes, this study effectively addressing various barriers to incorporating mobile technology into diabetic management in the digital age.
Whitehead, L., & Seaton, P. (2016). The effectiveness of self-management mobile phone and tablet apps in long-term condition management: A systematic review. *JMIR*, *18*(5), 97-108. doi:10.2196/jmir.4883	A systematic was conducted review and assess the effectiveness of mobile phone and tablet apps in self-management of key symptoms of long-term conditions (Whitehead & Seaton, 2016)	9 papers we reviewed, 6 of the interventions demonstrated a statistically significant improvement in the primary measure of clinical outcome. Participants ranged from 48 to 288 per year (Whitehead & Seaton, 2016).	Systematic Review	The evidence indicates the potential of apps in improving symptom management through self-management interventions (Whitehead & Seaton, 2016).	Level I: Systematic Review	Two selected apps only during the selected time frame. More rigorous research needed on larger scale to improve research results.	Yes, this study supports various trials that have improved patient outcomes with the Incorporation of mobile apps.
Yang, S., Kong, W., Hsue, C., Fish, A. F., Chen, Y., Guo, X., ... Anderson, R. (2016). Knowledge of A1c predicts diabetes self-management and A1c level among Chinese patients with type 2 diabetes. *PLoS One*, *11*(3).	The study was designed to assess the knowledge of A1c and its relationships with diabetes self-management and A1c level among Chinese patients	A study sample of 5957 patients was utilized. 3040, 1247, and 1670 were from Eastern, Central, and Western China (Yang et al., 2016).	Cross-Sectional study	The results also show that there was a correlation between understanding of A1c, diabetes self-management behavior and glycemic control. This implies that	Level IV: Cross-sectional study	Limited factor assessment of hemoglobin A1c control. Limited questionnaire	Yes, provides a large sample with the correlation between increased education and improved A1c.

doi:10.1371/journal.pone. 0150753	with type 2 diabetes (Yang et al., 2016).			a good understanding of A1c can improve clinical outcomes, such as FBG, 2hPPG, and A1c. Those with better understanding understood their A1c performed better self-management behavior (Yang et al., 2016).			

Clinical Question: In underserved patients with T2DM, does utilization of a Diabetes App, compared to previous self-care management and clinic education, lower the Hemoglobin A1c over a three-month period?

*Note: Melnyk's Level of Evidence (LOE) Pyramid is required for appraising the level of evidence.

Appendix B

Permission to Use and/or Reproduce The Iowa Model (1998)

Kimberly Jordan - University of Iowa Hospitals and Clinics <noreply@qualtrics-survey.com>

Mon 11/19/2018, 3:33 AM

To:

Smith, Fred <fsmith23@liberty.edu>

You have permission, as requested today, to review and/or reproduce *The Iowa Model of Evidence-Based Practice to Promote Quality Care (Revised 1998).* Click the link below to open.

[The Iowa Model of Evidence-Based Practice to Promote Quality Care (Revised 1998)](#)

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Citation: Titler, M. G., Kleiber, C., Steelman, V. J., Rakel, B.A., Budreau, G., Everett, L. Q., ...Goode, C. J. (2001). The Iowa model of evidence-based practice to promote quality care. *Critical Care Nursing Clinics of North America, 13*(4), 497-509.

In written material, please add the following statement:

Used/reprinted with permission from the University of Iowa Hospitals and Clinics, copyright 1998. For permission to use or

reproduce, please contact the University of Iowa Hospitals and Clinics at 319-384-9098 .

Please contact UIHCNursingResearchandEBP@uiowa.edu or 319-384-9098 with questions.

Appendix C

Diabetic Self-Questionnaire

Please circle the following questions below according to your current lifestyle

1= strongly disagree

2= disagree

3= neutral (neither agree or disagree)

4= agree

5= strongly agree

1. **I check my blood sugar level at home at least once a day**

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

2. **I record my blood sugar level at least once daily.**

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

3. **I take my diabetes medication at home as prescribed by my doctor or nurse practitioner**.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

4. **I follow the diabetic dietary recommendations given to me by my diabetic educator, doctor, or nurse practitioner.**

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

5. I choose foods to eat that makes it easy to achieve good blood sugar levels.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

6. I plan my meals.

 1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

7. I use healthy diabetic recipes to prepare my meals.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

8. I exercise 15 to 30 minutes at least 3 times a week.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

9. I keep all of the appointments recommended for my diabetes treatment.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

10. I use a diabetes app to help educate me on diabetes and health issues associated with diabetes.

1= strongly disagree   2= disagree   3= neutral (neither agree or disagree)   4= agree   5= strongly agree

Appendix D

Letter of Support for the Site

October 29, 2018

Attention: IRB
Liberty University
Lynchburg, Virginia

IRB Members:

Fred Allen Smith Jr, BSN, RN, Liberty University Doctor of Nursing Practice Student (Principal Investigator) and Dr. Vickie Moore, DNP, FNP-C, Assistant Professor of Nursing, and DNP Scholarly Project Chair (Faculty Chair) have proposed to conduct Mr. Smith's Doctor of Nursing Practice Scholarly Project: Mobile Based Technology App used to Improve Self-Care Management of Patients with Type 2 Diabetes Mellitus

Bassett Family Practice is committed to providing excellent, comprehensive care for our patients, facilitated by the pursuit of quality improvement. Mr. Smith's Doctor of Nursing Practice Scholarly Project reflects our commitment that every patient receives optimal quality health care.

Bassett Family Practice is pleased to support Mr. Smith's Scholarly project: Mobile Based Technology App used to Improve Self-Care Management of Patients with Type 2 Diabetes Mellitus

Feel free to contact me if I can be of further assistance.

Respectfully,

Appendix E

Collaborative Institutional Training Initiative Certificate of Successful Completion

Appendix F

IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

March 14, 2019

Fred Allen Smith Jr
IRB Approval 3686.031419: Mobile-Based Technology App Used to Improve Self-Care Management of Patients with Type 2 Diabetes Mellitus

Dear Fred Allen Smith Jr,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

2. Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows:
   a. from healthy, nonpregnant adults who weigh at least 110 pounds. For these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week; or

b.   from other adults and children [2], considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, MA, CIP

Administrative Chair of Institutional Research

Research Ethics Office

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Appendix G

Consent Form

The Liberty University Institutional Review Board has approved this document for use from 3/14/2019 to 3/13/2020 Protocol #

3686.031419

CONSENT FORM

MOBILE-BASED TECHNOLOGY APP USED TO IMRPOVE SELF-CARE MANAGEMENT OF PATIENTS WITH TYPE 2

DIABETES MELLITUS

Fred Smith Jr

Liberty University

School of Nursing

You are invited to participate in a scholarly research project. You were selected as a possible participant because you are between the ages of 19-70, have type two diabetes mellitus (T2DM) for greater than six months, English speaking, have access to an Android or iOS device, and have had a referral to the diabetic educator within the last 12 months. Please read this consent form and ask any questions you may have before agreeing to be in the study. Fred Smith Jr, a doctoral candidate in the School of Nursing at Liberty University, is conducting this scholarly project.

Background Information: The purpose of this scholarly project is to determine if the utilization of the Diabetes app will decrease the

hemoglobin A1c in patients diagnosed with T2DM in the underserved patient population. Furthermore, the development of the

Diabetes app aims to provide the underserved patient population with full-time access to improve self-care management techniques

and diabetic education to improve their hemoglobin A1c.

Procedures: If you agree to be in this study, I would ask you to do the following things:

1. During your normal appointment, you will be asked to have your hemoglobin A1c drawn, fill out a 10-question diabetic questionnaire, demographic form, and be provided access to the custom Diabetes app. The app is **FREE** of charge to all participants in this study. Estimated time to complete this procedure is 30 minutes.
2. Participants will be provided a detailed explanation of the Diabetes app in person during their first hemoglobin A1c draw by the project team leader (Fred Smith). Participants will receive two push notifications each day, one at 8am and one at 5pm, with helpful self-care management tips. Participants will be asked to utilize the Diabetes app daily during a three-month period. Participants are asked to utilize the Diabetes app daily during the three-month study period.
3. Following the three-month window participants will take the same 10 question diabetes questionnaire again and have their hemoglobin A1c drawn during their normal three-month chronic care appointment at BFP. Estimated time to complete this procedure should take about 20 minutes.
4. Data will be pulled from each user's activity during the three-month period. User data studied will consist of screen time of each user and actions within the app.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: The Diabetes app will serve as an education hub for all study participants. The Diabetes app will consist of dietary food

options, recommended exercise regimens, blood sugar log, diabetic education in congruence with the American Diabetes Association,

and self-care techniques for diabetes management.   In addition, the goals of increased self-care management should improve patient's

hemoglobin A1c outside of traditional diabetic educational methods. Increased availability of disease management techniques endorse

better chronic disease management. Better management of diabetes prevents further associated complications of uncontrolled diabetes

such as diabetic neuropathy, diabetic retinopathy, heart disease, kidney disease, and overall shorter lifespan.

Benefits to society may include: Technology supports self-care management by providing patients the ability to have blood glucose

monitoring, dietary recommendations, medication adherence, and user platform discussion forums. The utilization of mobile app

technology improves barriers to healthcare access, improves patient education, and increases patient exposure to self-care

management techniques. Healthcare providers should incorporate the utilization of mobile-based technology to effectively manage

T2DM. Better short term and long-term management of T2DM will reduce associated costs of complications with ineffective T2DM

management. Potentially an estimated 327 billion dollars could be saved in estimated healthcare costs associated with T2DM

complications.

Compensation: Participants may be compensated for participating in this study. All study participants will have the opportunity to

have their name placed in a drawing to win a 19inch television. This number of times each participant is based on who has the highest

app utilization, fastest study enrollment, and overall highest hemoglobin A1c decrease (three ways to boost entry count). Every day

participants that login the Diabetes app they will be given one entry, for a maximum of 90 entries (1 entry potentially each day for 90

days). Participants that sign consent within three days will receive 50 additional entries to their grand total. In addition, the

participant with the overall highest hemoglobin A1c decrease will receive an additional 100 entries at the end of the study. All study

participants based on the previously mentioned criteria will have their entries totaled and randomly selected at the end of the study

during a drawing. The winning participant must complete the entire study time of three months and must complete all before and after

questionnaires for the study to receive the 19-inch television.

Confidentiality: The records of this study will be kept private. In any sort of report or presentation I might publish, I will not include

any information that will make it impossible to identify subjects. Any information gathered from the app utilization will be protected

under encrypted codes within the app (private app). All information will be encrypted with no personal information related to study

participants. There will be no interactions with other users. All feedback from potential users will be sent directly to the project team

leader email or cell phone. The Diabetes app is exclusively available to only participants associated with this study. Research records

will be stored securely, and only the researcher will have access to the records. I may share the data I collect from you for use in

future studies or with other researchers; if I share the data that I collect about you, I will remove any information that could identify

you, if applicable, before I share the data.

- Participants will be assigned a randomized number.
- Data will be stored on a password locked computer and may be used in future presentations. After three years, all electronic records will be deleted in accordance with federal law.

- All data collected and gathered from the Diabetes app will be stored and secured with an encrypted login and private secure database. This app is made private, and only available to involved study particpants. Data will be sent to previously mentioned above password locked computer and may be used for future presentations. After three years, all electronic records will be deleted in accordance with federal law.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or Bassett Family Practice. If you decide to participate, you are free to not answer any question or withdraw at any time.

How to Withdraw from the Study: If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is Fred Smith Jr. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at 336-837-5190 or fsmith23@liberty.edu. You may also contact the researcher's faculty chair, Dr. Moore, at vbmoore@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

_____

Signature of Participant   Date

_____

Signature of Investigator   Date

Appendix H

Demographics Questionnaire

Please answer the following questions below: (Any section may be left blank)

Age:

Sex:

Race:

Highest level of education:

Household income:

Years of diabetes:

Home diet:

Current diabetic medication:

All information is kept confidential and encrypted

Appendix I

Likert Scale Ranking Score Diabetes Questionnaire

Total score as follows:

20 or below Bad (high risk complications)

25-20 Poor

30-25 Below-Average

30-40 Average

40-45 Good

45-50 Great

Appendix J

Instructions for Diabetes App:

1. Please turn on phone
2. Please locate markets for your service provider (App store for iOS users), (Android marketplace for Android users)
3. Please type in the search engine "Diabetes app
4. Please locate free version
5. Login with user email and create password
   a. For Apple users you may utilize your Face ID to sign in for your password, or thumbprint on older models once your password is created
   b. For Android users you will have to set up with an email and password.
6. Once logged in you will be taken to the home screen. Please click the in app mobile widget named "Welcome"
   a. Inside the welcome function you will watch an introductory video, purpose of this scholarly project, and will receive step by step instructions on how to use each function from team leader Fred Smith Jr DNP candidate.
7. If you encounter any problems with gaining access to the welcome screen, please contact the app developer Fred Smith.
a. Contact any time with questions at 336-837-5190 or email any questions to fsmith23@liberty.edu. You will receive a response within 24-hours
8. I hope you enjoy this app!

Appendix K

Timeline of the Scholarly Project

Completion Date	Planning	Pre-Implementation	Implementation	Evaluation
7/31/2018	Meet with Scholarly project chair to present idea and project development			
8/30/2018	Receive approval from scholarly project chair, then identify key stake holders individually to obtain their support and organization endorsement.			

8/30/2018	First meeting with clinical director and organization providers to present ideas for project.			
9/30/2018	Receive verbal endorsement of letter of support from Bassett Family Practice clinical director.			
10/30/2018	Began and draft pre-proposal for IRB submission			
11/1/2018		Pre-screen 60 participants who meet inclusive criteria for the project		

12/15/2018		Submit pre-proposal to scholarly project chair		
1/16/2019		Perform mini-presentation to scholarly project chair		
1/20/2019		Submit IRB application		
2/20/2019		Develop app with Appy Pie software		
2/20/2019- 3/1/2019		Receive IRB approval		
3/1/2019		Develop Diabetes App for Android and iOS platforms		
3/15/2019		Launch 5 beta testers of app		
2/20/2019- 3/20/2019			Obtain consent for 60 participants, and instructions on how to utilize mobile app,	

			implement diabetes questionnaire and	

3/25/2019			Implement utilization of Diabetes app for scholarly project for three-month period	
3/25/2019			Start two-push notifications daily for enrolled participants during three-month period	
6/25/2019			Conclude three-month scholarly project Diabetes app and distribute post survey.	
6/25/2019				Utilize SPSS software to analyze data, prepare presentation
7/15/2019-8/1/19				Present data