

Patients' Experiences in Using Diabetes Self-Management Application: A Scoping Review

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Abstract

Diabetes cases continue to increase and burden the nursing system worldwide. Diabetes Self-Management application software (DSM apps) can enable patients to manage their disease independently while simultaneously reducing the burden of the system. These apps are already available, yet global patients' interests in using them are still low. This study aimed to describe the global tendencies of diabetes apps usage as an effort to manage diabetes cases by exploring the perceptions of diabetes patients on the use of DSM apps. This study summarized journal searches from the Elsevier, Wiley, BMC, and JMIR database with the search terms "web-based and mobile technology," "digital health intervention," "diabetes management mobile application," "mobile health for diabetes self-management," "tablet-based self-management," and "diabetes self-management qualitative." A total of nine journals published between January 1, 2018, to December 31, 2020, that meet the inclusion and exclusion criteria were selected. The study concludes diabetic patients in Asia, Africa, Europe, Australia, and America stated that the DSM apps used was helpful in managing diabetes. Other demographic factors such as age, level of education, and economic status have influenced the perception and tendency to use the DSM apps.

Keywords: application, community nursing, diabetes, diabetes self-management, scoping review

Introduction

Diabetes is a chronic disease and, to date, is expressed as one of the global health emergencies of the 21st century.¹ Currently, the number of people with diabetes worldwide is recorded at 463 million people, and it is estimated that the number will reach 700 million by 2045.^{2,3} This condition is due to prediabetes now being diabetic, including those who have long suffered from diabetes and have not been able to control it well.^{4,5}

On the other hand, the nursing system cannot accommodate the growth of diabetes cases. The number of available nurses is not proportional to the number of diabetic patients. By 2030, the need for health workers to be fulfilled will only reach 65 million, while the predicted health workers should be reached 80 million.⁶ It is necessary to find a way out, so that diabetic patients are able to carry out diabetes care independently. In line with Korzs' statement in 2020, diabetic patients need to engage in continuous self-management in self-care activities.⁷

Nowadays, as technology advances, there is a technology for self-care activities, and Diabetes Self-

Management application software (DSM apps) can enable patients to manage their disease independently while reducing the burden on the nursing system.⁸ The presence of technology can reduce the burden of health costs by 700 billion USD in 2017.⁶ Cost of lost productivity due to disability, absenteeism, complications, and death due to diabetes.^{3,9} Since 2013, there have been various internet-based apps (mobile and web apps) designed to help diabetes patients in self-management of disease, control, treatment, and convenience that can be tailored to the needs of each patient.¹⁰ Also, patients can discuss disease progression with health professionals.¹¹

Several studies predicted that there would be an increase in the use of technology for diabetes care, such as diabetes treatment applications and digital diabetes self-management.^{9,12} The apps are equipped with features including eating, physical activity, the use of diabetes drugs, and monitoring blood glucose using an insulin calculator.¹² The apps can help reduce the risk of developing diabetes complications, such as chronic renal failure disease, diabetic retinopathy, neuropathy, and diabetic wounds, improving glycemic control and quality

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of care.^{3,9}

Since many constraints affect, it is necessary to conduct a scoping review that explores the tendencies of diabetic patients' perceptions on those apps. However, in-depth studies that led to the patients' perception of using the DSM apps to manage their Type 2 Diabetes Mellitus (T2DM) were very limited,¹³ especially focused on comparing patients' perceptions in different continents of the world. Henning in Kelly, *et al.*, study stated that even in the last 30 years of qualitative studies, only a quarter have looked at aspects of self-management, with a smaller number looking specifically at the experience of using digital apps to aid self-management.¹⁴ Therefore, the authors are considering using qualitative studies to fill the academic gap.

This study hypothesized that there were technical and non-technical barriers (globally only) affecting the use of the apps. Therefore, this study designed three study questions: (1) How do patients from different continental regions perceive the DSM apps? (2) What factors influence patients' tendency to use the DSM apps? (3) Which features do the patients want in the DSM apps? The aim of this study was to see the global tendencies of patients' experience in using the DSM apps. Therefore, the objective of this study would be reached by analyzing articles about those issues from five continents: Africa, Asia, America, Australia, and Europe. Moreover, this study hopes that it could empower families, healthcare supporters, community groups, practitioners, nurse educators, and regulators to support patients in using the DSM apps. Furthermore, this study also hopes it could give developers suggestions to create apps designed according to diabetic patients' needs.

Method

This study used a scoping review to find out more about the experiences of diabetic patients using DSM apps. There were five steps of the scoping review methodology according to Sargeant, *et al.*,¹⁵ including (1) Identifying the question, (2) Identifying the studies, (3) Selecting relevant study, (4) Charting the data, and (5) Summarizing/result.

For the first step, the authors have identified three questions in the scoping review, especially about patients' perceive the DSM apps, patients' tendency to use the DSM apps, and the DSM apps features that patients need. The articles were searched and selected to answer all three questions. As step of identifying the studies, in this study, searching for articles manually through Google Scholar has collected journal articles representing Asia, Africa, America, Australia, and the European continents. Five databases were used in the search: Science Direct, Wiley, BMC, Elsevier, and JMIR journals for studies published between January 1, 2018, and

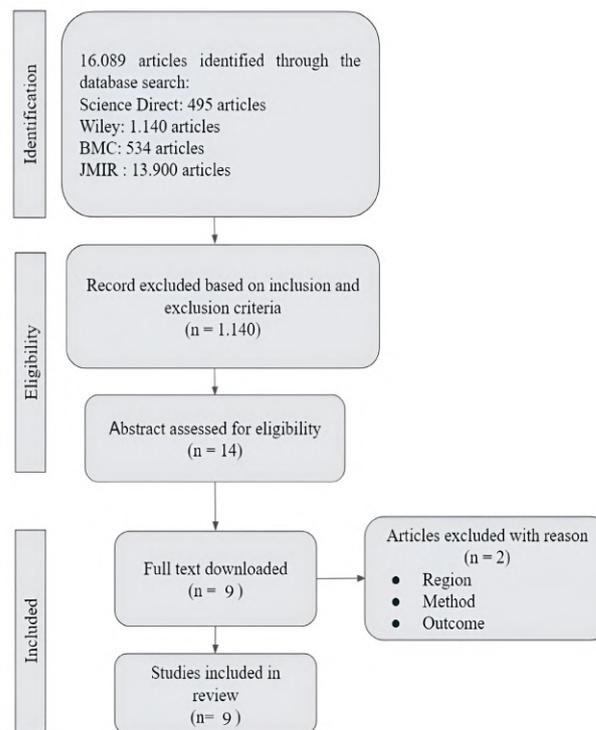


Figure 1. Flowchart of PRISMA-ScR

December 31, 2020. The terms "web-based and mobile technology," "digital health intervention," "diabetes management mobile application," "mobile health for diabetes self-management," "tablet-based self-management," and "diabetes self-management qualitative" were used during the search. The identification process is described through a flowchart of PRISMA-ScR on Figure 1.

The third step was selecting relevant study. The journal articles that met the inclusion criteria: (1) the journal articles analyze patients' experiences, opinions, and/or perceptions of the diabetes application, (2) use qualitative or mixed study methods, (3) study participants have been diagnosed with T1DM and T2DM, and (4) the internet-based diabetes self-management programs are accessed in tablets and/or mobile phones were chosen. Journal articles were taken using a mixed-method approach, and qualitative analysis was selected for this scoping review. Studies that did not meet the criteria were excluded.

The following step was charting the datas. The title and abstract of each article that met the inclusion criteria were then downloaded. The title, abstract, objectives, methods, and study results were read thoroughly. The authors have identified nine selected and relevant articles for scoping review. Then it was arranged as shown in

Table 1. The last step was summarizing the data finding.

Results

Of the nine selected journals, three analyzed themes describe the patient's experience, including the patient's

Table 1. Summary of Selected Studies (n = 9)

| No. | Author | Year | Type of DM | Study Design | Sample | Purpose | Result |
|-----|--------------------|------|------------------------------|--------------------------------------|---|---|--|
| 1 | Pal, et al. | 2018 | T2DM | Focus group discussion | 20 patients in the United Kingdom. The average age of patients: 57 years. Duration of diabetes: 0 - >10 years. Sex of patients: 8 female, 12 male. | To explore T2DM patients' perspectives on their needs for self-management. | Patients felt digital health intervention (DHI)/DSM apps could solve their existing problems. |
| 2 | Kelly, et al. | 2018 | T2DM | In-depth interview | 15 patients in the United Kingdom. The average age of patients: 55.4 years. Duration of diabetes: 3 months to 24 years. Sex of patients: 10 female, 5 male. | To understand the impact of using web-based and mobile technologies to support the management of T2DM patients. | Web-based and mobile technologies have had a positive impact. |
| 3 | Rossmann, et al. | 2019 | T2DM T1DM Pre-diabetes | Semi-structured interview | 21 patients from Singapore and 16 patients from Germany. The average age of patients: 48.35 years (Singapore); 44.5 years (Germany). Duration of diabetes: 1 to 38 years (Singapore); 0 to 49 years (Germany). Sex of patients: 10 female, 11 male (Singapore); 9 female, 7 male (Germany). | To examine T1DM or T2DM patients integrate mobile technology into their diabetes self-management. | T1DM or T2DM patients with long-term users tend to perceive DSM apps as applicable while the rest does not. Diabetic patients in Germany felt the need for DSM apps. |
| 4 | Petersen, et al. | 2019 | Uncategorized | Semi-structured interview | 131 patients from South Africa. The average age of patients: not specified. Duration of diabetes: not specified. Sex of patients: not specified. | To explore patients' challenges and barriers to the adoption of ICT tools for diabetes self-management. | Patients' tendency to use ICT tools for diabetes is influenced by educational factors. |
| 5 | Zhang, et al. | 2018 | T1DM | Mixed-methods study | 18 diabetes patients from China. The average age of patients: 6 to 33 years. Duration of diabetes: 0 to 12 years. Sex of patients: 11 female, 1 male (adult patients), 4 female, 3 male (young patients) | To investigate the perspectives and needs of T1DM patients and diabetes experts in China concerning diabetes apps. | T1DM patients use HCP-recommended apps. |
| 6 | Baptista, et al. | 2020 | T2DM | Focused interview | 19 diabetes patients from Australia. The average age of patients: 14-60 years. Duration of diabetes: less than 5 years to 20 years. Sex of patients: 8 female, 11 male. | To investigate the Australian T2DM patients' daily experiences with the My Diabetes Coach application. | T2DM patients tend to use DSM apps when it is encouraged by HCPs. |
| 7 | Jeffrey, et al. | 2019 | T2DM | Semi-structured telephone interviews | 16 applications and 14 non-application users (patients) in Australia. The age of patients: 30-79 years. Duration of diabetes: >6 months. App use: 17, Non-app use: 13. Sex of patients: 14 female, 16 male. | To understand the experiences, barriers, and facilitators for the use of applications in people with T2DM. | Both users and non-users show that the application is very useful for health and self-management. |
| 8 | Franklin, et al. | 2019 | T1DM | Semi-structured interview | 8 patients in the United Kingdom. The age of patients: 27-57 years. Duration of diabetes: more than one year. Sex of patients: 4 female, 4 male. | To explore how mobile technology can support self-management in adults with T1DM. | T1DM patients who have used DSM apps have found it easy, decision-making saving time and enabling them to easily share their data with their consultant. |
| 9 | Alkawaldeh, et al. | 2020 | T2DM | Semi-structured interview | 12 patients in the United States of America. The average age of patients: 68.65 years. Duration of diabetes: 5 to 20 years. Sex of patients: 7 female, 5 male. | To analyze elderly patients' perceptions in using the tablet-based application for 30 days as a routine component of diabetes self-management care. | The table-based application can help T2DM to become self-dependent and more accountable for their actions. |

Notes: T2DM = Type 2 Diabetes Mellitus, T1DM = Type 1 Diabetes Mellitus, DHI: Digital Health Intervention, ICT = Information Communication and Technology, HCP = Health Care Professional.

perception of using the apps, the tendency of the patient to use the apps, and the apps features of interest.

a) Perception

From the statements (Table 2), the majority of patients feel that the DSM apps has a positive impact on disease management and health. Comply with using the apps, especially if HCPs or doctors re-

commend the apps.

b) Tendency

The factors influencing the patient's tendency to use the DSM apps can be reviewed in Table 3.

c) Feature

Advanced features as preference by the patients who has been already using the apps (Table 4).

Table 2. Patients' Perception toward Diabetes Self-Management Application

| Article | Quotation | Analysis |
|---------|---|--|
| 1 | "..If you just put that diabetes is such and such but can be controlled or managed or whatever word you want to use, through very simple means, I think that's a huge relief to people" | Patients felt that digital health intervention digital health intervention (DHI)/DSM apps could solve their existing problems. |
| 2 | "...The apps on my phone has a graph and how many steps is your target for walking in a day, how much water intake and what you are eating so you can record that. So it's easy to trace that way." | Web-based and mobile technologies have had a positive impact on the management of T2DM patients. |
| 3 | "Not all patients would be willing to pay." "If you put medical information in the cloud, then this becomes a... data-privacy issue". | The perception of patients in the use of DSM apps is not fully accepted, and they find some obstacles in their use. |
| 4 | "I don't always have the money to buy" "If technology were cheaper, I would use it every day." | The DSM apps are also perceived as expensive. |
| 5 | "I tried once to make an appointment with a doctor in the Weltang apps. But for his few minutes he needed to charge, so I exited. An unfamiliar doctor, you consult him, but you need to pay. Maybe you have a sense of..." | Apps were preferred because they were more effective and efficient. Meanwhile, consulting a doctor, requires a limited amount of time. |
| 6 | "If I did it my own way, I wouldn't have done it. I think an appointment (with HCPs) time kept me accountable." | Self-discipline and commitment to flexible digital consulting encourage by HCPs. |
| 7 | "I also don't see the need to have to use technology because I have my family around me for support." | The application was felt because there was support from the family. |
| 8 | "...my GP and all that, I'm extremely confident in them; they haven't mentioned it to me at this stage..." | Patients' good experiences were obtained from GPs' application recommendations. |
| 9 | "It helps me improve my management; I can see the connection to what I did that day." | Patients have positive acceptance of the DSM apps. |

Notes: T2DM = Type 2 Diabetes Mellitus, DHI = Digital Health Intervention, DSM = Diabetes Self-Management, HCP = Health Care Professional, GP = General Practitioners.

Table 3. The Factors Influencing the Patient's Tendency to Use Diabetes Self-Management Application

| Article | Quotation | Analysis |
|---------|---|--|
| 1 | "...but sometimes it's a question of having too much information, and you can't take it all on board, and you can't make all the changes overnight." | There is a need to improve its conditions, so they are willing to use the apps. |
| 2 | "..I can keep track of my carbohydrates, and, more importantly, I can keep track of my sugar, so I know, if it tells me the sugar" | Continuous use of the apps to study daily patterns of blood glucose levels. |
| 3 | "How motivated is the patient...somebody who's...very energetic,...it's interesting, you know, something that's new to them, they'll do it." "You always have to put your glasses on your mobile phone." | There are limitations in using the apps. |
| 4 | "I also don't see the need to use technology because I have family around me for support." | DSM apps were less desirable. Patients depend on their families and HCPs. |
| 5 | "if I go to the hospital, I feel I have no time. Because if I learn on a mobile apps, videos can be saved; I can learn when I have time. I think the apps is better." | Apps are more efficient than direct consultations with the clinic. |
| 6 | "I'm interested in the technology of diabetes care. I'm interested in stuff all over the place, like reading about the impact of sugar on muscle." | Patients are interested in the application for consideration in making decisions in diabetes care. |
| 7 | "I also don't see the need to have to use technology because I have my family around me for support." | The family has supported the patient. |
| 8 | "If there were something that combined the 3, the blood glucose, the insulin amount, and the carbs altogether, that would be quite interesting... So I don't do it because there isn't really an easy way of doing it." | Patient decision-making is strengthened by the apps. |
| 9 | "It's a great application; It keeps me on track. It definitely does discipline me." | Improve their discipline skills in daily diabetes activities. |

Note: HCP = Health Care Professional

Table 4. Patients' View According to the Features of Diabetes Self-Management Application

| Article | Quotation | Analysis |
|---------|--|---|
| 1 | "I suppose I'd want something that was a bit, kind of, an A to Z of one's life." | The apps has provided "one-stop shop" information for managing diabetes. |
| 2 | "I like the alarm [on the CBG monitor]. I often have it off at work, not because I am at work, just because my blood sugar is usually higher at work....", | Alarm feature to control blood sugar. |
| 3 | "Every device does its own things." | Required application with full features. |
| 4 | "They could use more pictures and less text on the applications." | The apps displays more visualizations than writing is in great demand. |
| 5 | "I consulted once. Because the doctor was busy, the response was not timely. Describing our condition by typing words may not be so good in meeting the needs of patients. After all, they are not our familiar doctors, and they don't know our condition. I hope to communicate directly with the doctor." | It would be even better if the communication with HCPs feature is linked to the electronic medical record for sustainability and direct consultation. |
| 6 | "It has to be reliable because that's my expectation now of apps and other things, and I can always find an alternative these days." | Information is presented by games or quizzes that are interesting, unique, and more interactive. |
| 7 | "What I wanted was like, a reading for the day, like a total reading and, and how much insulin I'd had each day and then sort of to see over a month what my average reading was..." | Visual representations of trends, particularly graphs for a month. |
| 8 | "I think the simplest way is really a line graph of the glucose levels..." | Blood glucose, where the display is a line graph visualization with the interpretation of high, low, or average trends. |
| 9 | "The opportunity to have reminders, I'm more consistent with taking medications." | Alarm feature to remind self-management schedule. |

Note: HCP = Health Care Professional, CBG = Capillary Blood Glucose

The quality of the studies in this review was analyzed, and the risk of bias was assessed using the CASP Checklist.¹⁶ Ten questions were filled out to ensure qualitative compliance with the study and were categorized as low, moderate, or high risk of bias. All nine articles were selected at low risk of bias.

Discussion

Perception

Several interesting things have been found in this study. Sociocultural differences have led to different patient perceptions of diabetes management apps. There are differences in cultural principles in the group of developed countries that are members of the European, Australian, and American continents compared to countries in Asia and Africa.

The principle of individualism is very prominent in diabetic patients in Europe,^{12,14,17,18} Australia,^{20,21} and America,²² was the principle that emphasizes more on personal choice and freedom.²³ The selection of diabetes apps is determined by the needs of each diabetic patient. There is no consideration of groups such as families or HCPs.

On the other hand, Asian diabetes patients (in the article represented by Singapore and China),^{17,19} tend to hold the principle of collectivism, which is a social principle that prioritizes groups or communities over individuals.²⁴ One of the principles rooted in collectivism is the Confucian principle embraced by the majority of Chinese in Singapore and China. Confucianism believes

that good moral character would create a harmonious society.²³ The perception and tendency of diabetic patients in Singapore and China to use diabetes apps are strongly influenced by groups (both families and HCPs).^{12,19} The collectivist culture also prevails in Africa; self-managed apps are used when they receive support from families and recommendations from HCPs.²⁵

Tendency of several factors influence the patient's tendency to use the DSM apps:

a. Age

Young diabetic patients were more technologically literate. They had no barriers to using the DSM apps than older diabetic patients. Meanwhile, older diabetic patients found it difficult to use the apps.¹⁹ Their mobile devices were old and out of technology. The small mobile phone screen makes it difficult for elderly diabetic patients to type words describing their condition on the screen.¹⁷ Thus, the lack of exposure to technology leads to feelings of lack of confidence and fear of using new technology. In the end, the perception of older diabetics tends to be less supportive or less interested.²⁶

b. Motivation

The internal motivation to use the apps grows when they desire to learn about diabetes problems since they were diagnosed with diabetes by a doctor.^{20,21} However, external motivation comes from health care professionals who recommend using the app.²⁰ Features perceived as useful or facilitated use included the visual representation of trends, encouragement of self-motivation, convenience and user-friendly designs.

c. Data security factor

The DSM apps is made to track and store the patient's daily blood glucose data as well as other important information, like diet and health data, that can be used for self-management and monitoring. Patients' daily data, such as blood glucose (obtained via the blood glucose metres, insulin pumps, or other diabetes sensors through Bluetooth), together with other biometric, food, and exercise data, are gathered by the patient's phone via a specialised smart apps. Studies confirmed that running self-managed apps connected to healthcare providers requires high funding and infrastructure investment and takes data security and privacy into account.^{27,28}

d. Level of Education

Patients are interested in using the apps if they are trained, and facilities are available from the local clinic.¹⁹ From a literacy perspective, technology is more readily accepted by patients with secondary education.^{25,29,30} Personalized education is an under-represented feature in diabetes mobile apps. The patients liked different modes of educational materials. Patients are interested in using the appd if they are trained, and facilities are available from the local clinic.

Desired Features

Advanced features are selected by the tech-savvy patients using the apps. One-stop apps are preferred because it is more complete.^{12,14,20-22} Alarm and feature graph as an evaluation of the DSM apps feature with the meaning high, low, or normal trends.^{18,26}

Limitation

Diabetic patients in this study were mostly representatives of the continents of Europe, America, and Australia, and very few studies were conducted in the Asian and African continents. Internal and external barriers have not been studied in depth.

Conclusion

Patients' experiences in this study have positive and negative perceptions and tendencies using the DSM apps. This tendency is influenced by sociocultural factors, where the patient is located, age, education, and motivation. This study recommends future study to explore the perceptions of other stakeholders (health professionals and local/national authorities) on the implementation of diabetes self-management.

Abbreviations

DSM apps: Diabetes Self-Management application software; USD: United States Dollar; T2DM: Type 2 Diabetes Mellitus; PRISMA: Preferred Reporting Items for Scoping Reviews and Meta-Analyses; T1DM: Type 1 Diabetes Mellitus; DHI: Digital Health Intervention; ICT: Information Communication and Technology; CBG: Capillary

Blood Glucose; HCP: Health Care Professional; GP: General Practitioner.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

The dataset used and analyzed are available in published documents and on the internet.

Authors' Contribution

The first author (SK) is the main contributor to the article, while the rest (SLP, SP, BFA) help with supervision and guidance.

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