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RESEARCH ARTICLE

Determining minimum set of features for diabetes mobile apps

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Abstract

Purpose Interest in mobile health applications (apps) for diabetes self-care is growing. Mobile health is a promising new treatment modality for diabetes, though few smartphone apps have been designed based on a proper study and prioritization. The aim of this study was to determine a minimum set of features for diabetes mobile apps.

Methods This study was conducted in three steps: 1.A review of the literature to collect all available features, 2. Assessing the validity of suggested features by Content Validity Index (CVI) and Content Validity Ratio (CVR), 3. Examining the importance of features by Friedman test.

Results We retrieved all features of available mobile apps for type 2 diabetes, which are suggested and discussed in literature and compiled as a single list comprising of 33 features. Then, a survey of expert's opinion produced a set of 23 final minimum features which includes all types of tracking, mealtime tagging, food database, diet management, educational materials, healthy coping, reducing risks, problem solving, Email, color coding, alerts, reminder, target range setting, trend chart view, logbook view, numerical indicators view, customizable theme, preset notes, and custom notes. According to the mean rank which indicates the priority of each feature, the most important one was blood glucose tracking (with 16.71 mean rank) and the least important feature was the numerical indicators like such as standard deviation or average (with 6.50 mean rank).

Conclusions The present study is the first step towards the development of our mobile apps for people with type II diabetes, and highest the essential features that are required for an optimal self-care comprehensively.

Keywords Mobile health · mHealth · Smartphone apps · Type 2 diabetes · Features

Introduction

Diabetes is one of the major concerns in healthcare. Diabetes could be a cause of many disabling complications such as cardiovascular disease, kidney failure, blindness, and amputation. It also affects the quality of life and the ability of the patients to manage their life during the course of the illness [1]. Since 1980, the number of adults with diabetes has quadrupled. More than 400 million people worldwide are diagnosed with diabetes, and these growing numbers tend to rise to more than 600 million by 2040 [2]. However, less than half of those people receive standard care [3]. Almost 90% of these cases make up Diabetes type 2 (T2DM) which is defined as insufficient insulin secretion or resistance to it [4]. Although diabetes type 2 patients play important role to control the progression of their disorder [5], there is growing concern whether traditional methods for monitoring the patient's self-care activities cover health care needs effectively. Therefore, modern methods are recommended. Also, the World Health Organization (WHO) emphasizes that no adequate coverage of global health without the support of electronically based interventions can be obtained [6]. mHealth is a subset of all types of electronic interventions in healthcare that refers to the use of smart phones for health care services [7]. It is also known as mobile health refers to the use of mobile computational technologies such as mobile phone

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in patient care that go beyond the traditional patient-physician communication [8].

Based on the data that patients import into mobile-based applications known as apps (whether manually or automatically, such as logging in via Bluetooth), these apps can provide appropriate feedback. These apps can enhance self-care skills through ease of communication with the healthcare providers and provide immediate monitoring and educational messages. It is proven that mobile apps may make clinical efficiency for T2DM control [9].

Here are some of the other advantages of this method, which increases the tendency to use it: (1) The ability to be present all over the place, (2) high scalability for provided services, (3) low cost and convenient for use by the end user, (4) usable in deprived and low-income areas, (5) provide two-way, close and comfortable patient and provider communication, and (6) can be personalized for patient's self-care. Mobile phones are now used as a supporter of health care services because they are widely available and relatively affordable. Researchers and healthcare providers have introduced this tool with ubiquitous nature, as a guide to help patients [7].

Because of these benefits, statistics show 44 million health apps downloaded in 2012 exceeded to 142 million downloads by 2016. Many of these apps are dedicated to manage chronic and costly diseases like T2DM [10]. Therefore, there are numerous mobile apps with various features for managing T2DM. The understanding of the use of mobile health apps is growing too, while the creation and completion of the apps are developing [11]. However, to utilize available opportunities for these apps, several necessary considerations are required [12]. Self-care improvement approaches are effective if mobile apps are designed according to the patient's status and complex condition. They need to consider a lot of necessary requirements for diabetes patients care such as continuous monitoring of blood glucose, physical activity, blood pressure, and medication simultaneously [13]. Unfortunately, such fertile opportunity is sometimes limited only to focus on using text messages [12]. or sometimes, patients are bewildered to use complicated diabetes mobile apps. Therefore selecting the appropriate one with adequate features, for satisfying the needs is so critical [14]. Many of these apps are designed without considering any scientific base and user requirement. Truly, many of the researchers offer a list of features merely considering expert's opinions [15–18]. That is, many apps help patients to guide, implement, and control their own self-care behaviors, still, there is a need to provide the desired template for diabetes patients self-care mobile apps [19]. The present study attempts to point out the minimum features as a base which is required for T2DM self-care apps based on previous research results and expert's point of view.

Methods

This study aims to offer a set of features for mobile apps designed for T2DM self-care. We used a mixed descriptive analytic method in which questionnaire tool was used to cover this objective. This research has been conducted following three steps.

The first step, the totality of available and suggested features were reviewed in the literature related to mobile based diabetes type II self-care. The articles in the databases of Web of Knowledge, Google Scholar, PubMed, Scopus, and Science Direct were retrieved using the keywords of "diabetes", "glucose", "blood sugar", "insulin", "mobile health", "mobile apps"," smartphone", "mobile phone" and "mHealth". All non-English articles were excluded. All articles older than 2012 were discarded. Articles that specifically did not deal with diabetes self-care straightly and were limited to topics such as physical activity, diet, or medication adherence, were removed in this step. Also, articles that did not directly mention the use of mobile devices in the field of T2DM self-care were also eliminated. We searched guidelines and standards related to self-care diabetes specially based on mobile apps too After that, all suggested features from remained studies were extracted. Then the duplicated features were removed. We tried to provide correct and uniform definition for each feature in order to make accurate understanding. Some features have well and complete definition, so we extracted that definitions from the literature; however, the definitions of some others have not any definitions or were vague, and we tried to provide acceptable definitions based on reviewed literature [20–25] and expert opinions.

In the second step, the validity of extracted features was analyzed. For this task, we examine both relevancy and necessity of features. We requested from six members of the interdisciplinary expert team including Iranian Board of Health Informatics, Health Information Management, Adult Endocrinologist, Health Education, and Promotion to comment to approve the most necessary and relevant features. Thus, for this purpose, the content validity ration (CVR) and content validity index (CVI) scales was calculated. The CVR is a useful statistical technique to determine the validity of individual questionnaire items related to necessity, as rated by a panel of content experts. The CVI provides a numeric value for the overall mean CVRs and related to relevancy of all items included in the questionnaire. To determine CVR scale, we used the formula shown in follow. According to Lawshe's table [26], if CVR's feature is higher than 0.99, that feature is accepted. The relevancy of the suggested features were examined based the predefined score of Lynn's table, those items would be accepted that have at a level higher than 0.79 among these six experts [27]. We collected the views of experts proposed on the four-part of Likert for the CVI includes non-relevant, to some extent relevant and relevant

calculated. Also, three parts of Likert for CVR include "necessary", "useful but not necessary", and "not necessary". After calculating the CVR and CVI, some features were revised to be kept or deleted. Afterward, we made a questionnaire by verified features, in order to determine the final features list and analyses the level of importance of them, a Likert questionnaire was made to considered the five-part of scales from "totally agree" (highest score), "almost agree", "indifferent", "agree" and "not agree" (least score). The list of names and email addresses of specialists in various areas include Health Informatics, Health Information Management, Adult Endocrinologist, Health Education, and Promotion was collected separately from the website of the Ministry of Health Scientometrics and Publications. The requirements for faculty members to complete the questionnaire at all universities across the country were a higher academic degree, a minimum of 5 years' experience and research experience in diabetes. Taking these criteria, we requested 34 specialists to comment suggested features; and 21 of them responded.

In third step, we used Friedman test to sort features importance with mean rank measure (P value <0.05). Non parametric Friedman test was used to sort out features in term of their importance based on their scores. we used this test, which is equivalent to analysis of variance to compare the mean of ratings among features. The Friedman test is used for one-way repeated measures analysis of variance by ranks. This measurement used when at least data in the ordinary scale. This test was exploited in SPSS 22.0.

Results

With respect to each step of the procedure, the results are reported. For the first step, the search process from online journal databases illustrated in Fig. 1 was done. Based on our inclusion and exclusion criteria, 12 relevant papers remained.

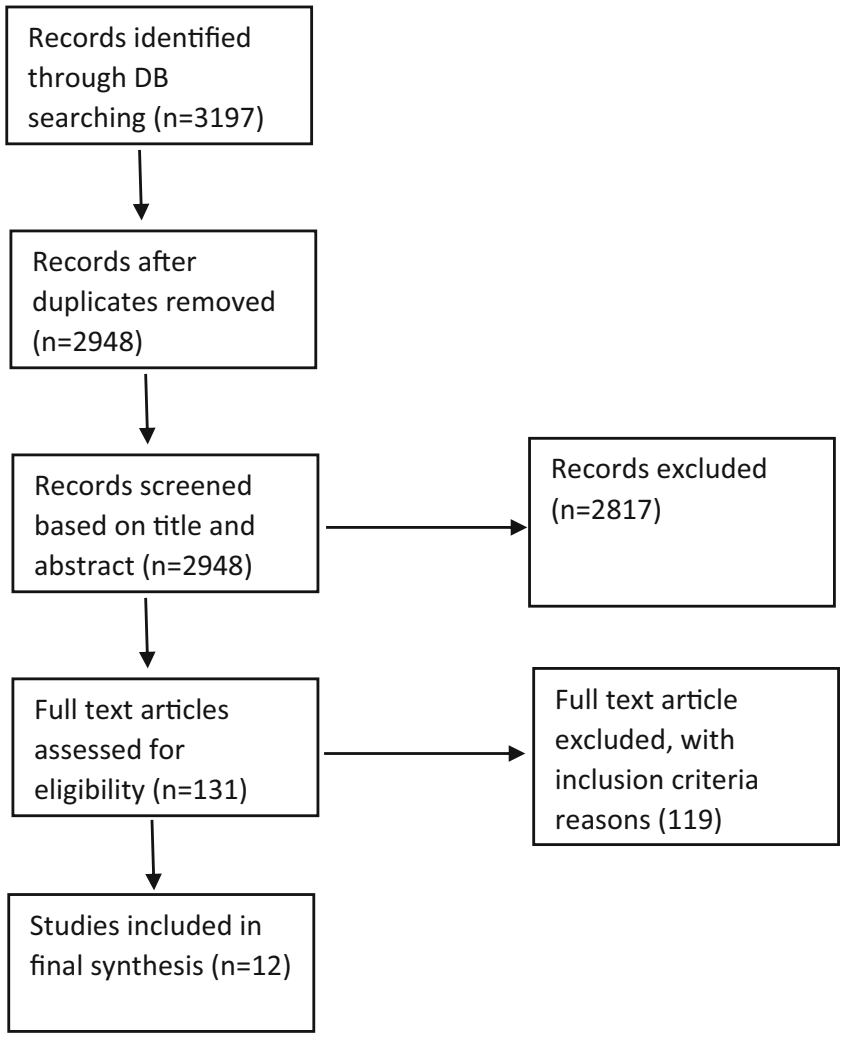

Fig. 1 PRISMA flow diagram of selection process for papers

We needed to have a clear definition that experts would be able to grasp the function of each feature in a straightforward manner and that the same impression would occur. Some features were well-defined and we extracted their definitions from the literature [18, 22, 25]; however, the definition of some others was vague; therefore, we tried to provide acceptable definitions based on reviewed papers. The identified features from the first step and their definitions are listed in Table 1.

To better utilize the potential of mobile technologies for interventions, it is better to use theories and models to design and develop complex interventions that respond appropriately

Table 1 Features list of diabetes mobile apps and their definition based on literatures database search

Record	Features	Definition
1	Blood Glucose Tracking	Comparison of BG test results entered in different sessions
2	Insulin and Medication Tracking	Comparison of insulin test results entered in different sessions
3	Physical Activity Tracking	Comparison of physical activity results entered in different sessions
4	Weight Tracking	Comparison of weight checking results entered in different sessions
5	Blood pressure Tracking	Comparison of blood pressure test results entered in different sessions
6	Diet Tracking	Comparison of calorie, fat or other nutritional information of consumed meal via barcode or selected from the list
7	Food database	The extent to which the user can choose consumed food in a list
8	Mealtime tagging	To tag, the time/s patients have had meal/s over a specific time
9	Education	To provide a specific tip for patients to better manage a condition
10	Messaging	To communicate healthcare to get a new update of app or events in the health center
11	Data export	To change entered data into other formats such as CSV or email
12	Synchronization to website	To keep the mobile app in coherence with the website in order to maintain data integrity between these two sources
13	Synchronization with PHR	To keep the mobile app in coherence with PHR in order to maintain data integrity between these two sources
14	Synchronization with social network	To keep the mobile app in coherence with the social network in order to maintain data integrity between these two sources
15	Color Coding	Categories are coded by different colors based on BG values including low, middle and high level
16	Alerts	To alert the user about the condition
17	Reminder	To remind patient about activities user must do for self-care
18	Prediction	To predict condition based on data entered into the system
19	Estimation	To estimate the value of the BG level based on user condition using entered related data
20	Detection	To detect specific condition based on the value of BG entered in the system
21	Trend Chart View	To show a graphical display of BG or others health-related measured values over time
22	Logbook View	To review important events related to BG management in an electronic page
23	Numerical Indicators	To calculate the measures of patient BG, BP and so on by Average, Standard Deviation
24	Customizable Theme	To change the display or layout of the app
25	Data Entry Automation	To upload the level of blood glucose into the app automatically due to the compatibility of the app and blood glucose meter reader or insulin pump
26	Preset Notes	To use a structured note by the user in order to remember something or a number
27	Custom Notes	To use unstructured note by the user in order to remember something or a number
28	Target range setting	To allow the user to establish what they want to achieve in terms of BG level or other important measurements
29	Security	The ability to put pin code or password for whole or database part of the app
30	Communication	The possibility of connecting patient to other patients, friends or family member via email, write a review or exchange their experiences
31	Problem Solving	The ability to figure out how to problem solve in general and for specific issues you may be facing.
32	Reducing Risks	The ability to find the best way to help reduce patients risks and avoid other health problems
33	Healthy Coping	The ability to find healthy ways to cope that work with patients' lifestyle

to different inputs [28]. One of the best references could be the American Association of Diabetes Educators (AADE) guidance, because of providing a collection of necessities for diabetes mobile apps. According to the American Association of Diabetes Educators, explicitly states that mobile apps for diabetic patients should improve or upgrade any of seven therapeutic elements. These seven elements include 1. healthy eating, 2. being active, 3. monitoring, 4. taking medications, 5. problem solving, 6. reducing risks, and 7. healthy coping [29].

For the second step based on expert's opinions, 23 relevant features out of 33 were approved with CVI = 0.79 or more. CVI of each feature presented in Table 2. In addition, all features had CVR higher than 0.99. These features include: blood glucose tracking, insulin and medication tracking, physical activity tracking, weight and BMI tracking, blood pressure tracking, mealtime tagging, food database, diet tracking, educational materials, healthy coping, reducing risks, problem-solving, messaging, color coding, alerts, reminder, target range setting, trend chart view, logbook view, numerical indicators view, customizable theme, preset notes, custom notes.

The next goal of this study in the last step was to evaluate the importance of features through the Friedman test. The results of the study are shown in Table 3. We can consider the cutting point to be 11.5. In other words, to select the best and appropriate features we assumed features which gain mean rank more than this point.

Among the features suggested by experts, the highest degree of importance was attributed to the blood glucose tracking feature with a mean score of 16.71, and the lowest grade of importance attributed to the display of numerical indicator with a mean score of 6.50. These results are also consistent with the results of the previous step, which is indicated by experts. Therefore, we have 23 final essential features with their rate of priority.

Discussion

Some experts have provided a brief list of features available in diabetes care apps in addition attention to language and platform of them, and apparent features [25]. Some others list different features based on some high rating of apps used for self-monitoring of blood glucose management [21, 22].

In our review focus was on the necessity, relevancy, and importance. In the suggested features set, the results are shown that blood glucose tracking is in the highest level of necessity and importance for diabetes type II self- care. This finding is also confirmed by previous studies. Many of the researches have reported that diabetes people could have a better self-care in case they control their blood glucose level [18, 25, 30].

Education that has been addressed as the second important feature might affect directly on self-efficacy which is a cornerstone element in self-care improvement [31]. Hence, this feature could be ranked in second. However, this feature is not sufficiently considered when diabetes app is being developed. Problem-solving was another feature which has been also emphasized by AADE [28]; This feature may lead to improve patient's self-efficacy and therefore this improve self-care [31]. This feature is less common in diabetes apps, unfortunately. One of the best reason for high priority of this features

Table 2 The values of CVI of each feature of Diabetes type II mobile application

Record	Features	CVI	Acceptable	Record	Features	CVI	Acceptable
1	Blood Glucose Tracking	1	√	18	Alerts	1	√
2	Insulin and Medication Tracking	1	√	19	Reminder	1	√
3	Physical Activity Tracking	1	√	20	Prediction of insulin dosage	0.66	×
4	Weight and BMI Tracking	1	√	21	Target range setting	0.50	√
5	Blood pressure Tracking	0.83	√	22	Trend Chart View	1	√
6	Meal time tagging	0.83	√	23	Logbook View	0.83	√
7	Food (Diet) database	1	√	24	Numerical indicators View	1	√
8	Diet Tracking	1	√	25	Customizable Theme	0.83	√
9	Educational Materials	1	√	26	Preset Notes	0.83	√
10	Healthy Coping	1	√	27	Custom Notes	0.83	√
11	Reducing Risks	0.83	√	28	Communication	0.33	×
12	Problem Solving	1	√	29	Estimation	0.50	×
13	Data export	0.66	×	30	Detection	0.50	×
14	Portability with the website	0.66	×	31	Data entry automation	0.16	×
15	Portability with social network	0.50	×	32	Security	0.50	×
16	Messaging	0.83	√	33	Portability with PHR	0.50	×
17	Color Coding	1	√				

Table 3 Descriptive analysis and ranking of final essential features

Rank	Variable	Mean	SD	Min	Max	Mean rank
1	Blood Glucose Tracking	4.90	.30	4	5	16.71
2	Educational material	4.86	.36	4	5	16.31
3	Problem solving	4.76	.44	4	5	15.31
4	Reminder	4.71	.46	4	5	15.24
5	Alert	4.71	.46	4	5	15.00
6	Weight and BMI Tracking	4.62	.50	4	5	14.14
7	Reducing risk	4.62	.67	3	5	14.02
8	Physical activity Tracking	4.57	.51	4	5	13.81
9	Healthy coping	4.57	.60	3	5	13.64
10	Blood pressure Tracking	4.52	.60	3	5	13.24
11	Insulin and Medication Tracking	4.52	.60	3	5	13.14
12	Trend chart view	4.48	.68	3	5	12.83
13	Log book view	4.40	.75	3	5	11.50
14	Diet Tracking	4.41	.96	1	5	11.02
15	Meal time tagging	4.19	.68	3	5	10.43
16	Target range setting	4.24	.63	3	5	10.50
17	Messaging	4.14	.85	2	5	10.21
18	Color coding	3.95	1.16	1	5	9.69
19	Custom note	4.14	.66	3	5	9.52
20	Food database	4.10	.54	3	5	8.95
21	Customizable theme	3.90	.83	2	5	8.33
22	Preset note	3.81	.75	3	5	7.19
23	Numerical indicator	3.57	1.12	1	5	6.50

is a relationship between education and blood glucose tracking as identifying the trends of blood glucose of patients could make a good plan or take educations more seriously to improve related self-care behaviors [9].

Other features that were recognized as the final and high score ones are related to the monitoring of the main elements of care for diabetes II, which are recognized as central and fundamental features for mobile apps like weight and BMI tracking or physical activity tracking [32].

Using communications means like reminders have been reported from other prominent and important features. Communication between patients and care providers plays a very important role in monitoring the disease and even patient education. For example, by sending reminders for taking medication or appointments or adhering to medical conditions and paying attention to educational tips, there are somethings that can be promoted to improve the self-care of diabetic patients [33].

Our results almost were in line with the results of the study of Chomutare et al. [18]. In their article, the analysis of apps in the market showed importance degrees similar to our results in Table 3. Perhaps one of the concerns of physicians about mobile apps has been the effectiveness of these apps. Another reason might be due to this fact that these apps have been delivered and marketed without clinical examinations without the presence of patients and experts' opinion [34, 35]. While, these considerations explicitly mentioned in mobile apps developing [16, 17]. Thus, it is necessary that the number of considered features in apps to be set up as low as possible and matched with the apps desired goals. Therefore, the development of features in diabetes mobile apps requires to be more specific and user oriented. That is, mobile apps can be a useful tool for customized self-care for diabetic patients if they would be blended with evidence-based self-care behaviors [36]. although, usefulness of healthcare mobile apps depends on other factors besides mobile phone technologies, such as the healthcare context, social values, and culture. therefore more researches are needed [37].

Conclusion

There are many diabetes mobile apps which are not consistent with the recommendations of the guidelines. Therefore, the more design and development of diabetes mobile apps based on studies and guidelines, future plans will be beneficial. Therefore, partnerships between academics and apps developers may be an important component of future diabetes mobile apps approaches both in research and practice. It is hoped that the results of this paper could be used to set an appropriate

framework of apps features and component for diabetes type II mobile apps in futures. In addition, this study could be a step for the path of designing the approved apps and presenting a set of features of the case.

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Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare.

Limitation The number of specialists filling out the questionnaire was less than expected. Due to the widespread geographical dispersion, there was no possibility to deliver this form in paper in person for all of them. Therefore the questionnaire form emeiled in electronic form. Inaccessibility to the full text of some articles were another limitation in this study.

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