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Design and Evaluation of Mobile-Based Logbook Application for Type 2 Diabetes Patients

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Abstract

Introduction: A paper-based logbook used to record the daily diabetes data may have many complications such as damage, forgetting to bring on physician appointments, and incomplete data analysis. Therefore, it is not counted as an effective tool for logging such data. On the other hand, due to the high popularity of mobile phones among the population, it is possible to use the numerous capabilities of this tool to help patients with diabetes. In this study, a mobile-based application for logging type 2 diabetes patients' data was designed, implemented, and then evaluated by patients and physicians.

Materials and Methods: Initially, the structural and content-based features of paper-based logbooks used in various diabetes associations were extracted, and four data elements containing blood glucose, food, medication, and physical activity were selected. The software was then designed using object-oriented analysis and programmed for Android and iOS operating systems. Heuristic and adaptability tests were also performed for proper application performance. Then, a questionnaire designed to evaluate the user interface and functionality of the software and was provided to 5 patients referred to the diabetes physician. Furthermore, five other patients were asked to report their data to the paper-based logbook in the traditional manner. Finally, another questionnaire was given to their treating physician (diabetes specialist) to compare the treatment process between the two groups of patients.

Findings: The findings of the study reveal that the software satisfied patients' needs by providing them facilities like blood glucose monitoring with automatic recording time, food intake and carbohydrate intake, physical activity, and calorie counting of each activity, as well as a list of patient medications. The comparison between the modern and traditional groups also showed the appropriate treatment in the modern group compared to the traditional group.

Conclusion: Using a mobile-based application for type 2 diabetes will provide necessary data to the physician to make better decisions. It will also help the treatment process and ultimately the effective management of diabetes.

Keywords: Type 2 diabetes; diabetes logbook application; mobile health;

Introduction

The Personalization of the treatment process for patients with type 2 diabetes is now primarily done through the paper logbook. This personalization includes measuring and recording blood glucose, exercise activities, food, and medications taken during day [1,2]. Due to the characteristics of these paper logbooks, special attention needs to be paid to problems such as damage, loss, failure to bring the logbook at the physician appointment time, and potential absence of disease history. Many patients enter unrealistic data just before the physician appointment time in the daily logbook [3]. Also, if a patient has a specific and variable glucose pattern, it is difficult to be analyzed by physician [4]. Reviewing and comparing old and new data from these daily reporting logbooks and prescribing treatment plans is also not performed efficiently by physicians [5].

Due to the high usage of mobile phones among community members - around 7 billion users worldwide [6,7] - people prefer to do a lot of their daily activities through mobile phones, and in a way, it can be described as an integral part of modern human life. In general, the prevalence of mobile phone use in the world has created an opportunity to provide a powerful platform for providing individual health care for patient comfort [8-10]. Using mobile-based software to manage the treatment process for patients with type 2 diabetes with the ability to record daily reports can alleviate the difficulties of using paper logbooks with electronic data recording, data storage, and retrieval operations performed in a more efficient and less error-prone manner. Patient data can always be accessible to the user, data loss is minimized, and data can be researchable for physicians. On the other hand, by providing all the data elements needed by the physician and controlling the timing of each data entry to distinguish realistic from unrealistic data, a practical step is taken to manage type 2 diabetes properly [11-14].

The primary purpose of this study was to design a mobile-based application for the daily report of type 2 diabetes patients called DiaLog and then evaluate this software among its users and a diabetes specialist.

Materials and Methods

Software Development

Table 1: Relative Frequency of diabetes mobile applications' characteristics.

Frequency Characteristic	Simple frequency	Relative frequency
Android	9	69%
iOS	9	69%
Blood glucose	13	100%
Medication intake	10	76%
Food intake	9	69%
Physical activity	8	61%

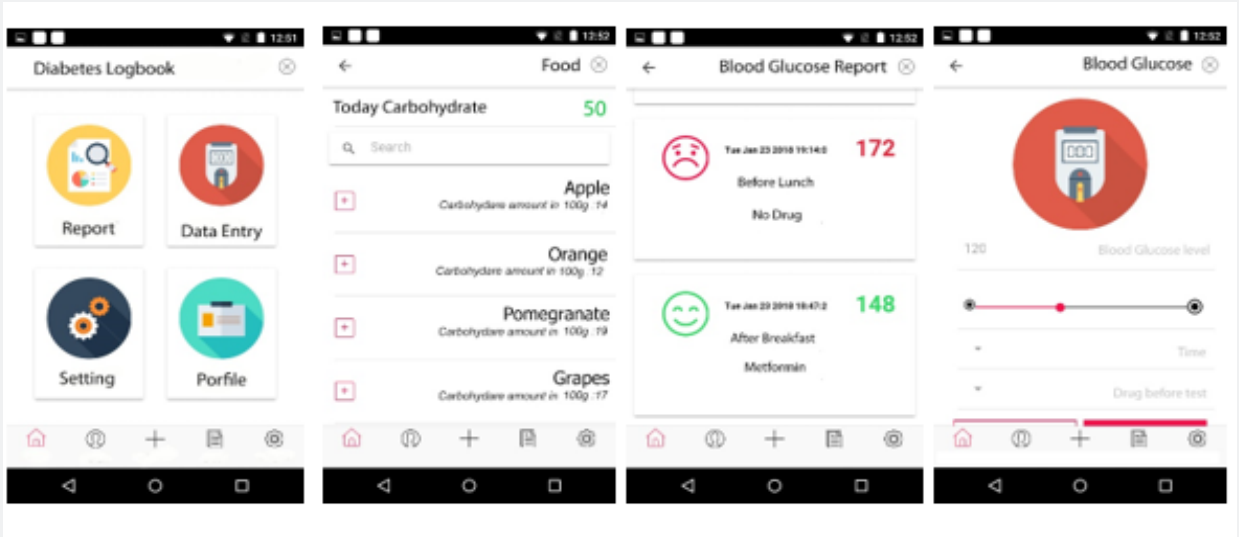

Figure 1: some views of DiaLog application.

First of all, the structural and content-based features of the diabetes logbooks were needed. For this purpose, the diabetes logbooks were selected worldwide. The recommended data elements on blood glucose, food intake, medication, and physical activity [15] were presented to 10 diabetes practitioners as the most frequently used data elements in logbooks. Finally, they decided to select all of these data elements for the structure of the electronic logbook. Moreover, mobile-based applications available for diabetes were downloaded and installed for both Android and iOS operating systems. Extracted data such as the presence of mentioned data elements and software-specific features in 13 mobile applications are summarized in Table 1. Critical features of the standard diabetes logbook in our mobile application contain four data elements of blood glucose, food intake, patient

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medication, and physical activity. The exact time of recording each data element was also identified as an essential feature in designing the electronic logbook structure. Subsequently, the object-oriented conceptual model of the software was designed using the UML modeling language, and software programming was performed based on the presented model. Considering the high number of users of both Android and iOS operating systems, which make up 99.6% of smartphones [16], the software produced in this study was generated for both Android and iOS using the JavaScript programming language and Exploratory and compatibility tests were also performed on a variety of mobile phones for proper performance (Figure 1).

Then software called DiaLog (Diabetes Logbook) was produced, and the following main features were considered:

i. Blood glucose record along with automatic registrations to prevent unrealistic dates from those being entered

ii. High or low blood sugar alert

iii. Food intake record

iv. Automatic calculation of carbohydrates consumed during the day

v. Daily carbohydrate alert

vi. Picture list of patient medications with name, dose, and time of use

vii. Physical activity record during the day

viii. Automatic Calculation and display of calories consumed for each activity

Software Evaluation

After producing the mobile application, two patient groups were selected. One group involved 5 patients using the paper-based logbook and another group 5 patients using the DiaLog mobile application to record the daily report. These patients were asked to record their data for three months (the first group in the paper-based logbook and the second group in DiaLog).

Then, two structured questionnaires were designed, and their validity and reliability were confirmed. One of the questionnaires related to the evaluation of the user interface, the items in the software, the number of positive effects, and its continued use was provided to DiaLog users. Another questionnaire was designed to compare the treatment process between the traditional and modern groups, and the physician was asked to answer the questions.

Findings

The results obtained from the evaluation of software features by five users are shown in Table 2. On the other hand, the overall evaluation obtained by the specialist physician regarding the comparison of the treatment process with the software users and the traditional patients also yielded the results shown Table 3. Software evaluation results showed that 98% of DiaLog users were satisfied with the software interface. Also, everyone stated that the features considered in the software were requisite ones. Some of the software's features, such as the automatic calculation of carbohydrates and calories burned, have helped control their blood sugar. The effectiveness of the software in the patient's mind was also assessed in this evaluation. These effects include not forgetting the medications after a few days of using the software, the habit of accurately recording blood sugar, and continually checking other software items such as nutrition and physical activity, with 90% reporting a positive response. It should note that 90% of patients stated that they would continue using this software, citing its simplicity and functionality. Findings from the questionnaire provided by the physician also showed that patients using the software had better control over their blood glucose in 80% of cases and always (100% of cases) had the needed data with them.

Table 2: Results of Evaluation of software properties.

Item	Relative frequency
User interface	98%
Fits software features to patients need	100%
Effectiveness in the patients need	90%
Continues use of software	93%

Table 3: Comparative evaluation results of modern and traditional patients.

Items	DiaLog Users	Paper-based logbook users
Blood glucose control	80%	40%
Provide physician data needed to make decisions	100%	20%
Forgetting to bring data	0	60%
Ease of use	80%	80%

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Discussion

The results showed that mobile application users provide complete and higher quality data than the traditional group. Therefore, blood glucose control in software users was better than in the traditional group. According to the specialist physician, the features considered in the software provide the data necessary to make a decision that is not available in the paper-based logbook. Forgetting to have data while visiting a physician is also a significant issue that software users have addressed through mobile phones. However, this study frequently forgot the paper-based logbook in traditional patients.

In this way, the mobile-based application with the aforementioned features can be a good substitute for the diabetes paper-based logbook to provide the maximum data needed for treatment. Moreover, such software can lead to effective care of the patient and their involvement in their treatment, which motivates them to continue the treatment process. One of the essential aspects of using a diabetes mobile-based application is to keep the patient aware of their blood glucose fluctuations at different times to have proper control over them. Awareness of consumed carbohydrates and calories burned will also help manage disease treatment better. The conflict of different medications and the lack of information of the specialist physicians about individual medications may interfere with the patient's treatment process. In this mobile-based application, the patient can prevent such problems by registering the medications used in the software and presenting them to physicians.

The use of mobile-based technologies may be complex at first glance for the elderly or illiterate, but with proper training, this problem resolves. Whereas educating family members or their nurses is the primary solution to preventing such problems.

Conclusion

In general, the mobile-based diabetes application can be a good substitute for paper-based logbooks. The ever-present mobile phone and its non-forgetting makes it an effective platform for providing essential data for patients with diabetes. Adequate and sufficient data for proper decision-making by physicians and the ability to perform a variety of analyses on them can lead to practical results in the treatment process. Continuing to use and encouraging patients to collect data is another essential feature of mobile-based applications that paper-based logbooks do not have. It assures that the patient can always access his data in the electronic logbook, record it, and share with the doctor immediately. By expanding this process and encouraging more patients to use these kinds of software, we can see an appropriate trend for chronic disease control, which is not an exception. Providing the right platform for the proper management of diabetes and providing data requirements in the mobile-based application compatible with a varied range of mobile phones are all considered in this research. We expect to see such software to help treat chronic diseases more and more in the future.

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