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THE EFFECTIVENESS OF DIABETES SELF-MANAGEMENT MOBILE APPLICATIONS AND ITS EFFECT ON SELF-EFFICACY, SELF-CARE AGENCY, SELF-CARE MANAGEMENT, AND HbA1C LEVELS AMONG PATIENTS WITH DIABETES MELLITUS

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ABSTRACT

Diabetes mellitus (DM) is a chronic and metabolic disease resulted from defects in insulin secretion, action or both. World Health Organization (WHO) reported that the incidence of DM is growing. It was estimated that 422 million adults having diabetes in 2014, compared to 108 million in 1980 (World Health Organization, 2016b). International Diabetes Federation (IDF) (2017) reported that the global prevalence of DM among those aged between 20-79 years was about 424.9 million patients (International Diabetes Federation, 2017).

KEYWORDS: Diabetes, Self-Management, HbA1C

INTRODUCTION

Diabetes as a chronic disease has many complications, which need management too. Self-care management plays an essential role in managing diabetes and its complications. Performing self-management activities depends on many factors like psychosocial factors, family and social support, patient's capability to perform self-care management activities, and his/her beliefs in owns' ability to perform these activities (American Diabetes Association, 2017). In other words, self-care agency and self-efficacy, which are considered as important factors in adaptation to and performing self-management in DM and other chronic diseases. Patients who have a high level of confidence in caring of their-selves and they are truly capable of performing self-care activities, they are expected to perform these activities (Sousa, Zauszniewski, Musil, Lea, & Davis, 2005). Committing to performing self-care activities could improve HbA1C levels among patients with DM (Al-Khawaldeh, Al-Hassan, & Froelicher, 2012; D'Souza et al., 2017; Gao et al., 2013; King et al., 2010). However, self-efficacy and self-care agency is inadequate to improve glycemic control. Thus, performing self-care activities is essential to control HbA1C levels(Sousa et al., 2005). Such activities are like diet, exercising, medications, a regular check-up for eyes, kidneys, and feet for early diagnosis of any complications and regular self-monitoring for blood glucose level (World Health Organization, 2016b).

American Diabetes Association (ADA) (2017) recommended lifestyle management for patients with DM. Lifestyle management may include diet, physical activity, smoking cessation, psychosocial care, diabetes self-management education and diabetes self-management support (DSME/S). Diabetes self-management education and diabetes self-management support aim to help patients in making decisions regarding their treatment plan, performing various self-care

management activities, problem-solving and collaboration with health care professionals to achieve better health outcomes and quality of life (American Diabetes Association, 2017). Diabetes self-management education and diabetes self-management support might contribute to improving knowledge about DM, how to cope with the disease, improving performing self-management activities, and thus reduced costs on all parties. Providing DSME will decrease the admission rates and use of acute and hospital services, and thus the burden on the health care providers and system (Rashed, 2013).

American Diabetes Association recommended that all patients with DM should participate in DSME/S. Diabetes self-management education and support should be provided for patients at diagnosis, annually, when any new factor affecting self-management, or any transition in care (Cefalu, 2017). Education is considered a key factor in improving patients' adherence for self-care and thus a better lifestyle. This is achieved by enhancing patients' knowledge about their disease and its management. Lack of knowledge may have negative effects on patients' self-management of their disease, and consequently on the treatment plan. Therefore, education is very important in diabetes self-management (David & Rafiullah, 2016). Diabetes self-management education may enhance patient's knowledge, which may affect self-efficacy, self-care agency, self-management, health status and quality of life (Atak, Gurkan, & Kose, 2008; Cefalu, 2017).

Mobile phones have been widely used recently among all age groups. So, health care professionals (HCPs) as practitioners and policymakers can take advantage of increased mobile users' number by introducing a mobile application that helps diabetic patients in self-management of their disease. Diabetes self-management education (DSME) can be achieved by mobile-health (m-health), which is considered an easy, practical and familiar method for all age groups. There are various DSME/S approaches which can improve self-efficacy, self-care agency, and self-care management. Using technology, specifically mobiles, in educating patients is one of DSME/S approaches. Using Diabetes self-management mobile applications might contribute to reducing DM complications, the progress of the disease, and consequently the health status and quality of life.

The aim of this article is to review the effectiveness of diabetes self-management mobile applications and its effect on self-efficacy, self-care agency, self-care management, and HbA1C levels among patients with DM.

Literature Search Strategy

The search was done using different Databases including Jordanian database for nursing research, Science-Direct, CINAHL, Pubmed, EBSCO-host, Springer-Link, Sage Journals, Wiley Online Library, Taylor-Francis, Scopus and Google-Scholars. The search was done using single and/or combined keywords including smartphone application, mobile application, diabetes mellitus, self-efficacy, self-care agency, self-monitoring of blood glucose (SMBG), self-care management, self-management, education, and glycemic control. Results of the search revealed many studies; however, the selected works were limited to studies published in English between 2006 and 2017.

M-Health and DM Mobile Application

World Health Organization (WHO) defined e-health as using information and communication technologies to improve health (World Health Organization, 2011). This is achieved by improving patients' access to services and the quality of these services, reducing costs, saving time and efforts for HCPs and patients, enhancing the collaboration and coordination between HCPs and thus enhancing the management of patients (World Health Organization, 2016a). Mobile health (m-health) is classified as a subdivision of e-health.

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M-health was defined as the use of mobile technology such as mobile phones (whether using voice calls, voice or short messages, or mobile applications), patient monitoring devices and other wireless devices to improve medical and public health practices and thus improving health (World Health Organization, 2016a).

There are thousands of mobile applications designed for self-management of Diabetes mellitus type I (T1DM) and Diabetes mellitus typeII (T2DM), and many of them cover many of these aspects. International Diabetes Federation categorizes these applications as tracking and logging, nutrition, fitness, device connectivity platforms, coaching/wellness, social networking and blogs applications (Rose, Petrut, L'Heveder, & de Sabata, 2017).

The Effect of Mobile Applications on Glycemic Control

The effect of DM mobile application usage on glycemic control was investigated by many studies, and the results revealed a significant reduction in HbA1C. But most of them combined the mobile application usage with other interventions like short message services (SMS), wireless devices, CDs, mails, feedback messages, video or clinical visits (Greenwood, Gee, Fatkin, & Peeples, 2017; Holtz & Lauckner, 2012; Kirwan, Vandelanotte, Fenning, & Duncan, 2013; Liang et al., 2011; Liu & Ogwu, 2012; Peterson, 2014; Quinn et al., 2016; Wang, Xue, Huang, Huang, & Zhang, 2017; Wu et al., 2017). Of these studies, meta-analysis' and systematic reviews' results revealed that most or more than half of reviewed articles resulted in a significant reduction in HbA1C (Frazetta, Willet, & Fairchild, 2012; Greenwood et al., 2017; Liu & Ogwu, 2012; Peterson, 2014). Also, in a systematic review of ten clinical effectiveness studies for NIDDM mobile applications, the authors found that effectiveness ranged from 0.15% to 1.9% (Fu, McMahon, Gross, Adam, & Wyman, 2017).

Furthermore, a meta-analysis result of 15 randomized clinical trials (RCTs) revealed that 12 of these studies resulted in a mean 0.39% HbA1C reduction comparing pre and post interventions. These interventions included mobile applications, SMS, phone calls and clinical visits. Authors found that the combined intervention of mobile phones and clinical visits resulted in a greater reduction of HbA1C than one intervention alone (Liu & Ogwu, 2012). Also, a systematic review investigated seven RCTs and four descriptive studies, and the results showed that four of the seven RCTs were effective in HbA1C level reduction. The interventions included mobile applications, feedback, and reminders from HCP, and educational SMS (Frazetta et al., 2012). Furthermore, authors of a systematic review of 25 reviews and meta-analyses articles found that 18 of these studies showed a significant reduction in HbA1C. Most evaluated studies investigated the effect of mobile phone with SMS. Authors found that the most effective interventions in reducing HbA1C levels were those included communication with HCP, analysis of patient-generated data, tailored education, and feedback (Greenwood et al., 2017).

As noted from above studies, combined interventions may improve the effect of mobile applications, but Baron and colleagues (2012) found in their systematic review that studies without feedback from HCP resulted in improved HbA1C. They refer the improvement to the recording and tracking of various data. As recording and tracking might increase patients' awareness, understanding, and motivation for self-management of DM. Also, when the patient knows that HCP will view the data, he/she will be more motivated to adhere to the self-care program (Baron, McBain, & Newman, 2012).

Inconsistent with all previous studies, an RCT aimed to investigate the effectiveness of Diabetes Under Control mobile application used by 31 patients with IDDM on glycemic control and other measures, compared to standard paper

diary used by the control group of 31patients. This study results showed that there was no significant difference in HbA1C levels between the two groups before and after the intervention by three months (Drion et al., 2015). This might confirm the importance of feedback by HCPs for patients.

The Effect of Mobile Applications on Self-Efficacy, Self-Care Agency, and Self-Care Management

Using mobile technology, may affect patients' knowledge which can affect patient's self-efficacy. An interventional study aimed to investigate the effectiveness of using the mobile system developed by researchers called Diabetes Self-Care System for six weeks on self-care knowledge, behavior, and efficacy. The study involved 28 patients with NIDDM, and the results showed that there was a significant improvement in patients' self-care knowledge by 17%, and a not-significant marginal increase in self-efficacy (Guo, Chang, & Lin, 2015). Also, a pilot study recruited seven adults with NIDDM evaluated the effectiveness of mobile phone intervention that included mobile phone application and SMS from the specialized educator, and its effect on self-efficacy. The results revealed an increase in self-efficacy after 1-month follow-up, but it was not significant (Quinn, Khokhar, Weed, Barr, & Gruber-Baldini, 2015). Moreover, an RCT conducted in Australia recruited 25 patients with IDDM in the intervention group and 28 patients in the control group, examined the effectiveness of a mobile application combined with feedback SMS by a certified diabetes educator, every three months and over nine months. Results revealed no significant improvement in self-efficacy over time (Kirwan et al., 2013). Nevertheless, three systematic reviews assessed the effectiveness of various mobile phone technology on diabetes management concluded a positive impact on patients' self-efficacy, but many of the reviewed studies in all these systematic reviews recruited samples with small size (Holtz & Lauckner, 2012; Liu & Ogwu, 2012; Wang et al., 2017).

Educational programs, including mobile applications, can improve patients' confidence about managing their disease, they would think that they can easily perform self-care activities, in other words, their self-efficacy (Atak et al., 2008). Based on the above literature review, most of the studies that investigated the effect of mobile applications recruited a small sample size of patients with NIDDM. Also, and based on literature review, there is no study investigated the effect of using mobile technology on self-care agency.

Additionally, as mobile technology can affect patients' self-efficacy, this may affect their self-management of disease. Many studies investigated the effectiveness of mobile technology on self-management for diabetes including many behaviors like diet, physical activity, weight management, medication adherence, and glucose monitoring. Two systematic reviews of studies assessed the effectiveness of using different mobile technologies among patients with diabetes, and results showed positive effect on self-care behaviors (El-Gayar, Timsina, Nawar, & Eid, 2013; Holtz & Lauckner, 2012), as well as positive impact on patients' attitudes toward diabetes self-management (El-Gayar et al., 2013). Another systematic review of studies evaluated the effectiveness of m-health interventions on diabetes treatment, self-management and weight management. The results indicated a positive impact on self-management and weight loss, with average loss ranged between −1.97 kg in 16 weeks to −7.1 kg in 5 weeks (Wang et al., 2017). Also, authors of aninterventional study assessed the effectiveness of a mobile system designed to help patients in self-care management for NIDDM, found that the system improves patients' self-care behaviors by 22% (Guo et al., 2015). However, an RCT result revealed no significant improvement in self-care activities after using a mobile application with feedback SMS from specialized diabetes educator (Kirwan et al., 2013). Another RCT evaluated the effectiveness of mobile application combined with a personal web portal linked to the application among 31 patients with IDDM in the intervention group. The results revealed no significant effect of this intervention on SMBG between and within groups (Drion et al., 2015). Also, the results of a

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pilot study of seven old patients with NIDDM, that assessed the effectiveness ofa mobile application with feedback message showed that participants became ready and confident to monitor their blood glucose levels and carbohydrate intake (Quinn et al., 2015). Furthermore, authors of a meta-analysis of 62 RCTs that assessed the effectiveness of consumer health information technologies on patients with DM, including mobile technologies, found significant improvement in blood pressure, total cholesterol, and triglycerides (Or & Tao, 2014).

As mobile applications may affect self-management of DM positively, this may lead to decreased hospitalization and emergency department visits. This was evident in a study involved 32 patients with NIDDM, whose phones were connected to the specific interactive system with feedback from HCPs. The results showed reduced numbers of hospitalization and emergency department visits. Authors did not report the significance of the results (Katz, Mesfin, & Barr, 2012). In conclusion, all previous effects of mobile technology on various aspects may result in improving the quality of life. But this was not the case in two RCTs (Drion et al., 2015; Kirwan et al., 2013), and one pilot study, in which only one domain increased significantly after the usage of mobile technology, which was the physical pain (Quinn et al., 2015).

CONCLUSIONS

Self-management of DM is a very essential aspect of care planned for patients. Self-care management can be affected by many factors, including self-efficacy and self-care agency. One of the emerging fields in chronic diseases management is m-health. There are many mobile applications and technologies developed for DM self-management, but few approved by the FDA. There must be specific characteristics in the mobile application to be qualified in DM management. Many studies' results showed the effectiveness of these applications, and many of them showed no differences after using those applications. However, no study indicated there was a negative effect of mobile applications for DM self-management. Health care professionals must take in consideration patients' perceptions and attitudes toward using such technologies, as well as the potential barriers and challenges to use these applications.

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