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Patient Engagement through Mobile Health Interventions of Diabetes: A Systematic Literature Review

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Full research paper

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Abstract

This paper aims to review the applicability of the Healthcare Information and Management Systems Society (HIMSS) patient engagement framework and to recognise the patient engagement features presented in current mHealth interventions for improving engagement in diabetes self-management. Scopus, Web of Science and PubMed databases were searched for relevant studies. The selected studies were then analysed using the Healthcare Information and Management Systems Society (HIMSS) patient engagement framework. Twenty engagement features were identified from 29 studies reviewed. Half of the HIMSS patient engagement framework categories were seen in the studies. This review shows that mHealth interventions have achieved the third and fourth phases of the HIMSS patient engagement framework. In addition, this review suggests improvements in patient engagement facilitation, including integrating patient-generated data into electronic health records, collaboration access to the health records, and peer support through online community forums. Finally, the future patient engagement framework is discussed for mHealth technology.

Keywords patient engagement, patient-centred care, mHealth, engagement features, diabetes.

1 Introduction

Patient engagement is a fundamental precursor to high-quality healthcare (Kaplan et al. 2017; Manafo et al. 2018). In the USA, the Affordable Care Act emphasises "patient-centred" care and patient engagement initiatives that concentrate on shared decision-making, empowerment, and self-management (Greene et al. 2015). The literature's definitions of patient engagement vary, but they share a similar focus on the extent to which patients are actively involved in their care (Hibbard and Greene 2013; Walker et al. 2017). Patient engagement emphasises patients' knowledge, skills, willingness, and ability to take independent actions to control their care (Graffigna et al. 2014; Kaplan et al. 2017).

A growing body of evidence demonstrates that patients engaged in their healthcare have better clinical outcomes, increased self-management skills, more effective decision making, higher medication adherence, improved health behaviours and better disease knowledge than disengaged patients (Sawesi et al. 2016; Win et al. 2016). Consequently, efforts to increase patient engagement in their care have received considerable attention recently (Walker et al. 2017).

Previous studies suggested that mHealth technologies can help efficiently improve communication between patients and healthcare providers, leading to improved patient engagement (Coquet et al. 2020; Huang et al. 2019). mHealth applications have been identified as an innovative way of influencing positive behavioural changes (Vlahu-Gjorgievska et al. 2018).

mHealth interventions often use one or a combination of modalities to facilitate patient engagement (Shan et al. 2019). Therefore, the design of engagement strategies is more critical to the effective use of these tools than the features of the technology (Krošel et al. 2016). To date, most studies have been designed to evaluate the effectiveness of mHealth interventions in improving clinical outcomes. However, less attention has been dedicated to understanding the impact of mHealth interventions on patient engagement and the evaluations of their involvement (Barello et al. 2016).

Several strategies and frameworks have been proposed for evaluating patient involvement at various levels (Bombard et al. 2018; Carman et al. 2013). For instance, a framework conceptualizes the continuum of patient engagement, from complaining, giving information, and listening through consulting to full participation and involvement (Bombard et al. 2018). Another framework describes the three main levels of patient and family engagement in healthcare: direct patient care, organizational design and governance, and policy making (Carman et al. 2013). Such frameworks have not considered the components of health information technology (HIT) in the involvement of patients.

The National eHealth Collaborative Institute, with the Health Information and Management Systems Society (HIMSS) foundation, established the HIMSS patient engagement framework in November 2012 in collaboration with over 150 top specialists in healthcare, technology, and human behaviours. The HIMSS patient engagement framework is a model created to guide healthcare organisations in developing and strengthening their patient engagement strategies utilising (Shapiro-Mathews and Barton 2013). Table 1 shows the basic version of the HIMSS framework. It describes how patients are engaged through 5 cumulative phases. There are 14 categories across the five phases: Information and Way-finding, Analytics/Quality, e-Tools, Forms: Printable, Patient-Specific Education, Interactive Forms: Online, Patient Access: Records, Integrated Forms: EHR, Patient-Generated Data, Interoperable Records, Collaborative Care, e-Visits, Care Team-Generated Data, and Community Support. As this framework is cumulative in nature, in order to achieve a higher level of engagement through health technologies, it is important to provide health technologies capabilities in more categories.

Diabetes affects millions worldwide, causing significant morbidity, mortality, and healthcare services utilisation. Without effective interventions, the number of people with diabetes is predicted to reach 578 million by 2030 (Saeedi et al. 2019). mHealth interventions can help patients with diabetes self-management (Potter et al. 2022; Shan et al. 2019). mHealth interventions that promote self-management and lifestyle improvement for diabetes management have been provided in previous studies (Vlahu-Gjorgievska et al. 2019). However, recent mHealth interventions targeting diabetes vary in their objectives and components, including self-management applications, wearable technology, text messages, and nurse coaching (Shan et al. 2019). Despite the potential of all mHealth technologies to facilitate patient engagement, it is unclear to what extent the current mHealth intervention studies are designed to engage patients in managing their chronic conditions. The HIMSS patient engagement framework is a helpful tool to evaluate patient engagement through the use of Health Information Technologies (HITs). However, there is a limited study of the HIMSS patient engagement framework in evaluating the involvement of patients in mHealth interventions in the current literature. Additionally, a study conducted on older patient engagement by (Franklin and Myneni 2018) found that mHealth applications that may enhance patient engagement have not been sufficiently studied: personalised

content, social support, and gamification. Similarly, a study conducted by (Geng and Myneni 2015), to determine the level of patient engagement facilitated in self-management of care for cancer survivors showed that most of the engagement features of these applications are in the early or middle stages of patient engagement. Therefore, the objectives of this review are (1) to examine the applicability of the HIMSS patient engagement framework for improving engagement in diabetes self-management and (2) to identify the patient engagement features presented in current mHealth interventions for improving engagement in diabetes self-management.

Phases	Categories
Inform me	Information and way finding, e-Tools, Forms: Printable, and Patient-specific Education
Engage me	Information and way finding, e-Tools, Forms: Printable, Patient-specific Education, and Patient Access: Records
Empower me	Information and way finding, e-Tools, Forms: Printable, Patient-specific Education, Patient Access: Records, Patient Generated Data, and Interoperable Records
Partner with me	Information and way finding, e-Tools, Forms: Printable, Patient-specific Education, Patient Access: Records, Patient Generated Data, Interoperable Records, and Collaborative Care
Support my e-community	Information and way finding, e-Tools, Forms: Printable, Patient-specific Education, Patient Access: Records, Patient Generated Data, Interoperable Records, Collaborative Care, and Community Support

Table 1: The HIMSS patient engagement framework

2 Method

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2.1 Search strategy

A systematic literature search was conducted using the online databases; Scopus, Web of Science and PubMed in September 2021. All keywords related to the definition of the HIMSS patient engagement framework were considered. A four-part terminology search was used to identify articles that (1) discussed patient engagement; (2) included health IT; (3) involved the participation of a patient and healthcare staff, and (4) focused on diabetes. To achieve this outcome, a search string was constructed as follows: (engagement OR participation OR empowerment OR satisfaction OR involvement OR activation OR adherence OR compliance) AND (technolog* OR mobile OR internet OR app* OR m-health OR e-health OR "health informatics") AND (patient) AND (nurse OR doctor OR clinician OR "health professional") AND (diabetes).

2.2 Search strategy

Selected studies focused on diabetes self-management, including self-blood glucose monitoring, healthy diet, exercise, and medication adherence delivered using mHealth technologies. The selected studies included only Type 1 Diabetes (T1D), Type 2 Diabetes (T2D), or both (T1D) and (T2D). Furthermore, mHealth technology that has been used in the studies should be one or more of (mobile phone applications, wristbands, smartwatches, smartphone glucometer, SMS, telephone call, video, and teleconferencing). However, studies that focused on managing other chronic diseases using mHealth technologies were excluded. In addition, studies that examined patients' perspectives on mHealth interventions in the management of diabetes were excluded as well.

2.3 Search strategy

All publications that met the eligibility inclusion and exclusion criteria were identified for analysis. NVivo 12 software was used to assist with the data coding. Firstly, the publications were imported into NVivo 12 software using EndNote references. Once all the publications to be included in the analysis were identified, all the observed engagement features of the mHealth interventions were categorised based on the conceptual framework (the HIMSS patient engagement framework). First, each engagement feature was aligned to the five phases of the framework. Then, it was classified into 14 categories within the framework (see Table 2). Finally, Matrix Coding Queries were conducted to show intersections between the two lists (articles and the HIMSS patient engagement framework phases, articles and the HIMSS patient engagement framework categories, and phases and categories of the HIMSS patient engagement framework).

3 Results

3.1 Search and Selection Results

The database search yielded 2803 potentially relevant studies. After removing 582 duplicate studies, 2221 studies remained for the screening process. All authors assessed 446 studies following the inclusion and exclusion criteria, and meetings were conducted to review the eligibility of studies until consensus was reached. After a full-text reading was applied, 417 studies were excluded. Hence, the authors included 29 studies in the final review. Figure 1 summarises the inclusion and exclusion criteria and the search steps in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart (Moher et al. 2009).

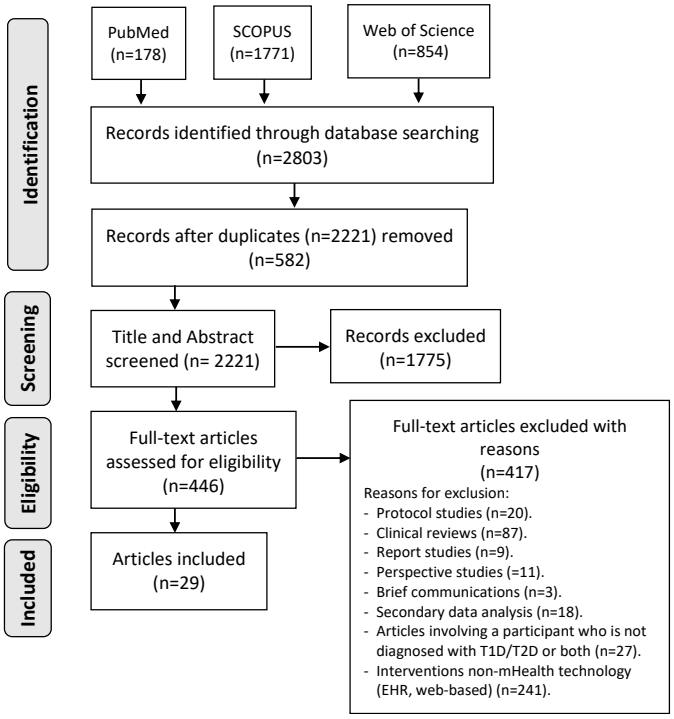

Figure 1: Summary of included studies in the article selection process displayed in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart

3.2 Characteristics of the studies

Studies included in this sample were published between 2004 and 2021. In this review, 13 of the studies employed a randomised controlled trial design (Bell et al. 2012; Cho et al. 2009; Dale et al. 2009; Hansen et al. 2017; Kwon et al. 2004; Levy et al. 2015; Odnoletkova et al. 2016; Patnaik et al. 2021; Quinn et al. 2016; Tang et al. 2013; Wild et al. 2016; Young et al. 2014; Young et al. 2020). Five studies were qualitative research (Frøisland and Årsand 2015; Hanley et al. 2015; Jeffrey et al. 2019; Maglalang et al. 2017; Peng et al. 2016), and five studies used pre–post-study design (Ang et al. 2021; Döğer et al. 2019; Graetz et al. 2019; McGloin et al. 2020; Welch et al. 2015). One study was a crossover-randomised study design (Fu et al. 2019), and two studies were quasi-experimental studies design (Bramwell et al. 2020; Damayanti et al. 2021). One was a prospective cohort study design (Hao and Xu 2018), and one was an implementation study design (Levy et al. 2018). The studies' durations in mHealth interventions ranged from 2 months to 24 months. Three studies included only studies that involved patients with T1D (Döğer et al. 2019; Frøisland and Årsand 2015; Levy et al. 2015). In contrast, 22 studies focused explicitly on patients with T2D (Ang et al. 2021; Bramwell et al. 2020; Cho et al. 2009; Dale et al. 2009; Damayanti et al. 2021; Ding et al. 2018; Hanley et al. 2015; Hansen et al. 2017; Hao and Xu 2018; Jeffrey et al. 2019; Levy et al. 2018; Maglalang et al. 2017; McGloin et al. 2020; Odnoletkova et al. 2016; Patnaik et al. 2021; Peng et al. 2016; Quinn et al. 2016; Tang et al. 2013; Welch et al. 2015; Wild et al. 2016; Young et al. 2014; Young et al. 2020). The remaining four included studies that involved patients with T1D, T2D, or both types of diabetes (Bell et al. 2012; Fu et al. 2019; Graetz et al. 2019; Kwon et al. 2004).

All mHealth intervention studies significantly affected patient health outcomes through engagement features in diabetes self-management. The included studies demonstrated improvement in HbA1c (Bell

et al. 2012; Cho et al. 2009; Frøisland and Årsand 2015), medication adherence (Graetz et al. 2019), self-monitoring (Peng et al. 2016), and patient satisfaction (Bramwell et al. 2020; Frøisland and Årsand 2015; Graetz et al. 2019). Further, improvement in self-management (Maglalang et al. 2017; Odnoletkova et al. 2016; Peng et al. 2016), increased blood glucose regulation (Patnaik et al. 2021; Peng et al. 2016; Quinn et al. 2016), improvement in control of diabetes and blood pressure (Dale et al. 2009) and self-efficacy (Kwon et al. 2004).

3.3 mHealth interventions

The mHealth technologies included in interventions were diverse. They used a variety of technological innovations; including SMS text messaging, voice calls, smartphone applications, Bluetooth-enabled monitoring devices, web portals and communication networks that could be accessed via the Internet with a smartphone. Four out of the 29 studies were nurse-coaching sessions via telephone or face-to-face videoconference (Dale et al. 2009; McGloin et al. 2020; Odnoletkova et al. 2016; Young et al. 2014). Five studies focused on smartphone Apps (Fu et al. 2019; Hao and Xu 2018; Jeffrey et al. 2019; Peng et al. 2016; Quinn et al. 2016), and three studies combined smartphone apps with mobile phones (SMS (Frøisland and Årsand 2015; Patnaik et al. 2021) and phone calls (Bramwell et al. 2020)). In addition, using mobile phone functions (SMS and phone calls) was considered in four studies (Bell et al. 2012; Damayanti et al. 2021; Levy et al. 2015; Levy et al. 2018). Six studies employed telemonitoring technologies (Cho et al. 2009; Hanley et al. 2015; Hansen et al. 2017; Tang et al. 2013; Welch et al. 2015; Wild et al. 2016). Three studies combined telemonitoring technologies with smartphone apps (Ang et al. 2021; Ding et al. 2018; Young et al. 2020). One study used mobile technologies and associated apps with a private Facebook group (Maglalang et al. 2017). Two studies included consulting with diabetes teams (through WhatsApp, phone or SMS) (Döğer et al. 2019; Kwon et al. 2004), and one study involved personal health records via mobile devices (Graetz et al. 2019).

3.4 mHealth interventions across The HIMSS Patient Engagement Framework

Table 2 examines the engagement features of mHealth interventions using the HIMSS patient engagement framework and the frequency of engagement features represented in the reviewed mHealth interventions. This review found 20 engagement features were aligned with specific phases and categories within the HIMSS patient engagement framework. Eight engagement categories were mapped out of 14 HIMSS patient engagement framework categories. The HIMSS patient engagement framework categories to which features are mapped include the following: Patient-Specific Education, e-Tools, Interactive Forms: Online, Patient Access: Records, Integrated Forms: EHR, Patient-Generated Data, Collaborative Care, and Community Support.

Feature	Phase	Category	Number of studies
Basic educational information	Inform me	Patient-Specific Education	7
Diabetes tracking (blood sugar, dose insulin, diet, weight, exercise, and sleep)	Engage me	e-Tools	10
Data sharing with peer online	Engage me	e-Tools	1
Tangible rewards	Engage me	e-Tools	1
Reminder	Engage me	Patient-Specific Education	4
Pay medical bills	Engage me	Interactive Forms: Online	1
Request medication refills	Engage me	Interactive Forms: Online	1
Schedule appointments	Engage me	Interactive Forms: Online	2
View health records	Engage me	Patient Access: Records	1
View lab results	Engage me	Patient Access: Records	1
Personalised education/coaching	Empower me	e-Tools	5
Secure messaging	Empower me	Patient-Specific Education e-Tools	4
Goal setting	Empower me	e-Tools	1
Customised feedback and recommendations	Empower me	Patient-Specific Education	7
Data analytics	Empower me	Patient-Specific Education	5
Data sharing	Empower me	Patient-Generated Data	8

Remote home monitoring	Partner with me	e-Tools	3
Data integrated into EHR	Partner with me	Patient-Generated Data	2
Multidisciplinary diabetes care	Partner with me	Collaborative Care	2
Social support	Support my E-community	Community Support	2

Table 2: Engagement features mapped to the HIMSS patient engagement framework categories and phases

Figure 2 (Label A) demonstrates that a total of 26 studies had engagement features in the "e-Tools" category. The "Patient-Specific Education" category included engagement features from 25 studies. Further, 17 out of the 29 studies had engagement features in the "Patient-Generated Data" category. Six studies included engagement features in the "Collaborative Care" category. Two studies included engagement features in each of the "Support my E-Community", "Integrated Forms: EHR", "Interactive Forms: Online", and the "Patient Access: Records" category.

Figure 2 (Label B) showed that seven out of the 29 studies had engagement features at the "Inform me" phase. There were 21 studies included more active levels of patient engagement slightly at the "Engage me" phase. In addition, 22 studies included engagement features at the "Empower me" phase. At more active levels of patient engagement, 19 studies were engagement features at the "Partner with me" phase. Finally, two studies were engagement features at "support my e-community" phase.

Figure 2 (Label C) shows a detailed distribution of the mHealth intervention studies across the HIMSS patient engagement framework phases and categories. For the "e-Tools" category, intervention studies were at the "Engage me", "Empower me", and "Partner with me" phases. For the "Patient-Specific Education" category, studies reached the "Empower me" phase, while for the "Interactive Forms: Online" and the "Patient Access: Records" categories, studies were at the "Engage me". There were intervention studies for the "Patient-Generated Data" category at the "Empower me" and "Partner with me" phases. There were studies for the "Integrated Forms: EHR" and "Collaborative Care" categories at the "partner with me" phase. Finally, intervention studies for the "Support Community" category were at the "Support my E-community" phase.

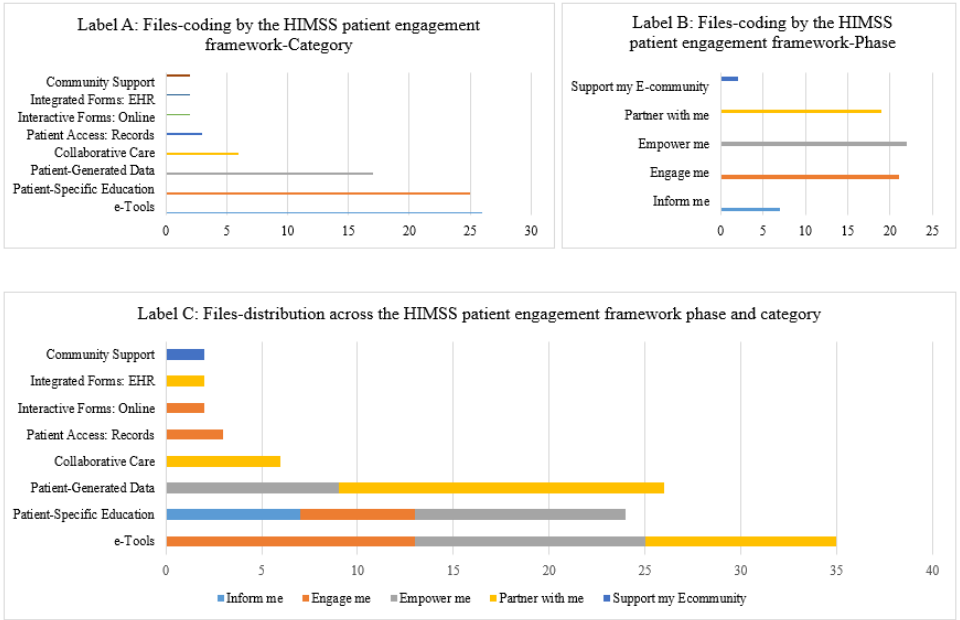

Figure 2: Labels A, B, and C

4 Discussion

The review findings showed that 57 % of the HIMSS patient engagement framework categories could be identified in the mHealth interventions for diabetes self-management analysed in this study. The finding

of this review suggests that mHealth interventions for diabetes self-management have reached modest levels of patient engagement (8 of 14 categories) based on the HIMSS patient engagement framework. This result is consistent with the results of the previous studies by (Franklin and Myneni 2018; Geng and Myneni 2015). However, the previous study results were limited to categories such as Information and Wayfinding, e-Tools, and Interactive Forms. In contrast, the results of this review are limited to the e-Tools, Patient-Specific Education, and Patient-Generated Data categories. In addition, this study differs from the previous study in that it is more comprehensive as it includes all mobile patient engagement-related health technologies. In contrast, the other study focused only on application, one specific technology. The difference between the study's results may be due to the difference in diseases and the needs of each condition.

The engagement features identified in this review support the HIMSS patient engagement framework at different phases. The majority of engagement features were in the first three phases of the HIMSS patient engagement framework (the "Inform me", "Engage me", and "Empower me" phases). Diabetes tracking, secure messaging, data sharing, and personalised education/coaching were the most common engagement features used in mHealth interventions for diabetes self-management. Other features included basic education information, reminders, PHR, goal setting, customised feedback and recommendations, and data analytics. Few engagement features in the last two phases of HIMSS patient engagement, such as remote home monitoring, multidisciplinary diabetes care, and social support included in the reviewed mHealth interventions. This result suggests that operationalised engagement features of mHealth interventions are at the beginning or intermediate stage of patient engagement in terms of self-monitoring of blood glucose levels and lifestyle and patient-provider communication.

Reflecting on the HIMSS patient engagement framework, the review found that most mHealth intervention studies have engagement features in the third and fourth phases, the "Empower me" phase followed by the "Partner with me" phase. The reason is likely that most of the mHealth intervention studies reviewed were tele-education and teleconsultation models using a person-centred approach. Such interventions include operationalised features that are centred on patient-provider engagement at these two active levels. Therefore, there is a need to develop patient engagement framework based on health behaviour change theories for mHealth intervention to ensure the increasing of patient engagement.

The findings of this review identified some areas for improvement in facilitating patient engagement. Interoperable records, collaborative care, and community support are significant areas that need a particular focus to achieve high patient involvement. Incorporating patient-generated health data is essential to delivering patient-centred healthcare (Aschettino et al. 2015). Integrating patient-generated data into clinical workflows provides opportunities to help patients achieve better health outcomes. The electronic health record is viewed as the centre of the clinical workflow (Kumar et al. 2016). Integrating patient-generated data into EHR can enhance clinical decision-making and empower patients to become actively involved in managing their health (Dinh-Le et al. 2019; Kumar et al. 2016; Levy et al. 2018). In addition to integrating patient-generated data, the collaboration between members of the diabetes team is crucial. To ensure that patients receive consistent reinforcement and support to achieve their self-management goals (Gucciardi et al. 2016). The interoperability of records into EHRs would improve multidisciplinary team collaboration by providing access and exchanging information (Odnoletkova et al. 2014). Moreover, integrating mHealth interventions with social media can facilitate the engagement of patients and their families by sharing experiences and providing clinical information and peer support (Maglalang et al. 2017). Online diabetes community forums were used for several health-related purposes to motivate others to adopt healthy behaviours. Participants in the PilAm Go4Health program provided peer support by sharing personal experiences, challenges, progress, and valuable solutions (Maglalang et al. 2017). For example, group Fitbit challenges gave participants competitive motivation to meet their goals (Maglalang et al. 2017). Further consideration must be given to the success factors of such patient engagement in mHealth interventions.

This review found that it is crucial to consider the cultural relevance of mHealth interventions in social support, health care providers, and educational materials. Integrating behavioural change theories is essential for engaging patients in health self-management (Serlachius and Sutton 2009). Behaviour change theories are the cornerstone for designing evidence-based mHealth interventions (Walsh and Groarke 2019). A review found that few behavioural theories and models have been cited in numerous publications as theoretical designs (Sawesi et al. 2016). However, several studies confirm that mHealth interventions were designed without a theoretical framework (Riley et al. 2011). This suggests that behavioural change theories about human cognition and social-technical factors should be considered in the patient engagement framework for technology. Therefore, a future framework for patient engagement is needed for mHealth technology that integrates behavioural change theories and health

outcomes assessment. Such a framework can promote patient engagement in their healthcare while showing how increased involvement can lead to improved health outcomes.

There are some limitations to this study. Firstly, the engagement features discussed were identified from academic studies, and there is the possibility that the articles in the review did not mention all the features. Secondly, the sample size and design of the study in each paper were significantly different to each of the other studies examined, and therefore a meta-analysis was not conducted.

5 Conclusion

This study systematically reviewed the literature on mHealth interventions for diabetes self-management to facilitate patient engagement using the identified features of the HIMSS patient engagement framework. This review showed that most of the operationalised engagement features of mHealth interventions are at the beginning (inform me) or intermediate (engage me, empower me) stages of patient engagement in terms of self-monitoring of blood glucose levels, lifestyle, and patient-provider communication. In addition, this study found much room for improvement in many areas of patient engagement, particularly the integration of patient-generated data into the EHR, the interoperability of records establishing collaborative care between multidisciplinary teams, and the facilitation of social support for peers through the online community. The impact of the mHealth interventions on patient engagement was also discussed in this review.

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