

**Improving Knowledge in Diabetes Self-Management Education and Support via mHealth  
Among Nurses: A Quality Improvement Project**

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### **Abstract**

Type 2 diabetes represents a growing threat to public and population health. Diabetes self-management education and supports (DSMES) is an evidence-based intervention for improving glycemic control in patients with diabetes. Despite the utility of DSMES, it is often not used by providers. mHealth applications to support DSMES may enable providers to improve this element of care, having a systemic impact on the patient, population, and healthcare costs. To this end, a quality improvement project was developed and implemented in an acute care facility to increase nurse knowledge of mHealth with the idea that this education will increase nurse use of mHealth in the care of patients with diabetes. A total of 11 nurses working at the practice site were included in this quality improvement project. Results from the project indicate that mean knowledge scores compared from baseline to post-education increased, 6.55 (s.d. 1.22) and 13.8 (s.d. 2.49), respectively. A Mann-Whitney U-test was conducted to evaluate the statistical significance of the data with the results indicating  $P = 0.000$ . This demonstrates that the results were statistically significant and support current evidence regarding the efficacy of provider education for mHealth. Based on the current evidence and the results from this quality improvement project, provider education for using mHealth in DSMES should be strongly considered.

*Keywords:* diabetes, self-management, DSMES, education, nursing.

## **Improving Knowledge in Diabetes Self-Management Education and Support via mHealth Among Nurses: A Quality Improvement Project**

Type 2 diabetes is a major chronic lifestyle disease associated with impaired control of blood sugar levels that leads to hyperglycemia. According to Dougherty and Heile (2020), this metabolic disorder is characterized by a decrease in the production, sensitivity, or a rise in cell resistance to insulin thus causing hyperglycemia. Globally, this disease affects more than 462 million people, and this number is likely to increase in the future because of the high number of people living with prediabetes (Khan et al., 2020). Maintaining optimal blood sugar levels requires proficient diabetes self-management associated with the adoption of healthy lifestyle behaviors and practices (Powers et al., 2020). Unfortunately, the delivery and use of diabetes self-management education and support (DSMES) in clinical settings are suboptimal thus causing high rates of either uncontrolled or poorly controlled diabetes (Powers et al., 2020).

The delivery of DSMES through mobile health (mHealth) applications is an alternative approach to optimizing access to and use of DSMES in diabetic patients to improve diabetes self-management. However, evidence does indicate that mHealth applications are relatively new and many providers may lack the knowledge needed to successfully utilize these tools in practice (Gagnon et al., 2016). Without this knowledge, providers may miss critical opportunities to educate patients regarding mHealth (Gagnon et al., 2016). This is troubling as evidence consistently demonstrates that patient use of mHealth applications can improve glycemic control in patients diagnosed with diabetes (Kitsiou et al., 2017). Consequently, the following PICO (population, intervention, comparison, and outcome) clinical question was developed to guide this quality improvement project: Among nurses providing care for patients with diabetes does the use of an educational program to foster mHealth use for DSMES increase provider

knowledge when compared with baseline knowledge (provider knowledge before the intervention)?

### **Problem Statement**

Effective diabetes self-management is the goal of diabetes treatment aimed at decreasing mortality and morbidity risks and optimizing blood sugar control. According to Reyes et al. (2017), self-management is the process by which patients actively perform self-care activities to optimize the control of adverse effects of diseases on their own health. This self-management improves as a result of obtaining skills and knowledge necessary for facilitating the adoption of practices and behaviors meant for achieving and sustaining better health (Reyes et al., 2017). Jeffrey et al. (2019) state that the delivery of DSMES is the most effective way to empower patients with the competencies, skills, and knowledge to perform self-care activities and comply with diabetes treatments. Being optimized through DSMES, diabetes self-management involves problem-solving, resource use, and decision-making, as well as taking self-action and working with healthcare providers (Reyes et al., 2017).

If optimally delivered, DSMES can significantly improve diabetes self-management and thus improve health outcomes and lowering the costs of treatment. However, the delivery of and access to DSMES in healthcare facilities is suboptimal thus leaving many patients without knowledge, skills, and competencies needed to perform self-care activities effectively contributing to poor diabetes control. mHealth applications could potentially improve outcomes for patients to self-manage their disease (Kitsiou et al., 2017). However, providers may lack knowledge of these tools and how to integrate them into the care of the patient, leading to challenges for patients to successfully access and use these tools in the management of their disease (Gagnon et al., 2016).

## Significance

Diabetes is a widespread metabolic condition at the national and global levels. Globally, Xu et al. (2018) explain that more than 415 million adults are living with this disorder, and the number might reach 642 million by 2040. The global population of adults with diabetes accounted for 6.28% of the entire human population translating to 462 million people in 2017 (Khan et al., 2020). According to Khan et al. (2020), diabetes is the ninth leading global mortality cause contributing to more than one million adult deaths across the planet. Therefore, diabetes directly affects millions of adults due to the high prevalence rates and mortalities thus creating the need for urgent intervention to optimize diabetes self-management.

At the national level, evidence proves that diabetes is one of the fastest-growing lifestyle diseases with high morbidities and mortalities. By 2014, Powers et al. (2020) reported that more than 22.3 million adults had diabetes. In 2018, the number of adults with diabetes rose significantly and reached 34 million (Dougherty & Heile, 2020). Reyes et al. (2017) report that 9.3% of the adult population in the United States live with diabetes; 8.1 million have undiagnosed diabetes with a higher risk of developing complications due to either poorly controlled or uncontrolled diabetes. In the near future, the population living with diabetes is likely to grow as a result of the country having 84 million adults with prediabetes, 70% out of which are predicted to develop diabetes in the next decade (Lord & Roberson, 2020). Annually, the United States documents more than 1.5 million new diagnoses of diabetes (Dougherty & Heile, 2020). In such a manner, diabetes is a major threat to the lives and health of adults because of the significant number of people in the population that currently have the disease or are at risk for developing it.

The consequences of either poorly controlled or uncontrolled diabetes due to suboptimal diabetes self-management owing to the reduced access to and use of DSMES are adverse.

Dougherty and Heile (2020) assert that poorly controlled diabetes increases the susceptibility of patients to complications, including diabetic retinopathy, renal diseases, peripheral neuropathy, cancer, and cardiovascular conditions. In the United States, 18% of adults with this metabolic condition have moderate to severe renal impairment with less than 15% and 37% of diabetic patients having end-stage renal disease and mild renal impairment, respectively. According to Einarson et al. (2018), uncontrolled diabetes, possibly as a result of noncompliance with treatments and suboptimal self-management, is associated with more than a 32.2% increase in the risk of developing cardiovascular diseases, for example, atherosclerosis, stroke, myocardial infarction, and heart failure, among others. Consequently, the risk of dying from these complications increases.

Notwithstanding, these complications predispose patients to costly hospitalizations with adverse economic ramifications. Dall et al. (2019) explain that diabetes is associated with a \$404 billion financial burden attributed to diabetes care in addition to productivity losses emanating from workplace absenteeism and disease-related disabilities. Annually, Dall et al. (2019) report an average expenditure of \$13,240 per patient in managing this condition, which can be reduced by improving access to comprehensive educational plans. Currently, the country spends more than \$237 billion in direct medical costs and \$90 billion incurred in indirect medical costs of diabetes (Lord & Roberson, 2020). The American Diabetes Association ([ADA], 2018) reveals that productivity losses due to diabetes amount to more than \$26.9 billion for employees and \$37.5 billion associated with diabetes related disabilities. In addition, the United States loses \$3.3 billion through the absenteeism of working patients with diabetes (ADA, 2018). Therefore,

it is important to note the need to find a better approach to decrease the financial burden of diabetes on patients and the entire nation.

### **Literature Review**

Uncontrolled diabetes has a systemic impact on patient and population health. Evidence regarding the implications of diabetes for patient health indicate that patients with uncontrolled disease are more likely to experience higher care costs as well as higher rates of morbidity and mortality (Einarson et al., 2018; Wang et al., 2018). While the human toll of diabetes is quite significant, society in general will face notable challenges in managing the costs to provide care for those diagnosed with diabetes and disease related complications. Current data provided by the American Diabetes Association (2018) indicates that in 2017 the United States lost more than \$237 billion in direct health care costs for diabetes with another \$90 billion in productivity losses. Of these losses \$26.9 billion was attributed to disability and sickness-related productivity losses, while another \$3.3 billion was lost through workplace absenteeism (ADA, 2018). Given the human and economic toll of uncontrolled diabetes, there is an impetus to identify effective solutions that could be implemented in practice to improve management outcomes for patients with diabetes including patient engagement in self-care behaviors, costs to provide care, and clinical outcomes such as glycemic control as measured through glycosylated hemoglobin (HbA1c) levels.

To improve outcomes for patients with diabetes, evidence-based practice guidelines provided by the ADA (2021) do recommend the use of diabetes self-management education and supports (DSMES) to improve patient knowledge and engagement in self-care activities aimed at prompting effective glycemic control. Evidence indicates that DSMES can have a positive impact on improving glycemic control in patients diagnosed with diabetes (Phillips et al., 2018).

Even though DSMES is widely recommended for improving the management of diabetes in clinical practice, evidence indicates that many providers fail to integrate DSMES when providing care for this patient population (Powers et al., 2017). Providers may lack the time, staff, and economic resources to provide DSMES in the clinical setting, leaving many patients without this evidence-based support for managing health (Hermanns et al., 2020). With this in mind, the goal of this project is to improve nurses' knowledge on DSMES via mHealth through a structured intervention targeting nurses to learn and understand the use of mHealth applications for diabetes self-management, education, and support.

To identify articles regarding the use of mHealth in the management of patients with type 2 diabetes and further to assess provider education as a means to improve the use of mHealth in clinical practice, a review of the literature on these topics was undertaken. A review of the search strategy employed as well as the evidence located for inclusion in this practice project are included below. Additionally, all of the literature reviewed for this document is included in a literature matrix that is attached as Appendix A. Evidence located to support this literature review was evaluated using the Johns Hopkins Nursing Evidence-Based Practice Individual Evidence Summary Tool and hierarchy of evidence (Dang & Dearholt, 2017).

### **Search Strategy**

A comprehensive search of scholarly resources was conducted through Google Scholar, PubMed, and Medline databases. The search terms included “diabetes,” “mHealth,” “provider,” “education,” and “knowledge.” Selected articles comprised meta-analysis, primary research studies, and systematic reviews. Only articles with relevant information related to the practice problem and the project intervention published in peer-reviewed journals, available in full-text for review, written in English and published in the last five years (i.e., between 2016 and 2021)

were selected for this literature review. The results were organized based on three primary topics germane to the current project and problem statement: barriers to mHealth adoption among providers; the benefits of mHealth for improving glycemic control in patients with type 2 diabetes; and educational programs for improving provider knowledge of mHealth interventions for use in clinical practice. A review of each of these themes is provided here.

### **Barriers to mHealth Adoption among Providers**

A review of the literature regarding the use of provider education to improve knowledge has demonstrated that practitioner knowledge is a significant barrier to the adoption and use of this technology in practice. More specifically, three Level I studies using a systematic review methodology were located on the topic indicating that provider knowledge of mHealth continues to lag, having a direct impact on the ability and willingness of providers to use mHealth in the care of their patients (Gagnon et al., 2016; Jacob et al., 2020; Zakerabasali et al., 2021). The first systematic review identified for inclusion in this literature review was written by Gagnon et al. (2016). In this study the authors searched four electronic databases including PubMed, EMBASE, CINAHL, and PsychInfo between the years of 2000 and 2014. The focus of this research was to identify both barriers and facilitators to mHealth adoption among medical providers. The search resulted in the identification of 33 articles that met the inclusion criteria. The authors note that there were individual, organizational, and contextual factors that influenced mHealth adoption in practice, including a lack of knowledge regarding the specifics of the technology tools and how to integrate them into the care of the patient.

While the results provided by Gagnon et al. (2016) did specifically indicate that knowledge was an individual provider barrier impacting the adoption of mHealth, the research also demonstrated the systemic impact of this issue for organizational and contextual barriers to

mHealth adoption. More specifically, Gagnon et al. report that a lack of provider knowledge was common within the workplace, making it difficult for providers to collaborate with one another to adopt mHealth. Further, Gagnon and coauthors found that organizations often provided little support—such as training and education—to foster the ability of providers to learn how to use this technology in practice. What this demonstrates is that while provider knowledge may be viewed as an individual factor influencing the adoption of mHealth, this individual factor has contextual and organizational implications as well.

The second systematic review regarding the barriers to mHealth adoption among healthcare providers located for this literature review was undertaken by Jacob et al. (2020). In this review, the authors carried out a structured investigation of four electronic article databases: MEDLINE, PubMed, the Cochrane Library, and SAGE. All articles included in the literature review were written in English and published between January 2008 and July 2018. A total of 171 articles were identified for inclusion and analysis of the literature facilitated the identification of eight dominant themes regarding barriers to the adoption of mHealth among providers. Themes identified that were relevant to this project included: a lack of awareness of mHealth, a lack of knowledge regarding mHealth applications, a lack of knowledge regarding how to integrate mHealth into the workflow associated with patient care, and lack of knowledge regarding how to manage technical issues associated with mHealth adoption and use in the clinical setting.

Much like Gagnon et al. (2016), the analysis provided by Jacob et al. (2020) also considered contextual and organizational factors, demonstrating how individual factors including a lack of knowledge systemically impacted the adoption of mHealth in practice. Of notable importance in the analysis provided by Jacob et al. was the fact that the broader organizational

environment and supports provided to healthcare practitioners surveyed appeared to have a greater impact on provider decision making when it came to the adoption of mHealth. What this suggests is that more providers may be willing to adopt and utilize mHealth if organizations provided some support for the process and were willing to work with providers to build an environment in which mHealth became a foundation for building patient care. While individual provider knowledge is therefore highlighted as being a significant issue of concern, the organizational context, including the lack of training programs for mHealth, may also contribute to this situation.

The final systematic review located on the topic was conducted by Zakerabasali et al. (2021) and included a review of information collected from four electronic article databases: PubMed/MEDLINE, Web of Science, Embase, and Google Scholar. All of the articles included in the review were published between January 2015 and December 2019. Content analysis and categorization of the barriers to mHealth adoption was the primary focus of this systematic review and the authors noted that 18 articles were selected for inclusion. For the purposes of this systematic review, Zakerabasali et al. categorized barriers to mHealth adoption based on individual, technical, and healthcare system factors. Knowledge and limited provider literacy regarding mHealth were identified as an individual barrier. However, Zakerabasali and coauthors also found that most organizations lack the resources, including time and money, to help educate providers about these tools and to ensure that they are integrated as part of practice. Here again it is possible to see that while individual provider knowledge is of concern, a lack of support from the organization to build mHealth knowledge through initiatives such as training also have implications or whether or not this technology is adopted and integrated as part of patient care.

### **Benefits of mHealth in Improving Patient Outcomes**

Literature elucidating the gaps in provider knowledge regarding mHealth does indicate that this problem is a notable concern that will impact the ability of patients to access and use this technology as part of their care. While this is important to note in the context of this quality improvement project, what is also helpful to consider are the benefits for patients with diabetes in utilizing this technology for improving self-management including health outcomes such as glycemic control. A review of the literature on this topic revealed several Level I systematic reviews and meta-analyses on the topic. For the purposes of this review, three systematic reviews/meta-analyses evaluating randomized controlled trials—Quality A as per the Johns Hopkins level of evidence (Dang & Dearholt, 2017)—are reviewed (Cui et al., 2016; El-Gayar et al., 2021; Hou et al., 2016).

The first systematic review/meta-analysis reviewed for this quality improvement project was undertaken by Cui et al. (2016). The primary objective of this study was to evaluate randomized controlled trials to assess the impact of mHealth interventions on changes in glycosylated hemoglobin (HbA1c), blood glucose, and body weight in patients with type 2 diabetes. Three electronic article databases were utilized to locate evidence on the topic: PubMed, the Cochrane Library, and Embase. Articles written in English and published between January 2005 and June of 2016 were included. All studies evaluated in this meta-analysis utilized comparisons of mHealth applications with standard DSMES or care as usual provided to patients diagnosed with diabetes. A total of 13 studies were included in the systematic review, of which, six qualified for inclusion in the meta-analysis accounting for 1,022 patients. The results were reported in terms of standardized mean difference (SMD) for subjects undergoing mHealth treatment and indicated that those who received the intervention fared much better in terms of

glycemic control as measured by HbA1c: SMD -0.40% (95% confidence interval [CI] = -0.69 to -0.10%,  $p = 0.008$ ). Although glycemic control was improved, the authors found that mHealth applications had no effect on weight.

Similar results were also found in a meta-analysis conducted by El-Gayar et al. (2021). In this Level I study the authors retrieved randomized controlled trials from PubMed/Medline and Web of Science published between January 2010 and October 2020. The purpose of this study was twofold including an evaluation of mHealth applications on glycemic control (HbA1c) when compared with care as usual and to evaluate differences in applications including comparing outcomes for those that did and did not use behavioral theories to guide patient self-care activities. A total of 21 studies including 1,920 patients with diabetes were included in the review. Overall, the authors found that mHealth applications led to significant declines in HbA1c as measured by SMD: -0.38% (95% CI = -0.50 to -0.25,  $p < 0.001$ ). When comparing mHealth applications using behavioral approaches, the authors did not find any differences in outcomes for glycemic control in patients. This suggests that various mHealth applications could be effective for enhancing care outcomes for patients.

The final systematic review/meta-analysis reviewed for this quality improvement project also demonstrated positive results for mHealth in improving glycemic control in patients with type 2 diabetes. Hou et al. (2016) identified 14 randomized controlled trials involving 1,360 patients through a review of five electronic article databases including Medline, CINAHL, Cochrane Library, Web of Science, and Embase. The articles were published between January 1996 and June 2015 and were also evaluated using GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria. The focus of the study was to evaluate the use of mHealth applications on glycemic control in the self-management of diabetes. The

systematic review of the data indicated that all studies showed positive results for reducing A1c values for patients. Meta-analysis of the data further indicated that the SMD for patients enrolled in mHealth applications compared with care as usual was -0.49% (95% CI = -0.30, -0.68). Application of GRADE criteria to the findings indicated a moderate effect, suggesting that mHealth applications should be considered for use in clinical practice to help foster better self-management and improved glycemic control.

### **Provider Education to Improve Knowledge of mHealth**

The evidence reviewed thus far indicates that knowledge gaps for providers limit the use of mHealth in clinical practice and further that mHealth applications can improve self-management outcomes for patients with diabetes as demonstrated by lower A1c values (i.e., better glycemic control). This suggests that there is a gap in practice that could potentially be overcome through the use of provider education. A review of the literature for this quality improvement project did yield four studies on the topic which all suggest that educational interventions can be effective for increasing provider knowledge of mHealth applications (Amoakoh-Coleman et al., 2016; Armstrong, 2019; Armstrong et al., 2018; Soloe et al., 2021). Two of the studies included a systematic review (Amoakoh-Coleman et al., 2016; Soloe et al., 2021) and two included primary interventions applied in practice (Armstrong, 2019; Armstrong et al., 2018). A review of this literature is considered here.

An overview of the systematic reviews indicates that both studies demonstrated positive results for provider education to increase knowledge regarding mHealth applications (Amoakoh-Coleman et al., 2016; Soloe et al., 2021). Amoakoh-Coleman et al. (2016), for instance, examined the use of provider education to improve knowledge of mHealth in providing care to improve maternal and neonatal outcomes in low- and middle-income countries. This systematic

review included acquiring 19 articles that had been published in one of five electronic article databases: the Cochrane Library, PubMed, EMBASE, Global Health Library, and Popline. Of the 19 studies located 10 included interventions and nine were noted to be descriptive (cross-sectional) in nature. The authors note that in each study increased provider knowledge was noted and was associated with the integration of mHealth applications into the care of the patient. The results indicate that not only does provider knowledge increase with education but also this knowledge clearly has a direct impact on the actions taken by providers in delivering care in the clinical setting. Thus, it is reasonable to believe that increased knowledge will lead to increased use of mHealth applications in patient care.

Soloe et al. (2021) also conducted a systematic review of the literature to evaluate provider education programs in using mHealth in the detection, treatment and survivorship care of patients with cancer. More specifically, the authors sought to evaluate provider knowledge and confidence associated with mHealth training. Articles for review were abstracted from three electronic article databases including PubMed, Embase, and Web of Science. Articles available in English and published between 2010 and 2020 were included in the review. A total of 23 studies were included with the authors noting that all studies demonstrated some improvement in provider knowledge and confidence following education on mHealth applications. Only half of the studies reported improvements in provider confidence for comparison. What is not assessed in this article is the impact that these changes in knowledge and confidence have on the behavior of the provider in terms of adopting and integrating mHealth into practice. However, the information provided does demonstrate that education can be instrumental in improving provider knowledge of the technology.

The remaining two studies included a review of direct interventions to evaluate educational programs for increasing provider knowledge of mHealth (Armstrong, 2019; Armstrong et al., 2018). The first study reviewed was undertaken by Armstrong (2019) and involved the use of an eight-day training program provided to 252 providers to educate them about the use of mHealth and best practices for integrating this technology as part of patient care. Providers involved in this study included direct clinical practitioners working for various Department of Defense (DoD) and the Department of Veterans Affairs (VA) hospitals and clinics. Knowledge of mHealth was measured before and following the intervention and the results indicate that provider knowledge increased from 49.5% before the education to 95.8% following the intervention. Follow-up at three months indicated that most knowledge had been retained: 83.3%.

The final study reviewed for this literature review was undertaken by Armstrong et al. (2018) and included a four-year longitudinal study to track outcomes of an mHealth educational program provided to 760 mental health providers working for the VA and other military clinics. The purpose of this study was to assess mHealth application use over the long-term following an educational workshop on the topic. Although direct provider knowledge was not measured in this study, the use of mHealth applications by providers was tracked for four years over the duration of the project. The results indicate that before the educational workshop only 41.1% of providers reported using mHealth as part of treatment. Following the intervention this increased to 93.7%. At four-years follow-up, 90.8% of providers were noted to be using mHealth as part of patient care. The results suggest that knowledge of mHealth had to increase as a result of the training program to make such a significant change in provider behavior.

### **Strengths and Limitations of the Literature**

With a detailed review of the literature provided, it is helpful to consider the strengths and weaknesses of the literature. A total of 10 articles were included in this literature review and of these, eight were noted to be systematic reviews/meta-analyses (Amoakoh-Coleman et al., 2016; Cui et al., 2016; El-Gayar et al., 2021; Gagnon et al., 2016; Hou et al., 2016; Jacob et al., 2020; Soloe et al., 2021; Zakerabasali et al., 2021). This methodology is noted to be one of the most rigorous for supporting evidence-based practice as the results combine critical data to collectively demonstrate the efficacy of an intervention (Dang & Dearholt, 2017). Further, the evidence reviewed positively demonstrates that provider knowledge is a barrier to the adoption of mHealth, mHealth when applied in DSMES of patients with diabetes has a positive impact on self-management as measured by better glycemic control when compared with care as usual, and provider education is effective for increasing provider knowledge and use of mHealth in practice. The strengths of this literature review, therefore, provide a robust foundation upon which to make practice change.

Despite the strengths of the literature, there are some challenges noted. First, it is important to note that it was only possible to find four studies regarding the use of provider education for increasing knowledge regarding mHealth use (Amoakoh-Coleman et al., 2016; Armstrong, 2019; Armstrong et al., 2018; Soloe et al., 2021). Additionally, the systematic reviews/meta-analyses included in this study only employed a limited number of databases which may have skewed the assessment of the literature on the topic. Finally, of the two intervention studies included only one measured knowledge outcomes and both utilized small samples from a single type of care setting (Armstrong, 2019; Armstrong et al., 2018). This may have impacted the generalizability of the results to all healthcare providers. These limitations are

important to note as they may have implications for the results obtained from this quality improvement project.

### **Summary of the Literature**

Synthesis of the literature provided here does indicate that education would be a useful support for enhancing provider knowledge of mHealth applications. The use of this knowledge when translated into practice should result in higher levels of mHealth use in the care of patients. In patients with type 2 diabetes, the use of mHealth will be instrumental in improving self-management behaviors resulting in better glycemic control. Based on this data, there is a strong evidence base upon which to initiate this quality improvement project to provide education for clinicians regarding this topic.

### **Purpose/PICO Clinical Question/Objectives**

The primary purpose of this quality improvement project is to deliver an educational program to increase provider knowledge of mHealth in providing care for patients with diabetes seen in clinical practice. The evidence reviewed above does clearly indicate that provider education can increase knowledge of mHealth (Amoakoh-Coleman et al., 2016; Armstrong, 2019; Armstrong et al., 2018; Soloe et al., 2021) and further that patient with diabetes who use this technology for self-management of their disease will have better health outcomes (Cui et al., 2016; El-Gayar et al., 2021; Hou et al., 2016). With these issues in mind, the following PICO question was proposed to guide the project: Among nurses providing care for patients with diabetes does the use of an educational program to foster mHealth use for DSMES increase provider knowledge when compared with baseline knowledge (provider knowledge before the intervention)? Based on this PICO question, the following objectives are noted for this project:

- Build an educational program for nurses regarding mHealth and how to use and integrate the tool in practice.
- Assess nurse knowledge of mHealth before the educational intervention.
- Deliver the educational program to nurses recruited for the quality improvement project.
- Assess nurse knowledge of mHealth following the educational intervention.

### **Definition of Terms**

To provide further clarification for this quality improvement project, terms specific to this practice change are defined here.

- **Type 2 diabetes:** Type 2 diabetes is a metabolic disease that typically develops with aging and is primarily associated with glucose dysregulation primarily caused by insulin resistance (ADA, 2018).
- **Diabetes self-management education and supports:** A group or cluster of resources provided to the patient that typically includes education to help the patient better manage the disease to improve glycemic control and reduce disease-related complications (ADA, 2018).
- **mHealth:** mHealth is an abbreviation for mobile health and includes the use of any electronic applications or devices that enable the user to access health information from remote locations (Cameron et al., 2017).
- **Glycosylated hemoglobin (HbA1c):** Principle diagnostic measure (blood test) used to diagnose diabetes and to assess the efficacy of treatment outcomes in disease management (Gupta et al., 2017).
- **Self-care and self-care behavior:** The engagement in health promotion activities to improve or maintain health (Jaarsma et al., 2020).

### **Conceptual Underpinning and Theoretical Framework**

The self-care deficit model by Orem was used as a theoretical framework underpinning this DNP project. The use of this theory is based on the idea that by increasing provider knowledge of mHealth applications in providing patients with DSMES, this will augment patient ability to engage in self-care, leading to better health outcomes over the long-term. Khademian et al. (2020) explain that based on this nursing theory, people are self-reliant individuals with the ability to perform self-care activities with a primary goal of improving, restoring, or maintaining better health. However, these individuals experience deficits in performing self-care activities, compromising their health status, which creates the need for nursing intervention. During the DNP project, the responsibility of the nurse is to ensure patients perform diabetes self-care activities ranging from physical activities to healthy eating, self-testing and self-monitoring for blood sugar, taking medications in compliance with provider recommendations, and seeking guidance or interventions in the case of deviations of blood sugar levels from the normal limits.

This nursing theory defines three nursing systems required to help patients to perform self-care activities. The wholly compensatory system involves the nursing professional performing self-care activities on behalf of patients with a complete inability to engage in self-care (Alligood, 2018). However, the partly compensatory system entails the nurse helping the patient perform self-care activities and not doing it on behalf of the person. Conversely, the supportive-educative system empowers the patient with knowledge and skills through training and guidance to improve self-management (Alligood, 2018). For this project, the supportive-educative system will be useful in guiding the delivery of DSMES through mHealth to improve diabetes self-management in PWD.

This theoretical framework has been used severally in guiding the delivery of DSMES in PWD, leading to better diabetes outcomes justifying the need to use it for this DNP project. For example, Surucu et al. (2017) used this self-care deficit model as a framework guiding the delivery of DSMES through a randomized controlled trial. Delivering DSMES based on this nursing theory effectively enhanced diabetes self-management in PWD, resulting in substantial improvements in glycemic control and the prevention of possible diabetes complications (Surucu et al., 2017). Similarly, Khademian et al. (2020) delivered health education and support through a quasi-experimental design based on Orem's model. This quasi-experimental study established that health education and support guided by the self-care deficit was effective in improving self-management in patients resulting in better health outcomes. Therefore, this project will be based on Orem's theory of self-care deficit to guide the delivery of DSMES through the supportive-educative system of nursing to empower PWD with knowledge, skills, and competencies to perform diabetes self-care activities.

### **Methodology**

To apply the evidence in practice such that a tangible impact on patient health and care quality can be made, it was necessary to operationalize the evidence through the selection of a methodology to implement practice change. A review of the purpose and PICO question developed for this project indicates that an intervention (provider knowledge) was used, and a pre- and post-assessment of provider knowledge was employed to assess outcomes from the intervention. The methodology did not use a control, and comparison for the project included an assessment of baseline and final mHealth knowledge in the project participants. This description indicates that an experimental quantitative methodology was needed employing a quasi-experimental design.

Information regarding experimental research methodologies indicates that these approaches typically involve either randomized controlled trials or quasi-experimental studies. Randomized controlled trials, as their name suggests, involve randomization of subjects to either a control or experimental group to measure and compare outcomes from the use of an intervention (Miller et al., 2020). This methodology is known for having a high degree of internal reliability and to demonstrate causality between the intervention and the outcomes (Miller et al., 2020). Quasi-experimental frameworks, on the other hand, also test an intervention but do not include a control/comparison group, randomization of the sample, or both (Miller et al., 2020). Internal validity of this methodology is not as high as for randomized controlled trials and the results often do not demonstrate causality (Miller et al., 2020). However, it is possible to identify a correlation between the independent and dependent variables if one is present (Miller et al., 2020).

For the purposes of the quality improvement project the quasi-experimental framework was selected as being the most appropriate approach. An experiment was needed to provide nurses working in the facility with an mHealth educational program. However, participants for the project were not randomly selected. Rather, participants were voluntarily selected from a group of nurses currently working at a single healthcare site: i.e., an acute care facility. Based on this assessment, this would indicate that a quasi-experimental methodology was used. Through the use of this approach, it was possible to compare outcomes for nurses participating in the educational program from baseline to after the intervention to determine if changes in knowledge regarding mHealth did indeed occur.

### **Setting and Participants**

The setting for the quality improvement project was an acute care facility operating in South Florida. Participants included nurses currently working on a single unit at this facility. Participants were over the age of 18 years, employed at the current facility, held at least a registered nursing (RN) license, and voluntarily agreed to participate in the project. Recruitment of participants occurred over a two-week period and involved outreach using an email to provide nurses with some background information regarding the quality improvement project (Appendix B). In total 11, nurses currently working in the clinical setting agreed to participate in the project.

### **Procedures**

The project began by acquiring permission from administrators and leaders at the practice site to provide the educational program to nurses working at the site. The site approval letter can be found in Appendix C. Once approval for the project was obtained, Institutional Review Board (IRB) approval for the project was sought from Florida International University (FIU). Appendix D includes the IRB approval letter from FIU that was granted on March 3, 2022. No recruitment or practice change activities could be undertaken until IRB approval confirming the ethical soundness of the project. Following IRB approval for the project, recruitment of nurses at the practice site began. This was done through an email sent to all nurses who currently work on the unit (Appendix B). The facility maintains an internal email directory of all personnel including nurses that was accessed by the principal investigator for recruitment. The initial email sent to nurses asked those interested in participating to respond to the email within one week. If nurses did not respond, a follow-up email will be sent at the end of the first week, requesting nurses to

respond by the end of the second week if they are interested. Nurses who did not respond to the email were excluded from future email communication regarding the project.

All nurses interested in participating in the project were sent a follow-up email with a letter of informed consent (Appendix E). To protect recipient privacy, all nurses that had agreed to participate in the project were blind copied. The email contained instructions for completing the informed consent form including the need to review the project details and to either sign the form electronically or to print the form and sign it so that it could be scanned and returned.

Recipients were also asked to complete the form within one week. Based on the nurses expressing interest in the project and the completed informed consent forms returned by one week, a follow-up email was sent to those who expressed interest in the project but did not complete the informed consent form. In the follow-up email recipients were asked to return their informed consent forms within one week. Nurses who do not return their informed consent forms in that time period were excluded from the project.

Once all informed consent forms had been returned, nurses were considered participants in the project and were sent an email via Qualtrics containing a demographic questionnaire (Appendix F) and a pre-test to evaluate their knowledge of mHealth (Appendix G). It was anticipated that the demographic questionnaire and pre-test will take participants between 15 and 20 minutes to complete. The email asked participants to complete the demographic questionnaire and pre-test and return it within one week. Participants who do not complete these forms were sent a follow-up email and were asked again to complete the forms within one week. Participants who do not complete the forms were excluded from the project. Results from the pre-test were evaluated to identify key knowledge deficits regarding mHealth for nurses. These gaps in

knowledge were addressed through the creation of an educational PowerPoint presentation that was used to educate providers about mHealth and its use in practice.

The educational PowerPoint was presented to participants via Qualtrics Survey link on June 4<sup>th</sup>, 2022. This was done via Qualtrics email and participants were asked to confirm that they have viewed the educational module. Participants were given two weeks to complete the educational module and to reach out to the principal investigator with any questions. Any participants who had not responded in two weeks were sent a follow-up email giving them an additional week to complete the module. At the end of this follow-up period participants who did not indicate that they have completed the module had their data excluded from the project.

Following the completion of participant education, a final Qualtrics email was sent with the post-test (Appendix G). The post-test included the same questions as those included on the pre-test with the questions placed in a different order. It was anticipated that it would take participants 15 minutes to complete the post-test. Participants were asked to complete the post-test assessment within one week. A follow-up email was sent to participants who do not complete the post-test assessment in this timeframe. Participants who failed to complete the post-test during the follow-up period, had their data excluded from the final analysis of the data. Data collected from the pre- and post-tests was evaluated and the scores for the pre- and post-test were entered into an SPSS spreadsheet for evaluation along with participant demographic data.

### **Protection of Human Subjects**

The protection of human subjects in any research must be considered to ensure that a study is ethically sound. To ensure that nurses participating in this project are protected, IRB approval for the project was initially sought. Acquisition of IRB approval was indicative of the fact that the project did not cause significant or substantial harm for the participant. Additionally,

for nurses agreeing to participate in the project written informed consent was required (Appendix E). Nurses were sent the informed consent form via email and were asked to sign and return the form. The principal investigator was responsible for addressing any questions that participants had about the project and for ensuring that nurses signed the consent form and were provided with a copy of the document for their records. Informed consent provided information to the nurse regarding project benefits and harms as well as their rights regarding project participation and withdrawal from the project.

Additional steps were be taken to protect participant data privacy. Demographic surveys collected from participants at the beginning of the project asked for nurse first names only. However, no other personal identifying information regarding the nurse was collected. Name and email data was not used outside of the project through the dissemination of project results and was not included on the SPSS spreadsheets that were developed for data analysis. The email addresses of nurses were be entered into a standard encrypted email program (Gmail) and used to send the final assessments from a password protected account that was only accessible by the principal investigator. All emails were blinded to ensure that nurses cannot see the names of other individuals that had agreed to participate in the project.

### **Data Collection**

Data collection for the project occurred at baseline and following the completion of the educational module. A demographic survey was used to obtain a descriptive understanding of those participating in the study and included general information such as gender, age, race, work title, and years of experience (Appendix F). A pre-/post-test was specifically created for this project (Appendix G).

### **Data Analysis**

Data analysis for the project began with a descriptive evaluation of the demographic data collected for the project. Demographic data collected was tabulated and compared including frequency, mean, and standard deviation. This data provided a comprehensive overview of the characteristics of the sample. Descriptive data analysis including mean and standard deviation were used to assess scores from the pre- and post-tests. This provided information regarding the directionality of the scores: i.e., if they increased or decreased. Because of the small size of the sample ( $n = 11$ ), it was not possible to demonstrate that the data collected was normally distributed (Mishra et al., 2019). Consequently, to complete the inferential analysis of the data a non-parametric test of equivalency was needed. The Mann-Whitney U-test, which compares mean scores and is analogous to the parametric paired t-test, was selected for use in the project (Mishra et al., 2019). This Mann-Whitney U-test provided insight into the statistical significance of the data utilizing an alpha value of 0.05.

### **Data Management**

Data management for the project must also be considered. All forms and tests were submitted and collected electronically. To protect the data, all information was sent through an encrypted email server and all data including SPSS data was stored on a password protected laptop to which only the principal investigator has access. All data collected for the project will be destroyed within five years. This will include having the hard drive for the laptop professionally removed and wiped to ensure that no data from the project is accessible from this device.

## Results

### Descriptive Data

As noted, when reviewing the data analysis procedures for this project, descriptive analysis of the demographic data was tabulated along with mean pre- and post-test knowledge scores for nurses. The demographic data is summarized in Table 1 and indicates that  $n = 11$  nurses were enrolled in the project. From the table it is possible to see that the mean age for the sample was 36.27 (s.d. 2.32) with a range of 24 to 47. Additionally, of those participating in the project 73% ( $n = 8$ ) were female, 100% ( $n = 11$ ) were Hispanic, and 46% ( $n = 5$ ) currently held an RN associated degree, 36% ( $n = 4$ ) held a Bachelors of Nursing (BSN) degree, and 18% ( $n = 2$ ) were credentialed as an advanced practice nurse.

**Table 1**

*Demographic Data for Project Participants ( $n = 11$ )*

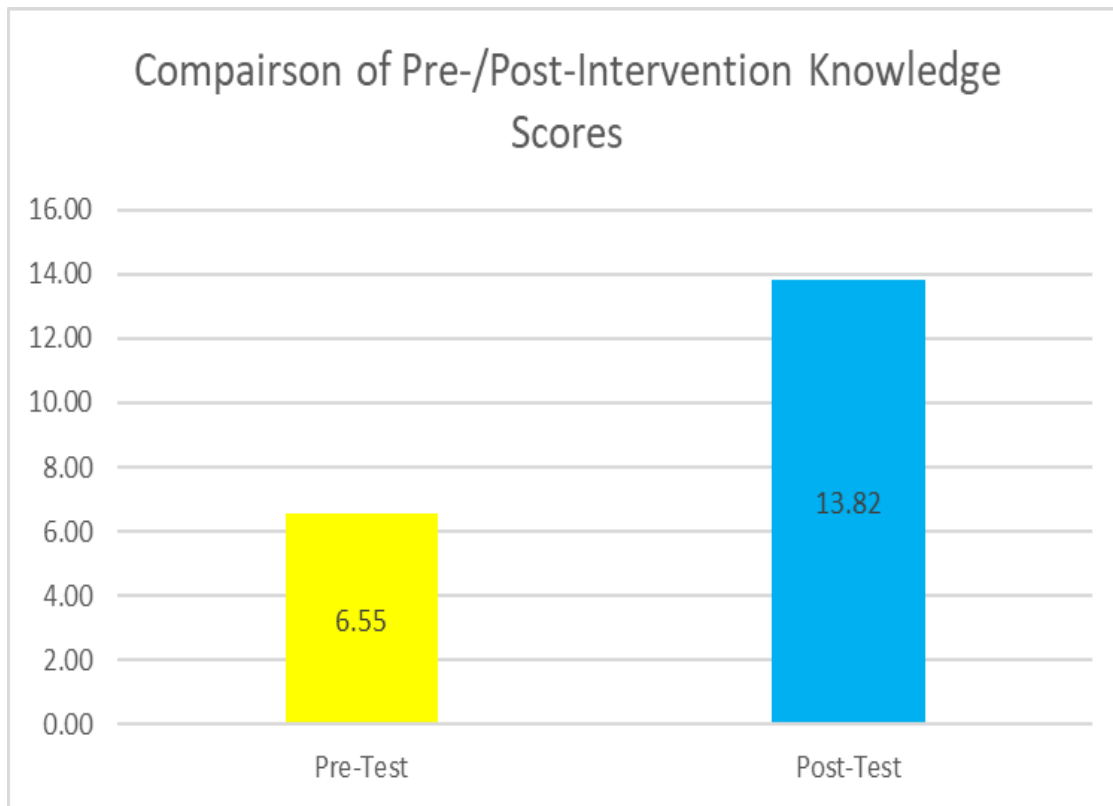
Age	36.27 (range 24 – 47) s.d. 2.32
Gender	
Male	3 (27%)
Female	8 (73%)
Race	
Hispanic	11 (100%)
Position/Education	
RN	5 (46%)
BSN	4 (36%)
Advanced Practice Nurse	2 (18%)

In addition to utilizing descriptive data analysis to provide an overview the characteristics of the sample, descriptive data analysis was also used to evaluate the mean and standard deviations for the pre- and post-intervention knowledge tests. The analysis indicated that for the pre-assessment of knowledge, the mean score on the assessment of 6.55 with a standard

deviation of 1.22 and a range of 1 to 9. The post-test knowledge scores indicated a mean of 13.8 and a standard deviation of 2.49 with scores ranging from 10 to 15. To provide a visual representation of the data, Figure 1, below, includes a bar graph which not only illustrates the differences in scores but also an increase in scores from the pre- to the post-intervention stages.

### Figure 1

*Comparison of Pre-/Post-Intervention Knowledge Scores (n = 11)*



### Inferential Data

Although the information from the mean pre- and post-intervention knowledge scores does indicate that these scores increased (as anticipated), the data analysis provided regarding these scores does not indicate if the change that occurred was statistically significant.

Consequently, inferential analysis of the data was needed to determine if the change in knowledge was a result of chance or was related to the educational intervention provided. As previously noted when reviewing the data analysis approach used in this quality improvement project, the small sample size makes it difficult to state with certainty that the data is normally distributed. Consequently, a non-parametric test to compare means, the Mann-Whitney U-test was used to evaluate the statistical significance of the data in comparison with an alpha value of 0.05. The results of the Mann-Whitney U-test revealed  $P = 0.000$ , indicating that the change in scores from the pre- to post-intervention periods was the result of something other than chance, i.e., the educational module.

pre	post
1	10
6	11
6	15
5	15
6	14
9	15
8	14
8	15
8	14
9	15
6	14
<b>Pre-Test Means</b>	<b>Post-Test Means</b>
6.55	13.82

t-Test: Paired Two Sample for Means		
	<i>pre</i>	<i>post</i>
Mean	6.54545	13.81818182
Variance	5.27273	2.963636364
Observations	11	11
Pearson Correlation	0.71062	
Hypothesized Mean Di	0	
df	10	
t Stat	-14.9071	
P(T<=t) one-tail	1.9E-08	
t Critical one-tail	1.81246	
P(T<=t) two-tail	3.7E-08	
t Critical two-tail	2.22814	

### Discussion

The data obtained for this quality improvement project does indicate that provider education regarding mHealth applications does improve provider knowledge of these tools. This is commensurate with the literature on the topic and does indicate that provider education should be used to increase knowledge (Amoakoh-Coleman et al., 2016; Soloe et al., 2021). Although the results of this quality improvement project do not indicate if this increased knowledge of providers for mHealth use in DSMES will increase provider and patient use of mHealth tools in practice, there is ample research suggesting that this outcome should result (Armstrong, 2019;

Armstrong et al., 2018). Therefore, while it is not possible to state with certainty that the increased provider knowledge will lead to changes in practice, based on the current literature there is reasonable evidence to suggest that this outcome will occur.

Type 2 diabetes is a growing threat to individual and public health (Dougherty & Heile, 2020; Powers et al., 2020). Improving provider knowledge of mHealth applications to expand the use of these tools for DSMES appears to be a useful approach to enhancing the care of patients. When reviewing the literature, the evidence does indicate that provider lack of knowledge regarding DSEMS as well as provider lack of time to implement this change in practice setting play significant roles in provider ability and willingness to provide DSMES for patients diagnosed with diabetes (Cui et al., 2016; El-Gayar et al., 2021; Hou et al., 2016). mHealth tools may alleviate some of these burdens by facilitating the ability of providers to introduce mHealth tools for patients such that patients can educate themselves and utilize specific mHealth tools that will enable them to achieve better glycemic control.

Although the current quality improvement project does not assess outcomes related to provider and patient use of mHealth, evidence does indicate that once providers are educated about these tools, the knowledge gained from education is retained over the long-term (Armstrong, 2019; Armstrong et al., 2018). Further evidence does indicate that following education, providers do increase their use of mHealth both in the short- and long-term (Armstrong et al., 2018). What this suggests is that the educational module provided for this project should continue to impact and influence provider practice when it comes to DSMES and the use of mHealth applications. Over time this should have several benefits including better self-care management by patients, improved glycemic control, a reduction in disease-related

complications, and a reduction in overall healthcare costs to provide care for patients with diabetes.

The insight provided here also indicates that there are numerous areas for additional investigation into the topic. Extending this quality improvement project to collect secondary data from providers educated such as use of mHealth and number of patients educated about mHealth could provide important insight into the effect of education on practice outcomes for nurses. Further, data could be tracked longitudinally to determine if knowledge is retained and further if nurses continue to advocate for mHealth in the clinical setting. Outside of this quality improvement project, it would be helpful to expand the number of nurses and healthcare providers involved in education while also expanding the project to different practice sites to determine if the results are similar. This data would be instrumental in supporting change and could expand the evidence base to foster the adoption of mHealth in other practice sites both nationally and internationally.

### **Limitations**

Even though the results from this quality improvement project do indicate that statistically significant increases in knowledge scores did result for providers, there are several limitations to the study that must be taken into consideration. The primary limitation noted is about the methodological weaknesses of the quasi-experimental design. As noted, quasi-experimental designs lack certain components of RCTs including randomization of the sample, the use of a control group, or both (Miller et al., 2020). In the present project, the sample was a convenience sample that was recruited from a single site and only included 11 nurses. While a single group comparison was made, a true control group was not utilized. These features of the quasi-experimental design have several implications for the project.

A lack of randomization in the sample, suggests that the sample used was not representative of the larger population (nurses who provide care for patients with diabetes). As a result, the results of this project may not be generalizable to other nurses working in diverse practice settings. Additionally, the sample is not compared to a tur control group, i.e., one that has not received the educational module. Thus, while it was possible to state that the increase in scores from the pre- and post-intervention phases of the study were statistically significant, it is not possible to state that causality is present. There is no indication that the educational intervention caused the increase in knowledge scores for nurses.

### **Implications of the Results for Nursing**

The implications of the results of this project for practice must be considered in terms of nursing practice, education, leadership, and administration. In terms of nursing practice, the results from this quality improvement project do support the current evidence-based literature demonstrating the utility of both mHealth and provider education for mHealth. Because the results align with the literature, it is reasonable to argue that a change in practice to educate providers regarding mHealth should be considered. Regarding nursing education, this quality improvement project does illustrate the importance of nurse education in the clinical setting to augment the care of patients. Nurses, especially those educated at the advanced practice level, should be able to work within their practice settings to educate providers about mHealth such that these tools can be utilized in patient care.

Nursing leadership and administration must also be considered in the context of this project. The project demonstrates the role of the Doctor of Nursing Practice (DNP) scholar-practitioner in leading change within the clinical setting. More specifically, this project highlights how nurses can conceptualize practice problems, identify solutions, and implement

change to bring about improvements in the way care is delivered along with patient health outcomes. Nurses can and should lead change and this project provides a clear model of how this can be done. For nurses working in healthcare administration, this project highlights the broader importance of integrating evidence-based practice and quality improvement into the healthcare setting. Administrators need to be aware of the need for change and the importance of advanced practice nurses in contributing to this change. Through their actions, administrators can support practice change through providing important organizational and material resources.

### **Dissemination and Sustainability**

Dissemination of the project will occur at the practice site as well as in the nursing profession. At the practice site, all leaders and nurses working at the facility will be provided with an executive summary outlining the contents of the project and its outcomes. Additionally, a poster will be created for the practice site and will be left on display for nurses and all healthcare providers to review. Outside of the healthcare organization, dissemination of the project will include efforts to have the work published in a peer-reviewed journal such as *Diabetes Spectrum* or *Diabetes Care*. These publications include work on improving the treatment and management of diabetes in clinical practice. Dissemination would also occur through a poster presentation at a national conference. One potential venue for presenting a poster would be at the International Conference on Applied Nursing which will be held on March 10-11, 2023 in Miami.

Sustainability of the project will be evaluated through data collection regarding how many patients receive education on mHealth applications. This should be recorded in the patient's chart and chart reviews conducted every six months should provide ample evidence regarding how the project is being sustained. Sustainability will also be addressed through educating new hires on the unit about the topic and expanding education to include other nurses

in other departments within the facility. Ongoing monitoring of the project and reporting results in terms of patients provided with education will be helpful to determine if additional action is warranted to keep the program thriving over the long-term or to determine if additional education and supports are needed for providers at the facility.

### **Conclusion**

Diabetes is a growing threat to health and to healthcare financing. Although there is no cure for diabetes, effective glucose control can reduce disease-related complications, morbidity, and mortality associated with the disease. Evidence-based interventions such as diabetes self-management education and support can be helpful for achieving these goals. However, if providers are not willing or able to provide DSMES, the ability of patients to effectively self-manage their disease will be lost. mHealth applications appear to fill vital gaps in the current delivery of DSMES for patients. Providers require education and training, however, to use mHealth tools in practice.

This quality improvement project demonstrated the benefit of increased provider knowledge following an educational program on mHealth. As reported in the literature, this increased knowledge should result in changes to practice that will enable patients to access, use, and integrate mHealth applications for DSMES in their daily lives. By making this vital change in practice, patients should be better able to manage their disease and further to improve health outcomes and quality of life while also reducing care costs. Even though this quality improvement project does have some notable limitations, there is enough evidence to support a practice change based on the current evidence, indicating that all providers working with patients that have a diagnosis of type 2 diabetes should be educated about the use of mHealth as a means to improve the care delivered to patients.

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### Appendix: Literature Matrix Table

Author/Year	Purpose/ Problem/ Objective/ Aims	Study Design	Sample (Setting)	Data Collection Measures	Results	Strengths/ Limitations	Relationship to Project	Level of Evidence
<b>Barriers to mHealth Adoption among Providers</b>								
Gagnon et al. (2016)	To evaluate the facilitators and barriers to mHealth adoption among providers.	Systematic review	Four electronic databases including PubMed, EMBASE, CINAHL, and PsychInfo published between the years of 2000 and 2014	33 articles meeting the inclusion criteria.	Provider knowledge noted to be an individual barrier to mHealth adoption that has systemic implications for the organization and context of the care setting.	Strengths: Demonstrates that provider knowledge is a barrier to mHealth; strong methodology and level of evidence.  Weaknesses: Limited search criteria; no meta-analysis.	Provides support demonstrating that provider knowledge limits the use of mHealth in practice.	Level I Quality B
Jacob et al. (2020)	To evaluate the barriers to mHealth adoption among providers.	Systematic review	Four electronic databases including MEDLINE, PubMed, the Cochrane Library, and SAGE published between the years of January 2008 and July 2018	171 articles were identified for inclusion.	Analysis of the literature facilitated the identification of eight dominant themes regarding barriers to the adoption of mHealth among providers. Themes identified that were relevant to this project included: a lack of awareness of mHealth, a lack of knowledge regarding mHealth applications, a lack of knowledge regarding how to integrate mHealth into the workflow associated with patient care, and lack of knowledge regarding how to	Strengths: Demonstrates that provider knowledge is a barrier to mHealth; strong methodology and level of evidence.  Weaknesses: Limited search criteria; no meta-analysis.	Provides support demonstrating that provider knowledge limits the use of mHealth in practice.	Level I Quality B

					manage technical issues associated with mHealth adoption and use in the clinical setting.			
Zakerabasali et al. (2021)	To evaluate the barriers to mHealth adoption among providers.	Systematic review	Four electronic databases including PubMed/MEDLINE, Web of Science, Embase, and Google Scholar published between January 2015 and December 2019	18 articles were selected for inclusion.	Knowledge and limited provider literacy regarding mHealth were identified as an individual barrier	Strengths: Demonstrates that provider knowledge is a barrier to mHealth; strong methodology and level of evidence.  Weaknesses: Limited search criteria; no meta-analysis.	Provides support demonstrating that provider knowledge limits the use of mHealth in practice.	Level I Quality B
<b>Benefits of mHealth in Improving Patient Outcomes</b>								
Cui et al. (2016)	To evaluate randomized controlled trials to assess the impact of mHealth interventions on changes in glycosylated hemoglobin (HbA1c), blood glucose, and body weight in patients with type 2 diabetes	Systematic review and meta-analysis	Three electronic databases including PubMed, the Cochrane Library, and Embase published between January 2005 and June of 2016. Randomized controlled trials only.	A total of 13 studies were included in the systematic review, of which, six qualified for inclusion in the meta-analysis accounting for 1,022 patients.	The results were reported in terms of standardized mean difference (SMD) for subjects undergoing mHealth treatment and indicated that those who received the intervention fared much better in terms of glycemic control as measured by HbA1c: SMD - 0.40% (95% confidence interval [CI] = -0.69 to -0.10%, p = 0.008). No changes in weight were noted.	Strengths: Demonstrates that mHealth improves self-management of disease; high level of evidence.  Weaknesses: Limited search criteria and databases used.	Provides support that mHealth can improve diabetes self-management,	Level I Quality A
El-Gayar et al. (2021)	The purpose of this study was twofold including an evaluation of mHealth	Systematic review and meta-analysis	Two electronic databases including PubMed/Medline and Web of Science published between	A total of 21 studies including 1,920 patients with diabetes	mHealth applications led to significant declines in HbA1c as measured by SMD: -	Strengths: Demonstrates that mHealth improves self-management of	Provides support that mHealth can improve	Level I Quality A

	applications on glycemic control (HbA1c) when compared with care as usual and to evaluate differences in applications including comparing outcomes for those that did and did not use behavioral theories to guide patient self-care activities		January 2010 and October 2020. Randomized controlled trials only.	were included in the review.	0.38% (95% CI = -0.50 to -0.25, p < 0.001).	disease; high level of evidence.  Weaknesses: Limited search criteria and databases used.	diabetes self-management,	
Hou et al. (2016)	The focus of the study was to evaluate the use of mHealth applications on glycemic control in the self-management of diabetes	Systematic review and meta-analysis	Five electronic databases including Medline, CINAHL, Cochrane Library, Web of Science, and Embase published between January 1996 and June 2015. Randomized controlled trials only. Also data also evaluated using GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria	A total of 14 randomized controlled trials involving 1,360 patients were included in the review.	The systematic review of the data indicated that all studies showed positive results for reducing A1c values for patients. Meta-analysis of the data further indicated that the SMD for patients enrolled in mHealth applications compared with care as usual was -0.49% (95% CI = -0.30, -0.68). Application of GRADE criteria to the findings indicated a moderate effect.	Strengths: Demonstrates that mHealth improves self-management of disease; high level of evidence.  Weaknesses: Limited search criteria and databases used.	Provides support that mHealth can improve diabetes self-management,	Level I Quality A
<b>Provider Education to Improve Knowledge of mHealth</b>								
Amoakoh-Coleman et al. (2016)	To examine the use of provider education to improve knowledge of mHealth in	Systematic review	Five electronic databases including the Cochrane Library, PubMed, EMBASE, Global Health Library, and Popline.	19 Studies located: 10 included interventions and nine were noted to be	In each study increased provider knowledge was noted and was associated with the integration of	Strengths: Demonstrates that provider education can improve knowledge of	Supports the intervention proposed for this quality improvement project.	Level I Quality B

	providing care to improve maternal and neonatal outcomes in low- and middle-income countries.			descriptive (cross-sectional) in nature	mHealth applications into the care of the patient.	mHealth; strong methodology and level of evidence.  Weaknesses: Limited search criteria; no meta-analysis.		
Armstrong (2019)	An eight day training program provided to 252 providers to educate them about the use of mHealth and best practices for integrating this technology as part of patient care.	Quasi-experimental pre-/post-test design	252 providers working as direct clinical practitioners working for various Department of Defense (DoD) and the Department of Veterans Affairs (VA) hospitals and clinics.	Pre- and post-test knowledge assessments.	Knowledge of mHealth was measured before and following the intervention and the results indicate that provider knowledge increased from 49.5% before the education to 95.8% following the intervention. Follow-up at three months indicated that most knowledge had been retained: 83.3%.	Strengths: Provides data to support the use of mHealth provider education; large sample of providers; comprehensive educational program.  Weaknesses: Lack of generalizability of the sample; does not show causation only correlation.	Supports the intervention proposed for this quality improvement project.	Level II Quality B
Armstrong et al. (2018)	Evaluate the results of a four-year longitudinal study to track outcomes of an mHealth educational program.	Quasi-experimental pre-/post-test design	760 mental health providers working for the VA and other military clinics	Assessment of provider use of mHealth before and after the intervention and at four-years follow-up.	Before the educational workshop only 41.1% of providers reported using mHealth as part of treatment. Following the intervention this increased to 93.7%. At four-years follow-up, 90.8% of providers were noted to be using mHealth as part of patient care.	Strengths: Provides data to support the use of mHealth provider education; large sample of providers; comprehensive educational program.  Weaknesses: Lack of generalizability of the sample; does not show	Supports the intervention proposed for this quality improvement project.	Level I Quality B

						causation only correlation.		
Soloe et al. (2021)	To evaluate provider education programs in using mHealth in the detection, treatment and survivorship care of patients with cancer. More specifically, the authors sought to evaluate provider knowledge and confidence associated with mHealth training.	Systematic review	Three electronic databases including PubMed, Embase, and Web of Science published between 2010 and 2020.	A total of 23 studies were included.	The authors noted that all studies demonstrated some improvement in provider knowledge and confidence following education on mHealth applications.	Strengths: Demonstrates that provider education can improve knowledge of mHealth; strong methodology and level of evidence.	Supports the intervention proposed for this quality improvement project.	Level I Quality B

**Appendix B: Email Recruitment Letter**

**Recruitment Email for Improving knowledge of Diabetes Self-Management Education and Support via mHealth among nurses: A quality improvement project.**

Dear Mercy 7<sup>th</sup> Floor Carroll Tower Nurse,

My name is Marisol Ortega, and I am a student from the Graduate Nursing Department at Florida International University. I am writing to invite you to participate in my quality improvement project. The goal of this project is to improve knowledge of Diabetes Self-Management Education and Support via mHealth among nurses. You are eligible to take part in this project because you are a registered nurse at Mercy Hospital, and you provide or may provide general care or postoperative care to diabetic patients. I am contacting you with the permission of your nursing director.

If you decide to participate in this project, you will be asked to complete and sign a consent form for participation. You will complete a pre-test questionnaire, which is expected to take approximately 10-15 minutes. Then, you will then be asked to view an approximately 20-minute-long educational presentation online. After watching the video, you will be asked to complete the post-test questionnaire, which is expected to take approximately 10-15 minutes. All activities, the consent, the pre and posttest and the educational intervention will all be done virtually. No compensation will be provided.

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate, please click on the link provided (link for Qualtrics questionnaire). If you have any questions about the study, please email or contact me at [morte097@fiu.edu](mailto:morte097@fiu.edu) or 786-376-2718.

Thank you very much.

Sincerely,

Marisol Ortega Rodriguez.

**Appendix C: Site Approval Letter**

Date: 02/11/22

Charles P. Buscemi, PhD, APRN  
Interim Director, DNP Program  
Clinical Associate Professor  
Nicole Wertheim College of Nursing & Health  
Sciences Florida International University

Dear Dr., Buscemi:

Thank you for inviting Mercy Hospital 7<sup>th</sup> Floor Carroll Tower to participate in the DNP Project of Marisol Ortega Rodriguez. I understand that this student will be conducting this project as part of the requirements for the Doctor of Nursing Practice program at Florida International University (FIU). After reviewing the project's proposal titled *"Improving knowledge of Diabetes Self-Management Education and Support via mHealth among nurses: A quality improvement project"* I have warranted her permission to conduct the project in this floor.

We understand that the project will be developed in our setting and that obtaining consents, pre/posttest, and educational intervention will all be done virtually, and probably be implemented afterward. We are also aware of our staff participation in supporting the student to complete this project, including grant the student access to our facilities, give consent, deliver the pre-test questionnaire, provide the educational intervention and the posttest questionnaire to the recruited participants, all activities will be conducted virtually, no face-to-face contact will be required.

This project intends to evaluate if a structured educational program targeting nurses will increase their knowledge in diabetes self-management education and support via mHealth applications. Before implementing this project, the Florida International University Institutional Review Board will evaluate and approve the procedures to conduct the project. Effective diabetes self-management is the goal of diabetes treatment aimed at decreasing the mortality and morbidity risks and optimizing blood sugar control. Evidence-based practice guidelines provided by the American Diabetes Association indicate that DSMES should be provided to all patients with a diagnosis of diabetes. Self-management enables patients to achieve greater glycemic control with the intention of preventing or delaying the onset of disease-related complications. Unfortunately, the delivery and use of diabetes self-management education and support in clinical settings is suboptimal thus causing high rates of either uncontrolled or poorly controlled diabetes

The educational intervention will be done via zoom or Microsoft team and will last 30 minutes. The student will provide the educational materials to each participant virtually. Any data collected by Marisol Ortega Rodriguez will be kept confidential and stored in a password-protected computer.

We expect that Marisol Ortega Rodriguez will not interfere with the normal floor performance. Furthermore, Ms. Ortega will behave professionally and follow the floor standards of care. As the Director of Nursing for this floor, I support our nurse's participation in this project and look forward to work with you.

Sincerely,


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Nathalie Aponte, RN  
Director of Nursing 7<sup>th</sup> Carroll  
Mercy Hospital

**Appendix D: IRB Approval Letter**

Office of Research Integrity  
Research Compliance, MARC 414

**MEMORANDUM**

**To:** Dr. Charles Buscemi  
**CC:** Marisol Ortega Rodriguez  
**From:** Maria Melendez-Vargas, MIBA, IRB Coordinator   
**Date:** March 3, 2022  
**Protocol Title:** "Improving knowledge in Diabetes Self-Management Education and Support via mHealth among nurses: A quality improvement project."

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The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

**IRB Protocol Exemption #:** IRB-22-0066      **IRB Exemption Date:** 03/03/22  
**TOPAZ Reference #:** 111447

As a requirement of IRB Exemption you are required to:

- 1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
- 2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
- 3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

*Special Conditions:* N/A

For further information, you may visit the IRB website at <http://research.fiu.edu/irb>.

MMV/em

## Appendix E: Informed Consent Form



### **CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT** “Improving knowledge of Diabetes Self-Management Education and Support via mHealth among nurses: A quality improvement project”.

#### **PURPOSE OF THE PROJECT**

You are being asked to be in a quality improvement project. The goal of this project is to improve nurses’ knowledge on DSMES via mHealth through a structured intervention targeting nurses to learn and understand the use of mHealth applications for diabetes self-management, education, and support.

#### **NUMBER OF PROJECT PARTICIPANTS**

If you decide to be in this project, you will be one of ten people participating in this research project.

#### **DURATION OF THE PROJECT**

Your participation will require about 15 minutes of your time in the first session and 20 minutes in the second session, and 15 minutes in the third section that will occur two weeks after your first session.

#### **PROCEDURES**

If you agree to be in the project, we will ask you to do the following things:

1. At your first session, you will complete a demographic questionnaire, which includes general information such as age, gender, position in practice; and a pre-test with the mobile health applications knowledge
2. In the second session, you will receive a 20-minute educational program about mobile health applications for diabetes self-management education and support in diabetic adults.
3. Two weeks later, you will be asked to complete the knowledge of mobile health application post-test.

All activities, the consents, pre/post test and educational intervention will all be done virtually.

#### **RISKS AND/OR DISCOMFORTS**

There are no foreseeable risks with you for participating in this project.

#### **BENEFITS**

As a result of this project, it is expected that participants will gain increased knowledge of mHealth application to delivery diabetes self-management education and support to diabetic patients. Furthermore, it is expected that this study will benefit society by guiding nurses to use

mHealth as a channel for disseminating educational and support messages, resulting in positive attitudes towards diabetes management and treatment compliance.

### **ALTERNATIVES**

There are no known alternatives available to you other than not taking part in this project. However, if you like to receive the educational material given to the participants in this project, it will be provided to you at no cost

### **CONFIDENTIALITY**

The records of this project will be kept private and will be protected to the fullest extent provided by law. If, in any sort of report, we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

### **COMPENSATION & COSTS**

There is no cost or payment to you for receiving the health education and/or participating in this project.

### **RIGHT TO DECLINE OR WITHDRAW**

Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

### **RESEARCHER CONTACT INFORMATION**

If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact Marisol Ortega at 786-376-2718, [morte09@fiu.edu](mailto:morte09@fiu.edu) or Dr. Charles Buscemi at 305-348-4870, [cbuscemi@fiu.edu](mailto:cbuscemi@fiu.edu).

### **IRB CONTACT INFORMATION**

If you would like to talk with someone about your rights of being a subject in this project or about ethical issues with this project, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at [ori@fiu.edu](mailto:ori@fiu.edu).

### **PARTICIPANT AGREEMENT**

I have read the information in this consent form and agree to participate in this project. I have had a chance to ask any questions I have about this project, and they have been answered for me. I understand that I will be given a copy of this form for my records.

---

Signature of Participant

---

Date

---

Printed Name of Participant

---

Signature of Person Obtaining Consent

---

Date

## Appendix F: Demographic Questionnaire

### PERSONAL INFORMATION

1. **Gender:** Male          Female          Other

2. **Age:** \_\_\_\_\_

3. **Ethnicity:**

Hispanic          Caucasian          African American          Asian          Other

4. **Position/Title:** \_\_\_\_\_

5. **Level of Education:** Associates                  Bachelors                  Masters

Other

6. **Certification in Specialty** (e.g. RNC): Yes No

### Appendix G: Pre-/Post-Test

- 1. According to the literature, mHealth is “the delivery of healthcare services via mobile communication devices, it refers to the concept of mobile self-care — consumer technologies like smartphone and tablet apps that enable consumers to capture their own health data, without a clinician’s assistance or interpretation”.**
  - a. True
  - b. False
  
- 2. What is the goal of mHealth? Select all that apply**
  - a. Improve delivery of healthcare
  - b. Screening patients at least once if they have personal or family diabetic history
  - c. Improve patient outcomes
  - d. Improve the quality of life
  
- 3. Select types of mHealth technology**
  - a. Tablets
  - b. EHR
  - c. Smart phones
  - d. Wearable
  
- 4. What is diabetes?**
  - a. A disorder involving excessive body fat that increases the risk of health problems.
  - b. a limit blood flow, increasing risk of heart attack or stroke.

- c. a disease in which the body's ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood and urine.
- d. a condition to reduced oxygen flow to the body's organs.

**5. Diabetes facts, select True (T) or False (F)**

- a. More than 37 million people in the United States have diabetes, and 1 in 5 of them don't know they have it. \_\_\_\_
- b. Medical costs and lost work and wages for people with diagnosed diabetes total \$127 billion yearly. \_\_\_\_
- c. Diabetes is the 7th leading cause of death in the United States (and may be underreported) \_\_\_\_
- d. In the last 20 years, the number of adults diagnosed with diabetes has more than doubled as the American population has aged and become more overweight or obese. \_\_\_\_

**6. What risks are associated with Diabetes:**

- a. Kidney failure
- b. low blood pressure
- c. heart disease
- d. loss of toes, feet, or legs.

**7. What is Diabetes Self-Management Education and Support (DSMES)?**

- a. a cost-effective tool proven to help improve health behaviors and health outcomes for people with diabetes

- b. a self- pay course to manage diabetes.
- b. is the process of facilitating the knowledge, skill, and ability necessary for diabetes self-care.
- c. not covered for most of the insurance.

**8. Who can provide diabetes education?**

- a. any healthcare professional holding certification as a diabetes educator.
- b. Registered Nurse
- c. Registered Dietitian
- d. Pharmacist

**9. Diabetes Self-Management Education and Support applications are:**

- a. BlueStar (FDA approved in 2017)
- b. Fooducate
- c. You tube
- d. MySugr

**10. Can a glucose meter be attached to the mobile device?**

- a. YES
- b. NO

**11. How can mHealth be applied to improving diabetes care? Select all that apply.**

- a) Information collection.
- b) Disease education
- c) Disease-related alerts and reminders
- d) Skip planned physical activity

