SYSTEMATIC REVIEW

Diabetes Management

Mobile applications for people with diabetes published between 2010 and 2015

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Practice points

- Although the related studies are well documented, they mainly focus on clinically relevant features and very little on those that affect a user's perception.
- This review highlights novel criteria like the perception of an app by users, the popularity and ranking given by users, press releases and the presence in social media.
- In order to identify the relevant studies matching our criteria, we searched in the major literature databases, in web search engines and in the vendors' online app stores.
- We found 26 relevant studies in the literature and 53 publicly available systems and apps. The results have shown a relatively high number of well-designed systems with a comprehensive set of features and a good average scoring by reviewers. Few have been recommended by medical specialists but the majority have been tested by patients. Outside of app stores, an app's presence in social media and the press is generally scarce.
- We observed that an increasing number of publicly available systems are integrated with cloud-based solutions and offer interoperability with smartwatches or Bluetooth blood glucose meters. Few systems have obtained any kind of certification or clearance, and we noticed that the certified systems have a higher number of users and a better ranking.
- We suggest that future systems comply with certification authorities and the development be evidence-based, in order to reach a higher level of popularity among users and aim for medical specialists' recommendations.

The use of mobile diabetes self-management applications (apps) is rising. However, current reviews mainly focus on clinically relevant features, and very little on those that affect a user's perception. This review highlights recent developments of these systems, coupled with user perceptions, public presence and availability. After including novel review criteria, we found that most apps have a comprehensive range of features and received good scores from public reviewers. However, the visibility of apps in social media or press is scarce, and few

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systems are recommended by medical specialists. While we noticed that certified systems are more desired, very few obtained certification or regulatory approval. We foresee that these criteria will be influential in user perceptions and ultimate success of future systems.

KEYWORDS
• diabetes mellitus • lifestyle
• mHealth • mobile apps
• self-management

Diabetes is escalating globally and, according to the WHO [1], affects more than 347 million people. While predictions say that the number of cases will double by 2030, the burden can be reduced through prevention and early diagnosis as well as through proper control of the four keystones of self-management: blood glucose and insulin levels as well as physical activity and diet [2]. The rapid advancement and wide spread use of pervasive technologies such as smartphones have paved the way for development of systems potentially helpful in diabetes self-management. The use of mobile apps to support an individual's self-management has been strongly suggested to improve their quality of life [3].

Recently, many reviews have been published regarding mobile diabetes self-management systems [4–8]. Chomutare *et al.* [9] reviewed the salient features of mobile applications for diabetes care, in comparison with clinical recommendations for diabetes self-management. El-Gayar *et al.* [4] reviewed the functional and nonfunctional requirements of applications that were developed between January 1995 and August 2012 together with related issues necessary for large-scale adoption of such interventions. Arnhold *et al.* [6] used experts to evaluate the usability of diabetes applications, and their appropriateness for use by an elderly population. Others include results of surveys or questionnaires that are intended to provide an understanding of users' perceptions. However, because of the structure and formality of these survey proceedings, designed to answer-specific research questions, there is limited consideration of unbiased or unsolicited responses. In effect, reviews conducted by clinical research are unbalanced, giving more weight to the medical use of these tools instead of the core of sustainable and effective use: the users' perceptions of a tool's usability and relevance to their specific needs. Indeed, patients decide what tool stays or goes in the commercial markets.

The concept of usability is a major determinant of a tool or product's sustainability. This is subsequently one of the largest concerns of individuals and health professionals alike regarding the use of mobile apps for diabetes self-management. Because these diabetes self-management tools have a larger presence in the commercial environment than within the medical environment, users' perceptions are shared just as they would be with any other consumer product: openly and honestly through social media and other public sources. In order to best assess their impact and potential, research reviews should take advantage of the candid and unbiased reviews of actual users in addition to targeted surveys through traditional research methods.

The objective of this review is to present a novel approach and an updated review of the most recent self-management solutions found in the literature and in the publicly available markets. Our approach emphasizes an app's appearance in public and social media in order to gain a greater understanding of user needs and an app's adherence to user demands. Our goal is not to predict an app success, but to investigate what apps offer and what patients are asking for. This could show where apps are falling short and in which ways they should be further developed. We also considered the incorporation of recent cloud-based services, emerging wearable devices and fitness apps to illustrate new developments. We describe each app's features according to the four keystones and symptom areas critical to diabetes outcomes [10,11], and to other criteria such as user-friendliness, interoperability, quality controls, popularity in social media and in the vendor online stores, and availability of the systems in terms of languages and platforms. Ultimately, we aimed to use these parameters to determine any correlation between certain app characteristics and its popularity or success among users.

Methods

The coauthors have extensive research experience with mobile applications and have a multidisciplinary background ranging from healthcare and business, to health informatics, statistics, computer science and electrical engineering. Search criteria, categories of assessment and finally the structure of our results are a combination of input from these coauthors and their experience in their fields as they pertain to mobile diabetes self-management systems.

We reviewed a variety of systems such as mobile applications, standalone systems and

prototypes, including systems that are classified as medical devices. We conducted our search between March and April 2015 using Google search engine, frequently referenced journal databases and the online app stores of the most commonly used platforms. We decided to separate search methods and their results by their origin to illustrate the differences in information available between research and publicly disseminated reviews, to further demonstrate the added value of data derived from social media. If a system appeared in more than one source, the results were combined to consider a comprehensive set of information about that system in our review, such as inclusion of available languages and the evidence-based background. Based on available data and our novel set of criteria, we performed evaluation and scoring on each of the selected apps, which is described under each search method type.

• Selection criteria & search strategy for scientific publications

In order to be included in the review, the scientific publications had to exhibit the following characteristics:

- Patient-operated mobile self-help system (e.g., smartphone app, smartwatch app, etc.)
- Support at least one of the self-management tasks (i.e., blood glucose, insulin, physical activity, diet)
- Include an evaluation or description of the system or the app written in English.

Publications excluded from the review were either designed to be exclusively used by healthcare professionals or were published prior January 2010. This 'cut-off date' was based upon the probability of outdated technology. The databases included were Google Scholar, PubMed, ScienceDirect, MEDLINE, ACM Digital Library, IEEE Xplore, DBLP Computer Science Bibliography, *Diabetes Management Journal*, Web of Science, Cinahl, *PLoS ONE*, Cochrane and Munin, the proprietary database of the University of Tromsø– The Arctic University of Norway. Searches were performed on peer-reviewed journals and journal publications of conference proceedings. The terms used were 'diabetes,' 'mobile,' 'smartphone,' 'system,' 'phone,' 'app,' 'application,' 'self-management' and 'self-help.' Logical operators 'AND' and 'OR' were used to combine the terms in multiple ways. First, we identified relevant articles by reviewing the titles, keywords and abstract for a preliminary filter with our selection criteria. We then reviewed full texts for articles that seemed relevant.

• Selection criteria & search strategy for publicly available systems

We searched for information regarding publicly available mobile diabetes systems on Google search engine, blogs and patient association websites. Publicly available systems are available on major vendor app stores, including Google Play Store as well as app stores specific to various mobile phone platforms including Blackberry App World, Apple iTunes, Nokia Ovi Store and Windows Phone Store. We used the terms 'diabetes' AND 'mobile' OR 'app' OR 'self-management' on the search engines and webpages, but only used the unique term 'Diabetes' on the app stores. We included systems that were attached to insulin pumps directly, which we separately classified as standalone 'Proprietary' mobile systems. Inclusion criteria for the publicly available systems are defined as follows:

- Mobile apps and systems that have a user interface in English
- Mobile apps and systems that are publicly available for free or for purchase
- Mobile apps and systems that provide at least the function for self-monitoring of blood glucose (SMBG)
- Mobile apps and systems that had a rating of more than three stars.

We excluded the mobile apps and systems that could only be considered as educational or informational tools, meaning those that did not provide any direct functionality for the self-management of diabetes-related issues.

• Selecting studies & apps for inclusion

From the search completed in the literature databases, one coauthor (AZ Woldaregay) vetted the initial hits to assess their relevance to our inclusion criteria by evaluating the titles, the keywords and the abstracts. Next, the two primary-authors (AZ Woldaregay and D-Z Issom) independently evaluated the full text of the selected studies. The inter-rater agreement was measured using the Cohen's Kappa test, and disagreements were resolved through discussion.

• Data categorization & data collection

Categories, upon which we extracted relevant app information, were based on previous research a literature reviews and further elaborated upon via iterative brainstorming among the coauthors. The agreed upon categories are as follows:

- Diabetes-related features: Diabetes self-management functionalities such as the tracking of physical activity, dietary habits, insulin doses and/or blood glucose measurements, among others. We used the following scoring mechanism to assess depth of the features:
- 0 was assigned if no chart, statistics or trends were available.
- 1 was assigned if the system or app was able to show trends, charts, lists or statistics.
- 2 if the system had more advanced graphs or statistics such as averages, deviations, distributions.
- Popularity and presence in social media: Popularity is also characterized by user feedback and comments, the number of installations, the number of ratings by reviewers and the score they gave as well as a system or app's presence on social media characterized by the number of likes on Facebook, the number of re-tweets and the number of Press releases.
- Availability: The platforms available, their cost and the languages in which a system or app can be used.
- Interoperability and 'shareability': Interoperability is defined by the ability for a system to communicate with other systems for data input or for data export. A main feature associated with this criterion is data export, which enables the app or system's ability to share data, thus taking into account the openness to other systems. We identified the information related to the format of data export, the compatibility with third-party apps, cloud-based solutions for the backup of data, the ability to transfer data to an electronic health record, compatibility with blood glucose meters or with other wearable devices such as smartwatches. We also considered the concept of 'shareability,' which describes the possibility for an app or system to mutually share information, for instance, on social media like Facebook or Twitter and also through other apps. It includes the ability of a system to be used by more than one user through, for instance, several accounts.
- User friendliness: This is defined by one main criterion; the type of data input, which can be manual or automatic. We did not assess the User Interface (UI) design or the quality of presentation.
- Quality assurance and regulatory oversight: This criterion identifies systems that are CE marked, FDA cleared or HIPAA compliant. A CE marking means that the system has been verified and complies with the safety and health standards defined in the European Union. The FDA clearance means that the use of the system or app for clinical treatment or prevention of the diabetes has been approved. A HIPAA compliant product follows the American law on the protection of personal healthcare information. This is also characterized by the level of maintenance of a system or app, including information regarding last update.
- Research based*:* This category identifies if the development of the system or app is driven by evidence-based research and if patients or clinicians have evaluated the system or app. For instance randomized clinical trials, or validation or evaluation tests done by individuals or groups other than the developer.

Results

• Search results for literature systems & apps

The literature review search retrieved a total of 287 papers (Google Scholar, n = 140, ACM n = 23, PubMed n = 51, IEEE Xplore n = 15, Medline (PMC) n = 36 and Munin n = 22). After removing duplicates, there were 272 records remaining. As illustrated in **Figure 1**, screening, which was based on our inclusion and exclusion criteria, eliminated 196 papers, leaving 76 relevant papers (Google Scholar n = 29, ACM n = 3, PubMed n = 21, IEEE Xplore n = 13, Medline n = 5 and finally Munin n = 5).

The inter-rater agreement, calculated using the Cohen Kappa test, was 0.595. According to Landis and Koch [12], this score is considered as a moderate agreement. Finally, 26 articles were accepted by consensus, and the study characteristics are shown in **Table 1**. Most of the studies 77% (20/26) were about design of the application or usability evaluations, and only 23% (6/26) were clinical trials or pilots assessing health outcomes.

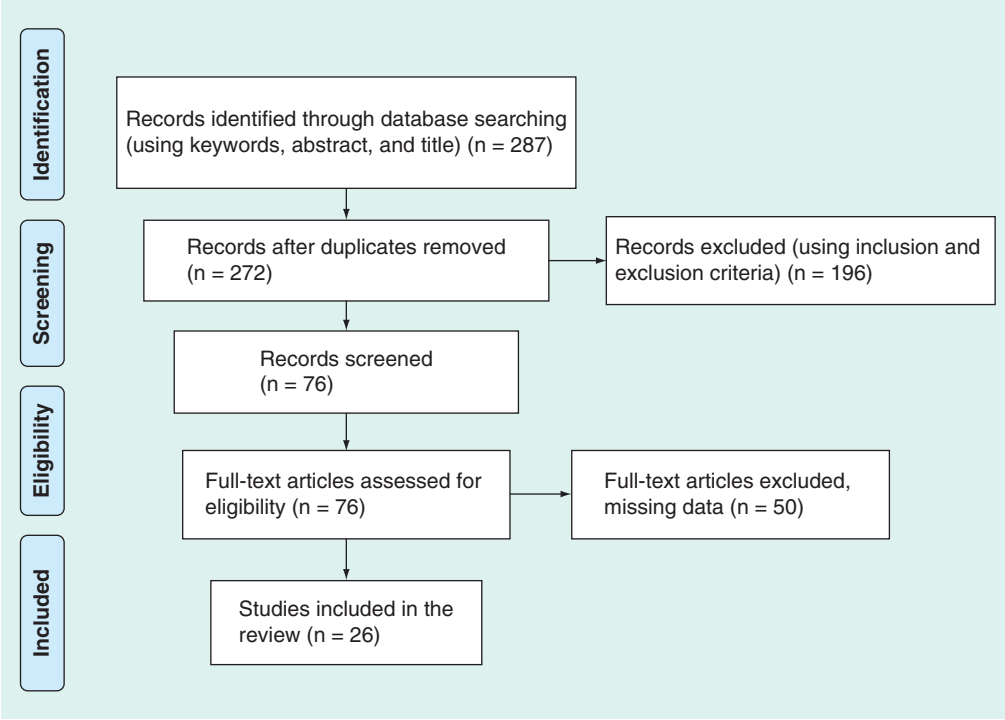

Figure 1. Flow chart of reviewed articles.

Two studies had a specific focus on children with Type 1 diabetes, and the follow-up period for clinical studies was 6 months or less. We present the literature-extracted studies and publicly available systems in two different tables, because most of the literature systems are prototypes, not publicly available for patients. We identified three applications used in the studies, which were also available on public vendor markets.

• Search results for publicly available systems & apps

The search for systems and apps occurred in April 2015 (Google Play store n = 261 apps, Apple iTunes n = 4000 apps, Windows Phone n = 240 apps, Blackberry App World n = 66 apps and the conference proceedings search n = 5 apps and systems). Searches in blogs, websites and patients associations' websites retrieved 81 apps and systems. After screening with the inclusion criteria, comparing the papers' abstracts, full texts, apps descriptions, testing the apps and discussing with the coauthors, 53 eligible apps remained, as illustrated in **Figure 2**.

Evaluation of the systems & apps

• Diabetes-related features

From the 26 relevant studies, 46% (12/26) have functionalities that support all four keystones of diabetes self-management, 16% (4/26) support at least two of the four keystones. We found that systems only supporting SMBG without another keystone accounted for 23% (6/26). The systems support nutrition 65% (17/26), exercise 62% (16/26) and medication management needs 58% (15/26).

The majority of the relevant studies extracted from the literature, 57% (15/26), provided statistics to the users. We gave one point to 30% (8/26) of the studies and the maximum two points to 27% (7/26) of the studies, based on our grading scheme for advanced graphs or statistical features.

From the 53 publicly available systems, 72% (38/53) have features that support the four keystones. Of these apps, 85% (45/53) allowed the user to manage their medication, while 77% (41/53) have a physical activity functionality and 85% (41/53) have a nutrition management feature.

We gave at least one point to most of the charts offered by the publicly available systems based on presence of basic statistics or trends. However, a few 28% (15/53) of the systems offered more advanced graphs or statistics.

• Interoperability aspects of the systems

Of the 26 relevant literature studies, only 8% (2/26) described their data export and import

Table 1. Included studies from the literature, sorted by year of study.

Study	Participants	Follow-up (months)	Diabetes/age	Type of study (design, usability, clinical study)	Year	Public market	Ref.
Quinn *et al.* (2015)	7	1	Type 2, elderly	Clinical study	2015	Yes	[13]
Årsand *et al.* (2015)	6	N/A	Type 1	Design, usability	2015	Yes	[14,15]
Padman *et al.* (2013)	8	2	Type 1, children	Clinical study, usability	2014	–	[16]
Bin-Sabbar (2013)	-	-	N/A	Design, usability	2014	–	[17]
Waki *et al.* (2014)	5	3	Type 2, adults	Clinical study	2014	–	[18]
Dohr *et al.* (2012)	-	-	Type 2	Usability	2014	–	[19]
Mougiakakou *et al.* (2010)	12	1/3	Type 1	Design	2014	–	[20]
Gittens *et al.* (2014)	45	N/A	N/A	Usability	2014	–	[21]
Tsui *et al.* (2014)	60	6	Type 1, Type 2, adults	Clinical study	2014	–	[10]
Le *et al.* (2011)	5	1/6	N/A, adults	Design, usability	2013	–	[22]
Takenga *et al.* (2014)	40	2	Type 2, adults	Clinical study	2013	–	[23]
Villarreal *et al.* (2014)	20	N/A	N/A, adults	Design	2013	–	[24]
Stroulia *et al.* (2013)	-	-	-	Design	2013	–	[25]
Tsai *et al.* (2012)	5	2	Type 1, adults	Clinical study, design	2012	–	[3]
Cai *et al.* (2012)	-	-	-	Design	2012	–	[26]
Batool *et al.* (2014)	276	N/A	N/A	Design	2012	–	[27]
Cafazzo *et al.* (2012)	20	3	Type 1, children	Usability	2012	Yes	[28]
Gislason *et al.* (2012)	N/A	N/A	N/A	Design	2012	–	[29]
Alhazbi and Alkhateeb (2012)	-	-	-	Design	2012	–	[30]
Pandey *et al.* (2012)	5	1/2	Type 1, Type 2	Usability	2012	–	[31]
Lee (2011)	27	N/A	Type 2	Design, usability	2011	–	[32]
Kim and Seo (2014)	N/A	N/A	N/A	Design, usability	2011	–	[33]
Rollo *et al.* (2011)	10	1/10	Type 2, adults	Design, usability	2011	–	[34]
Harris *et al.* (2010)	14	N/A	Type 1, Type 2, adults	Usability	2010	–	[35]
Curran *et al.* (2010)	6	1/2	N/A	Design	2010	–	[36]
Valdez *et al.* (2010)	22	N/A	Adults	Design, usability	2010	–	[37]

mechanisms. Harris *et al.* [35] describe the use of Extensive Mark-up Language (XML) and Årsand *et al.* [14] describe the use of CSV, XLS, PDF or a formatted e-mail for the export of data. Approximately 35% (9/26) used a Bluetooth interface for wireless data input from blood glucose meters. In terms of standards-based data interchange, only one study 4% (1/26), Takenga *et al.* [23], implemented the Health Level Seven International (HL7), Web Services Description Language (WSDL), Clinical Document Architecture (CDA) and XML standards. Cafazzo *et al.* [28] integrated their system with a cloud-based electronic health record (TELUS) powered by Microsoft's HealthVault, and Årsand *et al.* [14] integrated their system with Pebble smartwatch, RunKeeper fitness app and also with Bluetooth blood glucose meters. In contrast, 54% (14/26) did not use any kind of wireless data transfer standard.

The majority of the publicly available systems offer some form of data export 81% (43/53). However, few offer a raw data format for export like CSV 23% (12/53) or XLS 34% (18/53). The most common form was via e-mail 45% (24/53). Of the less common data export options were iTunes (n = 1), Twitter (n = 1), web platform (n = 5), desktop (n = 1) or plain text (n = 3).

In publicly available systems, we found that many apps offered a wide variety of interoperability options, but less than half 34% (18/53) offered any kind of support for other systems or devices. The apps were compatible with cloud-based services offered by Apple Health Kit, Microsoft HealthVault, Google Fit, Google Drive, OneDrive or Dropbox. Two of the smartphone-based apps (NST's Diabetes Diary and Diabetes:M) and one standalone system (Dexcom G4) include a user interface designed for smartwatches like Android Wear, Apple Watch or Pebble.

• Availability of the systems

Based on extracted information from the literature studies, **Figure 3** (left) shows the distribution of available platforms. As shown, many of the systems have been exclusively developed on Android 42% (11/26). However, not all specify the platform of development 19% (10/53). Complete results are displayed in **Supplementary Data 1**.

The publicly available systems show a different distribution. Most of the systems are available on Android 51% (27/53) and/or iOS 53% (28/53), with some available on multiple platforms. As shown in **Figure 3** (right), the less common platforms included Blackberry. We found only three standalone systems: one Blackberry app, one app on Nokia Ovi Store and one for Amazon Kindle. More details on the platform availability are in **Supplementary Data 2**. We found that most publicly available apps were free 81% (43/53), and 30% (16/53) of the apps were available in an additional language other than English.

• User-friendliness

In the 26 studies from the literature, 54% (14/26) support both automatic and manual data input, while 42% (11/26) support only manual entry and 4% (1/26) support only automatic only data entry. Among the publicly available systems and apps, the majority 89% (47/53) offered manual data input, while 38% (20/53) offered automatic and 25% (13/53) offered both.

• Quality assurance & evidence-based research

Of the literature studies, 46% (12/26) performed some form of evaluation. Interviews and questionnaires, mainly for clinicians, were used in 35% (9/26) of the studies, while 23% (6/26) assessed clinical outcomes. Regarding the publicly available systems, 8% (4/53) were FDA approved, 4% (2/53) were HIPAA approved and 6% (3/53) were CE approved. Most 89% (47/53) of the systems found in the publicly available places have not been evaluated by patients through questionnaires, usability or acceptance studies.

• Social media presence

Of the systems found in the literature, we found that only the system by Årsand *et al.* [14] had an appearance on Facebook (502 likes) and the app made by Cafazzo *et al.* [28] on Twitter (78 times).

28% (15/53) of the publicly available apps have been reviewed by more than 400 users. 64% (34/53) of the apps have a score of at least four stars. 84% (21/26) of the Android apps have a score above four stars in the Google Play Store, while 70% (18/26) of the iOS store have a score above four stars. We observed that the apps on Android have the highest scores, while iOS and multiplatform apps are the most popular on social networks (see **Supplementary Data 2**).

Most of the apps found in the literature did not have any press releases 96% (23/26). We also found that 68% of the papers are neither widely cited nor viewed/downloaded in social

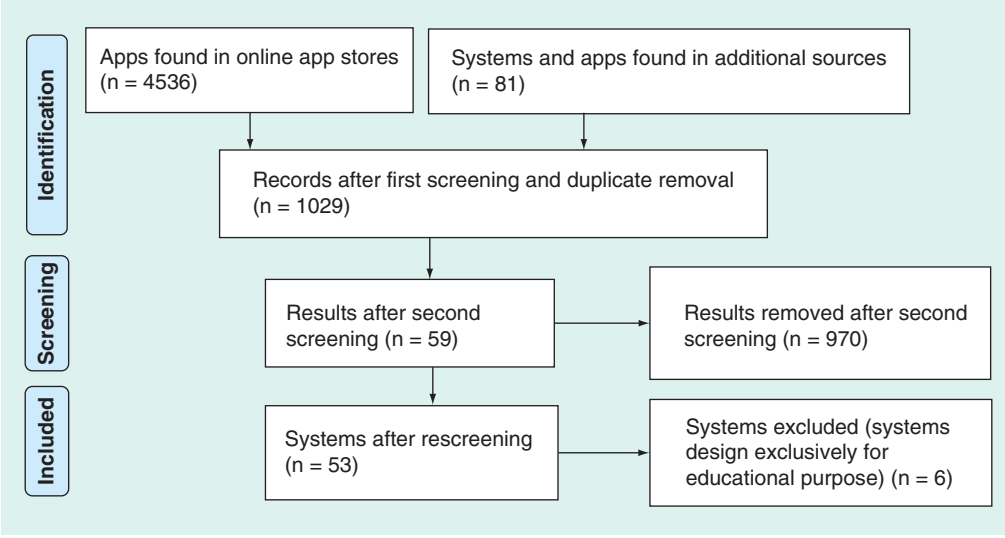

Figure 2. Flow chart of the publicly available systems.

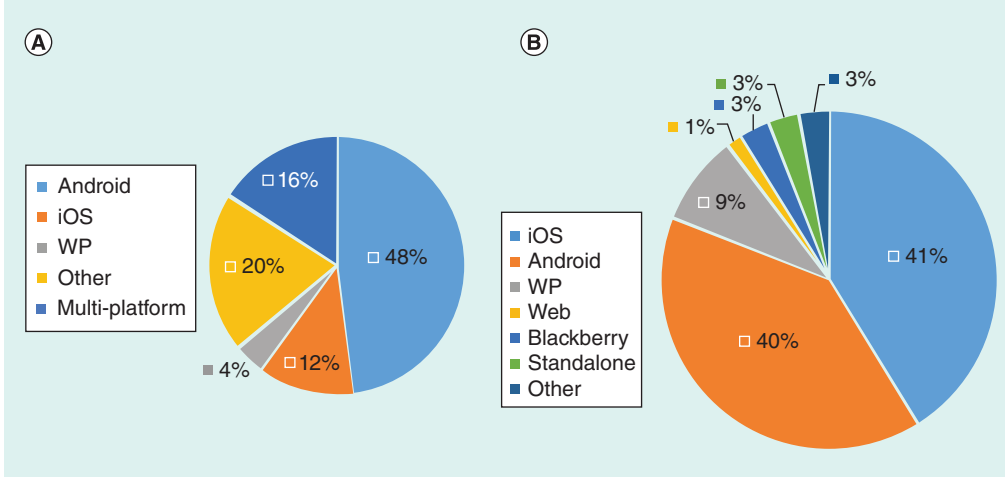

Figure 3. Platforms for literature-extracted studies (left) and publicly available systems (right).

media such as ResearchGate or Facebook, while 88% did not have any social media presence. Twitter and Facebook are equally represented and press releases are the most popular way of communicating about the apps. We noted that only the Google Play store provides information regarding number of current installs. The mean score of the apps that have not been updated since January 2014 is 3.8 stars and that of more recently updated apps is 4.2 stars.

Discussion

From these results, we were able to make additional inferences about apps than were not evident through research and literature-based studies alone. While clinical research provides essential information regarding relevance to the medical realm, by including such novel sources as social media and public reviews, we introduce a number of features of the apps, and characteristics surrounding the apps themselves, that influence an app's relevance to users' needs, in other words, the context in which they are used.

An important finding is the absence of most of the literature-extracted studies in social media or press releases, limiting the possibilities of evaluating the users' perception of literature papers and limiting it to the clinicians' perception and approval. Overall, the most popular methods of dissemination were via press release on tech blogs or public information from companies and communications through popular science articles. And, while we expected much more information from Twitter and Facebook sharing, consistent with their prevalent use, most apps are not shared or discussed on social networks. However, of those that were present, we found that the most commented on or 'liked' apps on social media tended to have a comprehensive set of features. This supports previous accounts by Quinn *et al.* [13,38–39], who reported that patients' self-efficacy could be improved by using apps that incorporate a comprehensive set of features.

It is difficult to demonstrate it, but compliance with standards and the use of gamification concepts seem to result in more comprehensive and well-received apps. Additionally, despite the fact that more evidence is need, clinical approvals and regulatory authorities compliance might ensure that an app is harmless. Moreover, patients who use only few of the publicly available apps such as MySugr Diabetes Logbook, NST Diabetes Diary, WellDoc BueStar Diabetes or BANT are founded on evidence-based research [14,28,40]. Such systems are often validated by randomized clinical trials that help to convince medical experts to recommend the apps to patients. Furthermore, based on examples we found, like BlueStar and mySugr, an app may be used and recommended more likely if it is integrated within the healthcare sector or showed a compliance with evidence-based practice and certifications authorities like the US FDA or CE.

Following with more granular details of an app's context, we observed that timing of release and the presence of more recent updates directly corresponded with the number of 'likes', comments or similar displays of attention during that time. We also found that iOS and multiplatform apps receive the most 'likes' within social network sites. However, there was no clear influence

of the price on an app's download trends or positive feedback from users. Moreover, nonfree apps have a mean score of 4.3/5 stars within app stores. This suggests users are willing to pay for apps of good quality.

Unexpectedly, we observed that an app's presence in social media was not necessarily dependent upon the level of usability. Some apps we judged to be less user-friendly had a strong social media presence. This finding seemed rather counter-intuitive because we expected apps with inferior design elements to have less social media visibility. This suggests that social media presence must be considered in the context of other metrics such as number of installs, ratings by users and recommendations by fellow patients or medical specialists.

We selected our ten 'favorite' apps (see **Table 2**) based on the design elements discussed in this study.

• Risk of bias & other limitations

Selected literature studies mostly focused on design and usability, and only a few assessed clinical outcomes. In spite of more than a decade with mobile applications, we have not seen many credible clinical trials. The studies that assessed clinical outcomes were poorly designed, with very short follow-up periods, and many had just a handful of participants, yet they made extraordinary claims. This poor evidence may partially explain why we have not seen many mobile application recommendations from clinicians or clinical guidelines.

In terms of search for publicly available systems, some online markets have restrictions on selected applications. There are applications with region restrictions that could not be found by normal search in the Norwegian Google Play market. This may have limited our reach, but it is unlikely that this limitation significantly affects our overall findings as we were able to contact developers directly for information for most apps in our review. Additionally, we omitted apps that did not include SMBG, putting the focus on the patients with the biggest self-monitoring needs.

The exclusion of the apps that have been ranked under three stars add bias in the calculation of the average rankings and should be taken into account. Furthermore, we do not know who is rating the apps, adding another risk of bias.

Conclusion & future perspective

An EU-funded report [41] found that, among individuals with diabetes, the most important

Table 2. Top ten most user-friendly diabetes self-management apps in rank order.

	Developer	Product	Platforms	Highlights
1	mySugr GmbH	Diabetes Logbook	iOS, Android, Web Browser	Growing list of compatible Blood Glucose Monitoring (BGM), compatible with Apple Health Kit, automatic data entry, large possibilities of data export, GUI full of gamification items, evidence-based, standard compliant and FDA, CE marking, praised by communities and the press, notable popularity and generally supported in social media. doi:10.1177/1460458214537511
2	WellDoc, Inc	BlueStar Diabetes	iOS	Comprehensive features, FDA cleared, the UI gives an immediate feedback on the automatic glucose data entries. It is supported by evidence-based research, and is highly recommended by doctors but must be prescribed. doi:10.1089/dia.2014.0341
3	NST	Diabetes Diary	iOS, Android	Effective and simple UI, very good interoperability, CE marking pending, based on research, evidence-based, RCT, automatic data entry. doi:10.1089/dia.2014.0276
4	MyNetDiary	Diabetes Tracker	iOS	Attractive design, full platform compatibility, follows best practices, praised in social media, regularly updated
5	Nicholas Martin	Diamedic	iOS	Follows best practices, sleek and simple UI, regular updates
6	FridayForward	Diabetes Diary	iOS	Large data export possibilities, very pleasant UI, charts and functions
7	MedHelp	Sugar Sense	iOS, Android	Many compatible devices, clear UI, lack of data export
8	Coheso	Track3	iOS	Sufficient level of interoperability, low level of maintenance
9	Taconic System	Healthsome G	iOS	Excellent possibilities of data export, large set of health data tracked, dated UI that can be difficult to read
10	Sanofi-Aventis	iBGStar Diabetes Manager	iOS	Pluggable BGM compatibility, simple UI but lack of updates and additional information

aspects of a diabetes app are the trustworthiness and accuracy of data or information. These are concepts which are tested throughout traditional research methods for health authority approval. Design approaches that take into account compliance with standards such as HIPAA, FDA clearing and CE marking, seem to enhance the quality of the apps and increase the chances of success among the users. Although research-based apps help build quality evidence for informing related clinical guidelines, they were not necessarily the determining factor of success among real-time users. Herein lies the potential for expanded review methods.

This review highlights areas which may contribute to sustainable use by patients, therefore, what will influence the greatest positive impact, and which much be considered by medical and commercial researchers. We have demonstrated that social media can be a positive tool for raising awareness of high-quality products. As more common trends suggest, we predict that in order to remain relevant and maintain the interest of users, developers must constantly attend to user comments, fix issues and update systems according to state of the art APIs available on the platforms. An outdated system that, for instance, does not offer any possibility for automatic data export or entry can become obsolete or undesirable the long-term and, thus, not relevant to patients and current users. Furthermore, although the number of user comments can be overwhelming, the feedback loop fosters attractive designs that are sensitive to user needs.

Our approach is a pilot study in itself of what is available and what should be included in the review of patient-empowering and patient-operated tools for disease self-management. Future trends that we expect to make a great impact on the medical realm as well as an individual patient's life include the observed growing trend in the use of wearable devices. From our results, we can predict that patient's will welcome the ease of use, ever presence and possibilities that this next generation of mobile and personalized health will offer. Therefore, we expect to see more concerted efforts toward the development of systems that are compatible with several devices and platform standards, like Apple Health Kit, Microsoft HealthVault or Google Fit. We foresee that greater interoperability by integrating platform standards [42] will be a valuable feature for future developments [43]. This ability facilitates the integration of more advanced features and could allow for the use of data for clinical decision support systems. Previous studies have reported that such features can lead to better long-term use, a greater interest, higher user ratings, higher number of users and, overall, better acceptance level among users [44].

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at www.futuremedicine.com/doi/full/10.2217/dmt.15.40

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