Diabetes self-care management using mobile applications among medically underserved population

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Abstract

Patients with type-2 diabetes can benefit from self-care behaviors that include eating a healthy diet, exercising regularly, and monitoring health conditions periodically. Most patients fail to abide by this routine, thus resulting in serious health complications. This situation is more prevalent among medically underserved populations (MUP). MUPs, typically, are from low-income groups and often lack health insurance and access to medical care. Mobile technology is increasingly being used in chronic disease management. In this study, we use a mixed method research approach to investigate factors that influence the intention to adopt mobile technology for diabetes self-care management among MUPs. We extend the Technology Acceptance Model (TAM) with relevant constructs (e.g. illness representation and privacy concern) to contextualize the healthcare setting of MUPs. This study will contribute to our understanding of mobile technology adoption behavior of MUPs and help improve diabetes management among this patient population.

Keywords
Diabetes, medically underserved population, adoption, mobile technology

Introduction

Diabetes is a highly prevalent chronic disease in the U.S. with an estimated total cost of $327 billion as of 2017 (American Diabetes Association, 2018). Nearly 9.4% of U.S. population are diabetics and their condition can lead to other complications such as kidney failure, non-traumatic lower-limb amputations, blindness, myocardial infarctions and strokes (Centers for Disease Control Prevention, 2017). Medically underserved populations (MUP) are more vulnerable to diabetes and self-care management helps individuals lead better lives (Reyes et al., 2017; Spencer et al., 2011). Healthcare access to MUPs has been a long-standing issue in the U.S. Often geographical distance can become a limitation in accessing primary health care services. In addition, obstacles to diabetes self-care management in MUPs include their socio-economic status, lack of insurance, medication cost, language barrier, lack of infrastructure, illiteracy and cultural differences (Ricci-Cabello et al., 2013).

Studies have found that health literacy is lower among Black and Hispanic adults compared to White adults (Kutner et al., 2006), and diabetes is disproportionately prevalent in these populations (Schiller et al., 2012). Bradley et al. (2007) found that MUPs may be poor, uninsured, have limited English language proficiency, and/or lack familiarity with the health care delivery system. They also live in locations where providers are not readily available to meet their needs. Self-management is key to keeping diabetes under control. Regular self-monitoring of blood glucose (SMBG), physical exercise, dietary control, smoking avoidance and foot care are routine activities in diabetes management. Seol et al. (2017) found that patients
among MUPs experienced lower HbA1c after intervention with visual tools such as Lifestyle Change Card (LCC) and Take-Home Diabetes Record (THDR).

Technology can play a key role in introducing aforementioned behavioral interventions. So far, most mHealth interventions were used to monitor patient conditions through health care personnel and few were used as self-care management tools. The use of mHealth apps can be effective in reducing the need for health care personnel, which in turn may reduce healthcare costs (Baron et al., 2012). Mobile devices may increase health-care access to people who lack time or means of transportation for regular medical visits (Burner et al., 2018). They can also help improve diabetes self-management behavior (Liang et al., 2011), and promote weight loss (Fukuoka et al., 2015). However, low income may pose a challenge to MUPs limiting their accesses to technology as well as traditional health resources (Chesser et al., 2016), thus leading to poor management of chronic diseases.

A review of the extant literature revealed a dearth of studies involving mobile technology interventions for diabetes self-care management among MUPs. The goal of our research is to fill this gap by designing a mobile technology-based intervention to promote diabetes self-care behavior among MUPs. Usage of mobile phone among MUPs lead us to search what factors influence the intention to adopt mobile technology and whether mobile phone apps are useful in improving diabetes self-care behavior among MUPs.

### Theoretical framework and hypotheses development

We developed a model (figure 1) of mobile technology adoption among MUPs using theoretical foundations of technology acceptance. Technology Acceptance Model (TAM) (Davis, 1989) has become a well-established, parsimonious model for predicting user acceptance and usage intentions of technology. While it originated in the context of mandatory use of office productivity technology, it has been subsequently found to effectively explain technology adoption behavior in diverse settings, including both voluntary and mandatory use contexts (Taylor and Todd, 1995; Venkatesh and Davis, 2000). We have incorporated illness representation and privacy concern as extension to TAM to adapt it to healthcare management scenario of MUPs.

### Illness Representation

The individual’s beliefs and perceptions of illness stored as illness representation in individuals’ memories provide five attributes about the disease such as disease identity (symptoms and label), timeline (time to develop or persist), consequences, causes, and controllability (Lau and Hartman, 1983). The Self-Regulation Model (SRM) views that individuals create mental representations of their illnesses based on the concrete and abstract source of information available to them and are motivated for a coping response to mitigate the threat and related distress (Leventhal et al., 1980). This information also influences the patient’s intention to seek external help or adopt an illness management regimen (Bishop and Converse, 1986). McGrady et al. (2014) found that greater illness representation (consequences) of diabetes is significantly related with glucose monitoring frequency, adherence to treatment and emergency precautions. Perceptions of individuals about the consequences of diabetes influence their motivations to lead disciplined and consistent lifestyles. Empirical studies support that threat perceptions of illness consequences are positively related to medication adherence (Brewer et al., 2002), adherence to medical...
Diabetes self-care management among MUPs

advice (Karademas et al., 2009) and self-care behaviors (Macinnes, 2013). These health-related perceptions of individuals influence their intention to adopt and use the technology for diabetes self-care management. Mobile technology brings a new opportunity to implement this behavioral change. Thus, we hypothesize

H1: Illness representation will have a positive effect on the intention to adopt mobile technology for diabetes self-care management among MUPs.

Perceived Usefulness

Perceived usefulness (PU) refers to prospective user’s subjective probability that using a specific application system will increase his or her job performance. An individual is keen to weigh the expected benefits from using technology before she/he intends to adopt it. Davis (1989) viewed that people tend to use or not use an application to the extent they believe it will help them perform their job better. Bandura (1982) extensive research on self-efficacy also supported PU and theorized it as a proximal determinant of behavior. A diabetic patient tends to develop beliefs about mobile application whether it can improve self-care management. This perception of expected benefits may influence the intention to adopt mobile technology. Thus, we hypothesize:

H2: Perceived usefulness will have a positive effect on the intention to adopt mobile technology for diabetes self-care management among MUPs.

Perceived ease of use

Perceived ease of use (EOU) refers to the degree to which the prospective user expects the target system to be free of effort. An individual’s assessment of the efforts is the initial obstacle that a user must overcome for using a system (Davis, 1989). Research studies on behavioral decision making (Payne et al., 1993) view that minimization of effort is positively related with intention and usage behavior. Adoption of mobile technology will tend to increase when the efforts involved in using mobile technology are less than other available tools. Diabetes self-care management using mobile application among medically underserved populations will demand less efforts and continue to improve patient’s overall health conditions. We develop our hypothesis as follows.

H3: Perceived ease of use will have positive effects on the intention to adopt mobile technology for diabetes self-care management among MUPs.

Privacy concern

Individuals may be unwilling to share personal health-related information in mobile applications if privacy concern looms in their minds. (Campbell, 1997) defined information privacy concerns as an individual’s subjective view of fairness within the context of information privacy. Internet privacy concerns represent an individual’s perceptions of consequences of providing information via the Internet (Dinev and Hart, 2004). The intention to adopt mobile technology for diabetes self-care management among MUPs is affected by information privacy concerns. Social Contract theory suggests that collection of personally identifiable data is perceived to be fair only when user is granted control over the information and is informed about the intended use of the information (Malhotra et al., 2004). Studies reported that privacy concerns increase when the Internet is used as a medium for transferring information (Dinev and Hart, 2004; Hui et al., 2007). Angst and Agarwal (2009) found that attitude and concern for information privacy influence the likelihood that the individual will opt-in to make his/her health-related data available in a digital artifact. Thus, we hypothesize:

H4: Increased privacy concern will have negative effects on the intention to adopt mobile technology for diabetes self-care management among MUPs.

Methodology

This evidence-based study will be approached in three phases. The first phase is to conduct two focus group studies. In this phase, we recruit 12-15 individuals in each group with type-2 diabetes from MUPs. The
objective of the first phase is to understand the lifestyle of this group and how they endeavor to manage diabetes through self-care management. This is expected to provide us insights about the expectations and challenges they face in tackling diabetes on daily basis. A professional diabetes educator will moderate the focus groups.

The second phase includes conducting a survey to collect data to validate the proposed model. A mobile application will be developed based on seven diabetes self-care behaviors advocated by American Association of Diabetes Educators. The insights from focus groups and the survey will be incorporated in the design of this app to reflect the specific needs of MUPs. The final phase includes a 6 week long field experiment with two groups: a control group with existing standards of care and an intervention group with mobile application in addition to standard care. The objective of this phase is to measure the impact of the mobile application on improving self-care behaviors of diabetes patients among MUPs.

Conclusion

This in-progress study is part of a larger research project that aims at developing mobile technology based interventions to improve diabetes care management among MUPs. The objective of the current study is to learn the factors that influence adoption of mobile technology for diabetes self-care among MUPs. It attempts to extend TAM with relevant constructs such as illness representation and privacy concern to shed light on mobile technology adoption in a healthcare context. This research will also help improve chronic illness management among MUPs, thus reducing health disparities, a major goal of population health management in the US.

REFERENCES

Diabetes self-care management among MUPs


