IMPLEMENTATON OF ANDROID BASED MOBILE APPLICATION FOR DIABETES PATIENTS

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ABSTRACT

Currently there are many diabetic patients of all ages in our country. According to some studies, the number of patients has been said to exceed 10 million. One of the most focused points of this disease, which sometimes occurs congenitally and sometimes later, is to be able to observe how it progresses and to adjust the dose rates of the drugs correctly. The disease, which can be seen in both young and old people, should be followed consciously for every meal.

There is almost no sector left in technology that does not benefit from mobile applications. Because these mobile applications are faster and practical to reach every kind of documents and information. Therefore, it assures more work to be done by saving time. The diabetic people spend their time on mobile devices and smart phones just as other non-diabetic people.

In this study, a mobile application has been designed to help them learn more about the insulin dose they need to take a meal, their basal metabolic rate, ideal weight, body mass index, body fat percentage, and diabetes to control their diseases while living their daily lives. With this application, which includes information about both insulin and diabetes, it is aimed to help people to be more conscious.

Keywords:

Diabetes, Mobile Software, Android, Insulin

120

1. INTRODUCTION

Diabetes, which is at the forefront of diseases of the age, was a type of disease that played a leading role in the formation of many deadly diseases and is quite common all over the world (Uri2,2020). The exact name of the disease is Diabetes Mellitus. Diabetes is a disease that causes an increase in blood sugar caused by the decrease in the function or amount of beta cells that secrete insulin in the pancreas for different reasons. This disease is divided into two main groups as type1 (insulin dependent diabetes) and type2 (insulin independent diabetes). However, there is another type that occurs with pregnancy called gestational diabetes.

If the disease is not treated in a timely manner or the necessary follow-up is not provided, it can lead to the emergence of different diseases that can even result in death. Nowadays, to control the progress of diabetes, it is possible to go to hospitals and administer drugs according to the results of a doctor's examination and blood analysis, regular exercise, and healthy and appropriate nutrition. However, due to the large number of people with this disease in our country or the unconsciousness of the patients, these controls are not performed regularly. When these operations are not carried out within a plan, they lead to undesirable consequences. These results, together with the deterioration of health, can reduce people's motivation materially and morally.

Self-monitoring of blood sugar is considered as a part of the disease. It is an important factor especially for patients who inject multiple times a day. Due to this monitoring, it is possible to compare blood glucose values with those in the past. The International Diabetes Federation: IDF Guidelines recommend continuous self-measurement of glucose in patients using insulin (Uri3, 2020).

Medical nutrition therapy is also an especially important factor if it is noticed early in patients diagnosed with diabetes. Studies show that the nutritional intervention performed within the first 6 months after diagnosis provides decreases in HbA1c levels up to 3% depending on the type and duration of diabetes (Pastors et al., 2012).

In our country, the Ministry of Health continues its efforts to control the cost burden of diabetes. According to the report "The Sixth Diabetes Atlas" published by the IDF in 2013, Turkey will be one of the countries having the highest number of people with diabetes among the first 10 countries of the world until the year 2035 (Uri4, 2020).

For this reason, to benefit the daily lives of people with diabetes, it is required applications that are easy to use, practical, inexpensive, simple, and easy to access. The Ministry of Health aims to spread today's technology among diabetic patients and to provide a good service.

121

With the improving technology and the increasing use of mobile devices, the number of mobile applications is also increasing. Smart phone applications are used to solve the problems that arise in the health area as other sectors. Mobile technologies are personal and shared tools used for the protection, monitoring, improvement, and development of people's health conditions. It is thought that mobile applications, which have a significant impact on human health, can achieve positive results on diabetes patients. Due to these applications, it is possible to make comments on the disease and obtain information about the course of the disease by providing remote doctor supervision without the need to go to hospitals.

There are some studies in the literature to regularly monitor and control patients' diseases, especially in the health sector. In the cloud-based mobile diabetes control application, a software based on mobile cloud computing technology has been developed for a more comfortable life without any intervention for diabetic patients. It is thought that the developed solution, which monitors the daily activities of the patients regarding diabetes, will also help the patients' recovery processes. The proposed system can send reminder messages to users in addition to many features (Yıldırım et al., 2017).

The Android-based watch application is a system that tracks the status of diabetes and displays physical activity and heart rhythm data. The user can provide the necessary control according to his preference with different functions such as button, sound, touch, or movement on the watch. In addition, the daily sugar rate, insulin rate and physical activity values can be entered by the user. At the same time, the application allows the person to follow the heart rhythm by measuring the instant heart rhythm. Heart rhythm and physical activity values are taken by the sensors of the watch (Pektaş et al., 2018).

In a system design study that can be used on mobile phones for diabetics, it is planned to develop a mobile application running on Java supported mobile phones for the monitoring and control of diabetics. A system has been designed to ensure that the amount of insulin used by diabetic patients under the supervision of a doctor is constantly, instantly, and accurately adjusted. In this way, it is aimed to facilitate the life of the patient with this disease and to keep the blood glucose level at the optimum level (Varol et al., 2013).

When diabetes is diagnosed early, the disease is largely prevented with a healthy and regular diet. The aim of this study is to enable people with diabetes or their relatives to have a more controlled life, to minimize the risks that may occur, and to be more conscious about the disease. When compared to similar solutions, it is seen that the proposed software contains more features and includes two new features. The biggest difference of this study is that five separate calculations (insulin dose calculation, basal metabolic rate calculation, ideal weight calculation, body mass index calculation, body fat percentage calculation) can be included in the same application. In addition, compared to other studies, a software with descriptive, detailed, and instructive information content under different main and sub-titles was developed. When examined in terms of usage, it has an easy and practical design, which makes it appeal to a wider audience. Whether it is a healthy individual or an individual with diabetes, it is an application that can be easily used to lead a better quality of life.

In the second part of this study, information about software, database and calculations that should be known for glucose monitoring is given. In the third section, there are studies made with the visuals of the proposed application. Discussion and results are presented together in the last part of the paper.

2. MATERIALS AND METHODS

In this section, Android, Google Firebase, calculations that the application includes are explained.

2.1. Android

122

Mobile application is the name given to software specially designed and coded for smartphones and tablets. These applications, which are formed in different software languages on different devices, are divided into Android, IOS and Windows Phone operating systems. It is especially used in projects and product sales platforms. Users can use their transactions faster, easier, and more comfortably with mobile applications.

According to the researches in 2017, there are 42 million mobile users in Turkey. These users are known to be inclined to download apps from Android or IOS markets. Also, the same users make searches on the internet with their mobile devices (Uri5, 2020).

Android is etymoned from the Latin human word and means "humanoid" (Uri6, 2020). It is a free open-source operating system based on Android and Linux Operating System developed by Google and Open Handset for mobile devices, tablet computers and smart mobile phones (Uri7, 2020). Since open-source operating systems are adaptable, all mobile device companies can change codes and create their own interfaces. Each operating system has its own extension, the extension of the applications that support the Android operating system is ".apk (android package kit)". Because it is open source, there is a large group of developers who write applications to increase the functionality of the devices. Not only its developer, but also its user group has found millions of people (Uri8, 2020).

2.2. Google Firebase

Applications and projects produced have their own unique software languages. In order to be permanent, they must appeal to the whole market and be used in the whole market. That is why it is developed on iOS, Android, and web platforms. However, the language and connection types of each software are different. As a solution to these problems, Google Firebase is a common solution

developed for free to support Web, iOS, OS X and Android platforms. Although Google Firebase is used in mobile applications, it is a technology that can be used by programs running on computers.

Google Firebase is a cloud-based platform for mobile and web applications that allows user login authorization, real-time and synchronized storage, and storage of data without the need for the developer to deal with the server side. In short, it is a technology that offers a Back-End service developed by Google. Thus, development becomes faster and easier (Uri6, 2021).

It provides the opportunity to examine the detailed analysis of the applications and to follow the analysis comprehensively. Google Firebase has many useful properties. Firebase's main features are

• Having a concurrent database
• Authorization for user logins
• Having storage space
• Development of machine learning kit
• Presentation of a performance test environment
• Ability to make common application analysis between the platforms
• Using common functions
• Ability to allow advertising materials
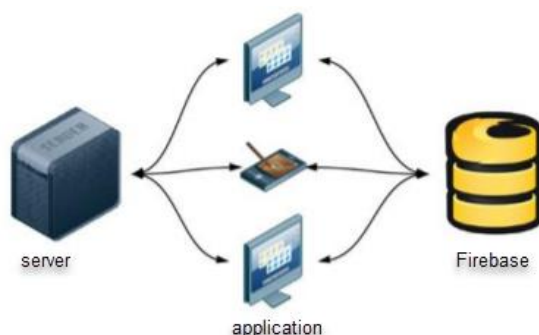• Sending notifications (Uri10, 2021).

Figure 1. The Communication Between Firebase and Application

Firebase is the platform that which developed by the google that provides control panel to any application in the platform. Its developer's user data storage and provides the access from every device to same data freely from platform.

As seen in the Figure 1, it can be communicating double directions among the server and clients. Server can enter database of firebase so easily and can interact with data. It can communicate with other data by processing them (Akyol et al., 2018).

2.3. Calculations

Basal metabolic rate, ideal weight, body mass index and body fat ratio and most importantly insulin dose rate can be calculated in applications.

2.3.1. Insulin Dose Calculator

Carbohydrate counting is one of the meal planning methods that can be preferred in the treatment of diabetes. It is one of the methods used in the medical nutrition treatment of Type 1 and Type 2 diabetes. Amount of Carbohydrate follow-up is important for adjusting the insulin dose and ensuring glycemic control.

If glycemic control is provided, it prevents the development of complications that may occur. The carbohydrate counting method allows the amount of carbohydrate taken in the diet during the day to be followed. In this method, it is important to calculate the amount of carbohydrate rather than its

123

type (Uri11, 2020, Uri12, 2020 and Uri13, 2020). Calculation of insulin dose amount has been shown in Equation (1).

$$Insulin\ Dose = (pre\ meal\ blood\ glucose\ level - 120)/(1800/(weight \times 0.55)) \\ + (amount\ of\ carbohydrate\ eaten\ at\ meal/(500/(weight \times 0.55))) \tag{1}$$

2.3.2. Basal Metabolic Rate Calculator

Metabolism is the whole of biochemical functions that take place to sustain life and fulfill the functions of organs. Basal metabolic rate (BMR) is the energy used by the body at rest.

BMR varies according to gender, age, body weight, size, muscle and fat amount, hormone levels secreted by endocrine glands, and sleep state (Uri14, 2021).

BMH can be calculated with the Harris-Benedict formula (Küçük, 2010).

Basal metabolism formula for women is given as in Equation (2).

$$BHM = 655 + (9.6 \times weight\ (kg)) + (1.9 \times height\ (cm)) - (4.7 \times age) \tag{2}$$

Basal metabolism is calculated with the Equation (3) for men.

$$BHM = 66 + (13.8 \times weight\ (kg)) + (5 \times height\ (cm)) - (6.8 \times age) \tag{3}$$

2.3.3. Ideal Weight Calculator

124

Ideal weight is the body weight that a person should have to be healthy both physically and psychologically. The ideal weight varies according to the age, gender, and height of the individual and varies from person to person. If the person has an ideal body weight, the risk of developing diseases is also minimal (Uri15, 2021).

The ideal weight formula for women is presented in Equation (4).

$$İdeal\ Weight = 45.5 + 2.3 \times \left(((height(cm))/2,54) - 60\right) \tag{4}$$

The ideal weight formula for men is seen in Equation (5).

$$İdeal\ Weight = 50 + 2.3 \times \left(((height(cm))/2,54) - 60\right) \tag{5}$$

2.3.4. Body Mass Index Calculator

This value gives information about the obesity status. The ranges determined by the World Health Organization in BMI values are taken as reference. According to the result, it can be understood whether the weight is ideal for height or not (Uri16, 2021).

BMI calculation formula is given in Equation (6) (Aslan et al., 2019).

$$BMI = weight\ (kg)/((height\ (m))^2) \tag{6}$$

2.3.5. Body Fat Percentage / Body Fat Calculator

Body fat contains essential body fat and stored body fat. Essential body fat is necessary to maintain life and reproductive functions. Essential body fat percentage: 3 to 5% in men and 8 to 12% in women (referenced by National Academy of Sports Medicine).

Body fat percentage: It is a measure of your fitness level. Because it is the only body measurement that directly calculates a person's relative body composition, regardless of height or weight (Uri17, 2020).

Body Fat Calculation Formula for men, is given in Equation (7).

$$BFP = (495/(1.0324 - 0.19077 \times \log_{10}(waist - neck) + 0.15456 \times \log_{10} height)) - 450 \quad (7)$$

Body Fat Calculation Formula for women, is seen in Equation (8).

$$BFP = (495/(1.29576 - 0.35004 \times \log_{10}(waist + hip - neck) + 0.22100 \times \log_{10} height)) - 450 \quad (8)$$

3. REALIZED ANDROID MOBILE APPLICATION

In this content, a personal account for each user is opened. This account is created with the help of mail and password. The person can edit their e-mail address, password, and user information at any time, as well as delete their account completely. When the information is entered, it is saved to the google firebase system.

The user will be able to see the nutrient's values in that meal when user enter daily meals and amounts of foods in the system. Then he can find the amount of insulin he needs to do based on the carbohydrate he takes. Thus, he/she will be able to follow himself/herself. He/She will be able to balance himself/herself to have a healthier metabolism by taking information not only on carbohydrate count and insulin dose values, but also on basal metabolic rate, ideal weight, body mass index and body fat ratio values.

125

Information about the use of the application is briefly explained in the block diagram shown in Figure 2.

First, the user creates an application account with email and password. If the person forgets her/him password later, she/he can reset it with the help of her e-mail address. In this process, a reset e-mail is sent to the e-mail account entered and a link address is sent to realize this operation. The person can get a new password for herself/himself. The user can log in the account with a new password.
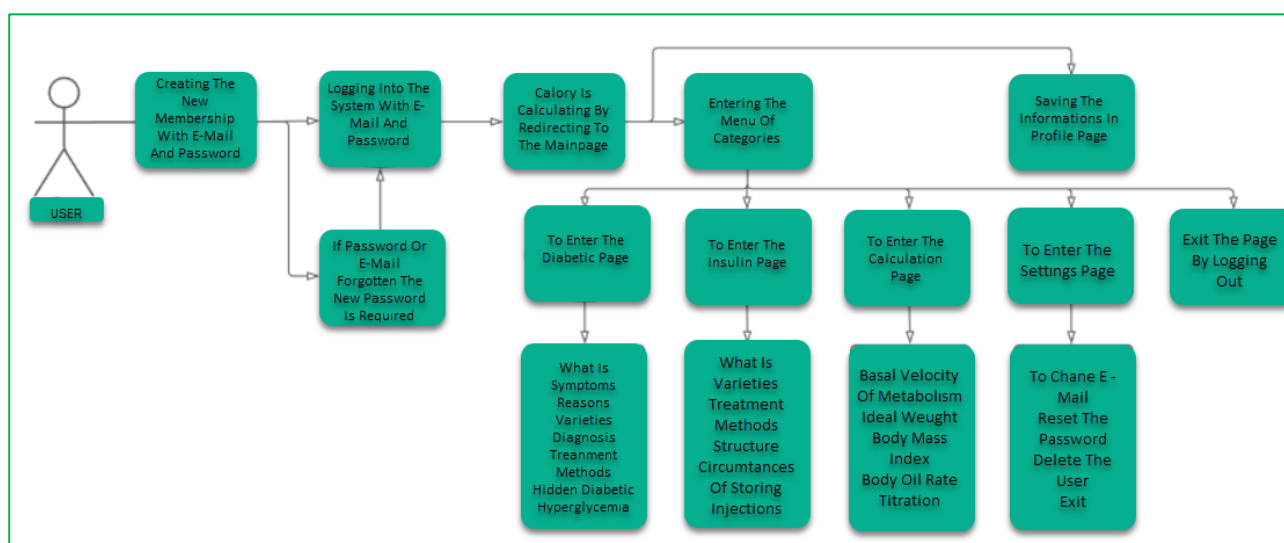

Figure 2. Block Diagram of the Application

After the user is logged in, he will be directed to the home page. In this section about foods, you can select the type and amount of food also you can get information about nutritional values (calorie, protein, fat, carbohydrate, calcium, iron, and sodium amounts).

In the profile page, the user can enter the required information (TR identity number, name, surname, gender, date of birth, address, telephone, height, weight, blood type, diabetes type and other disease information) to the system and save and change it.

Users can go to subcategories (diabetes page, insulin page, calculations page, settings page) or log out with the category's menu on the home page.

On the first sub-category, the diabetes page, the desired information can be reached as the subtitles (what is diabetes, the symptoms of diabetes, the causes of diabetes, the types of diabetes, the treatment methods of diabetes, hidden sugar, hyperglycemia, and hypoglycemia) about diabetes.

On the insulin page, which is the second subcategory, there are subtitles (what is insulin, types of insulin, insulin treatment methods, insulin structure, insulin injection and insulin storage conditions) for insulin.

In the third sub-category, the calculations page, five different calculations (basal metabolic rate, ideal weight, body mass index, body fat ratio, titration) can be made by the user.

On the fourth sub-category, the settings page, the user can change his/her password, e-mail address and delete his/her account. Finally, he / she can log out from his / her account.

3.1. Login Page

The opening screen of the application is shown in Figure 3. If the user does not have an account before and wants to open a new account, they can press the "*Create New Account*" button. Then the screen in Figure 4 opens. After entering the requested information on this screen, if the message "*Registration Successful*" is received, the user can start using the application. If the member does not remember the password, they can access the page in Figure 5 by clicking the "*Forgot My Password*" button. On this page, the e-mail address information can be written, and the password can be reset on the mail sent to the mailbox. It is possible to log in again with its new password.
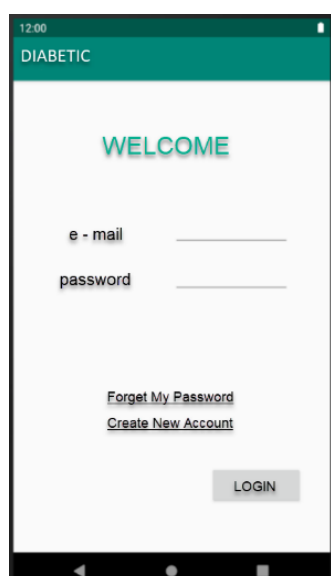
126

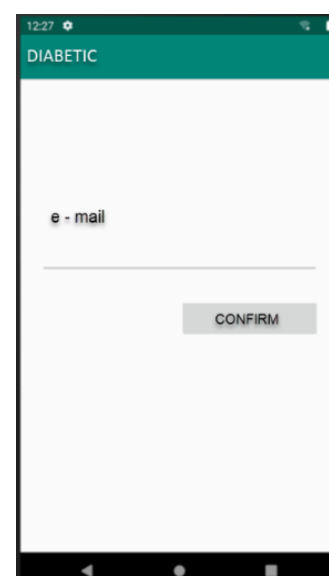Figure 3. Log in Screen　　Figure 4. New User Screen　　Figure 5. Password Reset Screen

3.2. Main Page

After logging in the account, the screen in Figure 6 opens. Owing to this screen, a person can access nutritional values depending on the amount of foods eaten / drunk in a meal. As an example, in Figure 7, cow's milk and quantity of 50g have been selected from the category of egg, milk and dairy products. Nutritional values of 50 g cow's milk have been calculated and given. The most important point here is the amount of carbohydrates. Because this amount is required for the insulin dose amount to be injected. In Figure 8, on the home page, what is diabetes, what is insulin and calculations, how to switch to the settings pages and how to exit the account are shown.
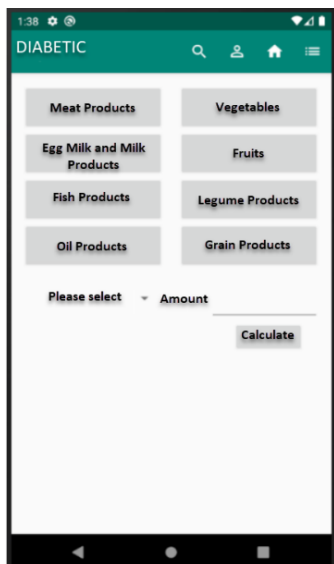
Figure 6. Main Screen   Figure 7. Detailed Main Screen   Figure 8. Detailed Main Screen
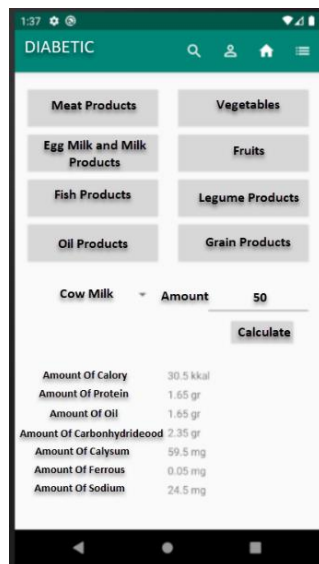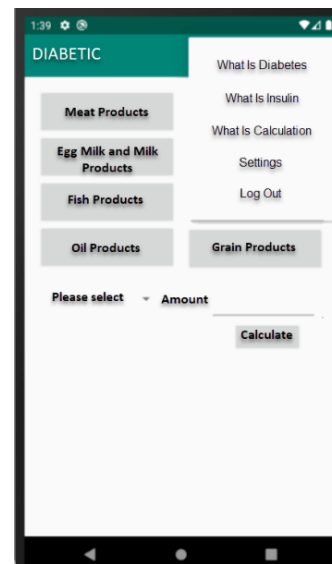
127

3.3. Categories

The categories that selected from main page; diabetes, insulin and calculation pages can be opened. Diabetes and insulin pages include informational and awareness texts. There are subtitles that are given in Figure 9 about Diabetes and in Figure 10 about Insulin. The user may find required information by reaching subtitles. The page contains some measurements for users to be more proper and healthier in Figure 11. The most significant point here is titration, that is, the amount of insulin dose to be taken.
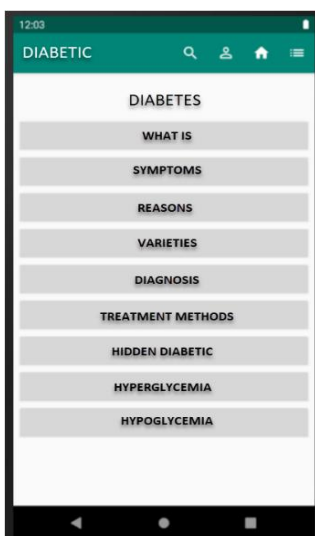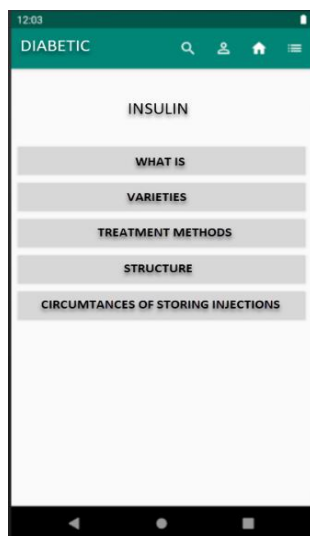

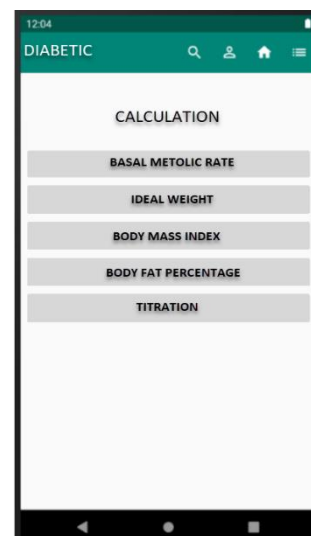Figure 9. Diabetes Screen   Figure 10. Insulin Screen   Figure 11. Calculation Screen

3.4. Profile

Personal information contact details and health status are required when the user enters the profile page. There is a blank profile page that belongs to a new user, in Figure 12. The new vision as in Figure 13 appears after the required information is entered and registered. Meanwhile the users might update their profile whenever they want. The information is saved to Firebase database as shown in Figure 14. In this way, the user has not to enter his/her information each time.

Figure 12. Profile Screen

Figure 13. Profile Screen

Figure 14. Firebase Database User Information

128

4. DISCUSSION AND CONCLUSION

Mobile health applications, like other applications, have been developing rapidly in the last few years. These studies are beneficial to help traditional health services and are used for early diagnosis and treatment of diseases by saving time. At the same time, it has an important place for both patients and doctors. This study was conducted to ensure that people with diabetes follow themselves more regularly, gain adequate, balanced, and healthy eating habits, and access reliable sources of information about the disease.

According to the researches, it has been seen that this software has different and comprehensive service features than other applications. A diabetic patient can control himself / herself with a single application and take his / her medications with the right method in the right dosage. At the same time, it is possible to reach the necessary information about the disease. This application does not only appeal to patients who are sick, but also to every segment and age group. One of its advantages is that it is easy to use, practical, understandable, and private.

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130