Ana Alsukary: an android mobile application to support diabetic children and parents in Saudi Arabia

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Abstract: Mobile health (mHealth) has been widely invested in managing chronic diseases. The usage of mHealth could assist in improving patients' understanding of their chronic diseases. This research contributes to this domain of knowledge by investigating the development and use of a mHealth that we call, Ana Alsukkary. This tool targets Saudi children with diabetes and their caregivers to help them better manage their diabetes. The tool allows children to share their blood sugar levels and communicate with each other while watching educational and motivational videos. Additionally, this app would allow parents/caregivers to communicate with each other and provide the location of stores that offer diabetes-friendly products. The Ana Alsukary app would additionally provide some information about the nutrition value amount in food and its effect on the blood sugar level. The tool has been built using Android-studio and technically evaluated using unit-testing and integration testing. The usability and ease of use has been evaluated qualitatively through a focus group where nine members participated. The results showed that the developed tool is convenient and easy to use. Caregivers have indicated that Ana Alsukary can assist several children to understand their diabetes condition and make adjustments with their lifestyle accordingly.

Keywords: mHealth, mobile application, diabetic children, health education, diet-related chronic diseases, usability.

1. Introduction

Diabetes is a global chronic metabolic disease that leads over time to many other serious issues/damages to nerves, eyes, heart, kidneys, and blood vessels. According to the World Health Organization, there are two types of diabetes, which are type 1 and type 2. Dramatically, the prevalence of diabetes has increased in all income-level countries, as well as all ages including children (WHO, 2016). Comparing to type 2 diabetes, type 1 usually occurs among children. Yet, with the obesity epidemic, type 2 diabetes is on the rise among children too (Mayo Clinic, 2020). According to the World Health Organization, around 422 million people have diabetes across the world. Also, there are 1.6 million deaths every year because of this chronic illness (WHO, 2021). The Kingdom of Saudi Arabia (KSA) is not immune from this global health crisis; KAS ranks the second country in Middle East with the highest rate of diabetes and as the 8th country in term of the number of type 1 diabetes cases (Robert et al., 2017). There are around 35,000 children and adolescents who are diagnosed with type 1 diabetes. Thus, KSA rank as the 4th country worldwide in terms of the incidence rate, 33.5 incidences per 100,000 individuals (Robert et al., 2017). Therefore, there is an urgent need to support those children in Saudi Arabia and to motivate and assist them in understanding and managing the chronic disease diabetes.

After a child is diagnosed with diabetes, the children themselves and caregivers/parents need a period of adjustment (Better Health Channel, 2021). Children may struggle emotionally with their health condition and reactions, especially those who are early diagnosed. Diabetic children need support from their parents/caregivers/lovers to manage their disease as well as their parents. This period after the diagnosis can be really challenging for both children and parents.

Digital technologies, such as mobile health (mHealth) have been widely used and played an important role in delivering health services for public (WHO, 2018). The usage of mHealth could assist in improving patients' understanding of their chronic diseases, as well as assisting them in managing their health condition (Shan et al., 2019). According to Statistica (2021), the number of smartphone users has increased from 3,668 billion to 6,378 billion between 2016 and 2021. This number is projected to reach 7,516 by 2026 (Statistica, 2021). The huge increase in smartphone users encourages IS/IT researchers to develop more mHealth intervention to assist patients across different ages and caregivers to quickly adjust understand and manage their diseases, such as diabetes.

To assist those children and their parents/caregivers in quick adjustment, understanding and

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management, this research article aims to provide an appropriate, Arabic, educational and management mHealth intervention for them. The Ana Alsukary app would allow the children to share their blood sugar levels and communicate with each other while watching educational and motivational videos. This app would also allow parents/caregivers to communicate with each other and facilitate the search for some of the child's special needs, with the ability to automatically calculate the A1C. The app would additionally provide some information about the nutrition value of food and its effect on the blood sugar level. The educational text information and videos would be uploaded by volunteer healthcare practitioners with expertise in diabetes (dietitians). Another important feature that this Arabic application is represented by the display which hoes names and locations of grocery stores selling some diabetic products, such as chocolate and snacks. Providing all these features and more would assist in speeding up the adjustment for both children and parents/caregivers, as well as aiding them in understanding and managing the disease. The proposed application has the scope to potentially aid all children, aged 6-13, who are diagnosed with diabetes, while helping their parents/caregivers to adjust easily and quickly.

The remainder of this paper is structured as follows. Section 2 provides a summary of the literature, including IT roles in managing diabetes. This is followed by a summary of some related work with similar applications. Section 3 explains the methodology in detail; this includes the application design, implementation, and testing phases. Section 4 illustrates the findings of the research study followed by the discussion. Finally, Section 5 concludes this research and provides some future work recommendations which can be considered by IS/IT researchers.

2. Literature review

2.1. Use of IT and tech applications in managing diabetes in the Arab world

According to Abd-alrazaq et al. (2021), there is a high rate of diabetes in countries in the Middle East and North African region. Using Qatar as a case study, the researchers analyzed the experience that patients and healthcare workers have with the use of the mobile application for self-management of diabetes. The researchers interviewed 14 respondents, of whom 9 were patients and 5 were nurses. The respondents were asked to download and to set up profiles on a diabetes app called Droobi. After using Droobi for 6 to 12 weeks, the research showed that the app offers a more convenient and efficient way for patients and health workers to communicate with one another. AlQarni *et al.* (2016) conducted a qualitative analysis of the content from Facebook regarding the diabetes groups from Arabic nations. The research collected data between 2010 and 2015, screened 55 Facebook groups and selecting 7 that fulfilled the eligibility criteria. Out of the 6,107 Arabic posts that were related to diabetes, 1551 were chosen or analysis. The study showed that a growing number of diabetes patients are sharing diabetes-related health information with fellow Facebook users and concluded that future research can work on improving public health by leveraging social media apps.

Abduo et al. (2020) explored the use of smartphone for diabetes management in Kuwait. The research applied a questionnaire on 111 diabetic patients. 79% had type 2 diabetes and 93% had have gotten diabetes for at least five years. Despite the fact that 94% of the respondents owned a smartphone, only 12% of them used a diabetes-related application. Among the factors inhibiting the use of such application include lack of awareness, loss of interest, inadequate time, complexity and language. However, the majority of respondents showed interest in an Arabic language app with a feature for medical appointment reminder. Alkhudairi (2016) stated that Saudi Arabia is faced with some limitations, caused by social and cultural factors, in the adoption of mHealth app. Therefore, doctors were interviewed during the study and online questionnaires were conducted for patients. Participants were optimistic about the use of mHealth application for diabetes. However, concerns were raised about inadequate training, privacy issues, educational level, etc. The study further evaluated ‘Glucose Buddy’, a diabetes management application, and concluded that it can be successfully adopted if implemented with adequate training and incentives.

Alanzi et al. (2018) evaluated the use of the WhatsApp mobile application to promote knowledge sharing, awareness and self-efficacy of diabetes management with the support of

intervention and control groups at Al-Khobar Teaching Hospital in Saudi Arabia. While the intervention group got weekly education on diabetes through WhatsApp, the control group received the existing regular care. The outcome of the study showed that the intervention group recorded a significant increase in diabetes knowledge and self-efficacy as facilitated by the WhatsApp mobile application. Alhuwail (2016) reviewed all diabetes-related mobile applications for Arabic speakers on Google Play Store and Apple App Store. The research found out that 18 applications were suitable for the study. Out of these, only 3 applications offered necessary features like glucose reading conversion. A shortcoming encountered in the applications was the fact that some of the information did not comply with the latest evidence-based medical data. Therefore, it is important to create an Arabic diabetes application that has the latest medical information and better functionality. Diabetes patients must be adequately engaged while building such applications (Alhuwail, 2016).

The Middle East is not alone in the context of the high prevalence of diabetes among children. As a matter of fact, children's diabetes has accelerated across the globe (Pinhas-Hamiel and Zeitler, 2005). In response to that, different types of mHealth applications have been proposed utilizing different technologies with the main goal of either raising awareness of the nutrient content (Alrige and Chatterjee, 2018), predicting blood glucose (Pustozerov et al, 2018), or managing diabetes in general (Kumar et al., 2018). There is sufficient evidence in specialised literature that the use of mHealth applications helps type-2 diabetics to better manage their condition and maintain their blood glucose levels (Wu et al., 2019). Diabetes is one of the chronic diseases that require different lifestyle adjustments such as physical activities and healthy carb-restricted diets. The focus of this study is on the dietary part. We have specifically targeted kids with diabetes to ease the burden on the parents or caregivers, using Saudi Arabia as a case study.

2.2. Related work

In this section, there have been identified some application that have been developed to aid diabetic children and their parents/caregivers in managing the disease. The applications were analysed and compared with the Ana Alsukary app. The results of this comparative analysis are shown in Table 1. The results show that our application is better than other apps as it has more services and features, including the feature that allows parents/caregivers to communicate with one other, as well as children. Additionally, this application allows users to display some grocery stores that sell diabetic products, such as chocolate.

2.2.1. Sukry application

Sukry is an Arabic application for diabetics targeting children and elderly patients. It assists in monitoring blood sugar level, meals, and physical activities. Also, the app provides guidance and advice to users; such information is also shared with the patient's physician. Some of the app features are listed below: (Google Play, 2021):

- Monitor blood sugar level, meals, and physical activates;
- Generate daily, weekly, and monthly reports with graphs which help to control blood sugar levels;
- Follow up with the doctor and/or health educator through the app.

2.2.2. Sukry Alatfal application

Sukry Alatfal is a special application developed to serve children with diabetes while in school and at home. The app's users are diabetic children, parents, and teachers. It includes some stories, movies, and games. The following are some of the application features (Google Play, 2021):

- The possibility of adding treatment dates;
- The possibility of adding doctor appointments.

2.2.3. Sukaryat application

Sukaryat is an application developed to serve diabetic patients by displaying glucose measurements. Also, it shows the weight measurement, which may assist in controlling patients' calories, as well as their meal planning (App Store, 2021).

2.2.4. Edarat Alsukary application

Edarat Alsukary is an Arabic educational application that covers information for type 1 and type 2 diabetes. It has several sections, such as some meals' recipes and introduction on food calories counting. In addition, this app covers some educational topics regarding women and diabetes during the pregnancy (Google Play, 2021).

2.2.5. The proposed solution: Ana Alsukary application

The presented application known as Ana Alsukary, is for diabetic children between 6 to 13 years, their parents and healthcare experts. The app will assist children in understanding and managing the disease through effective communication. Thus, diabetic children who use this app can communicate and support each other. Moreover, this application allows parents/caregivers to interact with each other and obtain answers to some of their questions and learn and understand children needs.

In addition, parents can reach out to healthcare experts to get answers to some questions. These experts can upload educational materials to increase the level of diabetes awareness among parents and children. Also, Ana Alsukary application automatically helps parents in calculating the A1C for their children, easily and in the comfort of their own house. The features provided by the Ana Alsukary application are listed below:

- Enter the blood sugar level;
- Calculate A1C;
- Enter the time of insulin injection;
- Children communication;
- Parent communication;
- Parent and healthcare expert communication;
- Display videos, stories, and educational materials about diabetes;
- Upload educational materials (by healthcare experts);
- Display some grocery stores that sell products for diabetes in Saudi Arabia.

We conducted a comparative analysis among the related applications and our application as shown in Table 1.

Table 1. Comparative analysis for all related applications

Applications	Sukry	Sukry Alatfal	Sukaryat	Edarat Alsukary	Ana Alsukary
Record reading for glucose level	✔	✔	✔	X	✔
Alert's notifications	X	✔	✔	X	X
Educational videos/clips	X	✔	X	X	✔
Educational information	✔	✔	X	✔	✔
Food record	✔	X	X	X	X
Standard dosing times	✔	✔	X	X	✔

Availability of the Arabic language	✔	✔	✔	✔	✔
Communicate with other diabetic children	X	X	X	X	✔
Targeting children	X	✔	X	X	✔
Display grocery stores selling products for diabetics	X	X	X	X	✔
Auto Calculating for Ac1	X	X	X	X	✔
User: Children	X	✔	X	X	✔
User: Parents/caregivers	X	✔	X	X	✔
User: Healthcare experts	X	✔	X	X	✔

Based on the above analysis, there are some differences between the related applications and the proposed one. Ana Alsukary application is significantly better as it facilitates effective communication among all users, children, parents, and healthcare experts. Moreover, the proposed solution provides a list of some grocery stores that sell products for diabetes. Currently in Saudi Arabia, there are limited stores selling these products as reported earlier by some parents during the data collection phase.

3. Research methodology

The methodology adopted for this research study has been explicitly designed to achieve the application's objective. Thus, the phases involved are data collection, application design, implementation, and testing as described in-depth below.

3.1. Data collection

The design and distribution of a survey through a social media platform helped in understanding the users' needs. The first part of the survey was mainly designed to collect some demography data, such as age, gender, marital status, and if the users have diabetic children or know someone who has. The second part was focused on the difficulty that participants face in the case of having diabetic children, as well as in using an application/technology to overcome these challenges. Also, in this part/section the participants were asked about what other features would be preferred and if they would allow their children to use the app. 378 responses were received, around We received 90% being women from Saudi Arabia. Most of the participants were in the age range of 19 to 29, 66.7%, and around 16% were aged from 30 to 39. Almost 40% of them had children with diabetes. Most of those diabetic children were in the age range of 6 to 13 years with almost 25%. Most of the challenges that those participants faced are listed below:

- Lack of knowledge about:
    - how to deal with emergency cases, such as if the sudden increase or decrease of blood sugar,
    - Fainting cases,
    - How to calculate the A1C/ sugar cumulative level;
- Children/patients refused to accept having diabetes;
- Patients' accepting the new eating style;
- Grocery stores' locations that sell diabetes' products in Saudi Arabia;
- Provide educational videos/clips regarding diabetes.

When asked about allowing their children to use an app that would assist the communication

with other children with similar age and health condition, most of the participants responded affirmatively (73.3%)."

3.1.1. Functional requirements

After analysing the collected data, the most important functional requirements that needed to be offered were outlined Functional requirements assist in describing all the services that any software will offer, so mainly it shows system's inputs, behaviors, and outputs (Kung, 2014). As a result, the following points are the functional requirements for the Ana Alsukary application:

- Registration/login: Child, Parents, Healthcare experts;
- Entering/viewing the blood sugar level;
- Communication between peers;
- Calculating the AC1/cumulative blood sugar level;
- Entering/viewing the time of insulin injections;
- Displaying Grocery stores' name and location;
- Displaying information about diabetes;
- Displaying educational videos about diabetes;
- Adding educational videos.

3.1.2 The application architecture

The Activity diagram is considered an advanced version of flow chart, which is usually used to shape the activity flow from activity to another. This illustration is as an important behavioral diagram in UML that clarify the system's dynamic aspects (Visual Paradigm, 2021). Thus, to understand the system structure and its behavior, the activity diagram was developed as shown below in Figure 1.

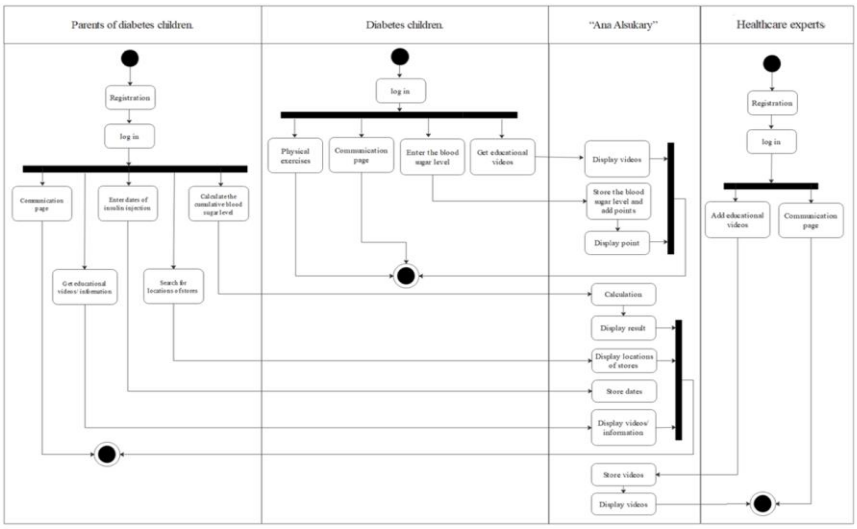

Figure 1. Activity diagram for Ana Alsukary

3.2. Ana Alsukary design

The design phase supports the process since it deals with transforming the users' needs into an implementable from using any programming language (Geeks for Geeks, 2019). In this phase, some of the system's interfaces were starting to be illustrated and represented in order to come up with the most effective solution. Thus, Ana Alsukary prototype has been constructed to get feedback from the potential users in the early stage (Arnowitz *et al*., 2007). A high-fidelity prototype was developed using Wondershare Mockitt, as shown in Figure 2, which is an open-

source program dedicated to designing mobile and iPad applications for all phone companies such as Apple and Samsung (Wondershare, 2021).

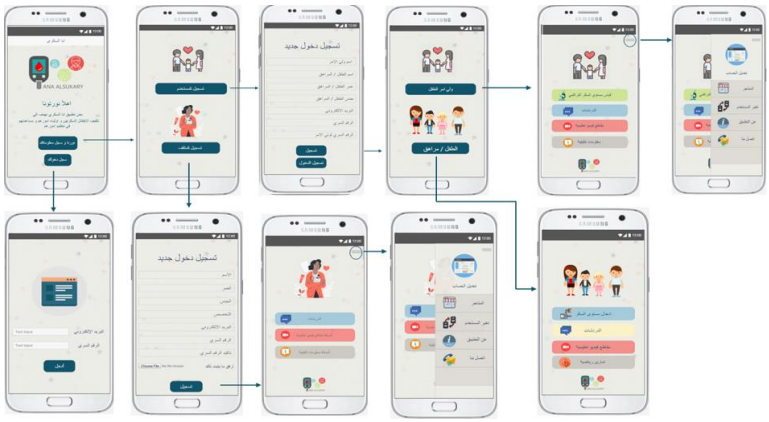

Figure 2. Ana Alsukary prototype

Nielsen's heuristic principles were followed, in order to create an app with the best possible interaction design (NNGroup, 2020). For improving and facilitating the use of the application, the following principles were applied:

- Visibility of system status: when the signup is successful, a message appears that the registration was successful;
- Match between system and the real world: realistic images and icons are used for easy identification, as well as supporting the Arabic language;
- Consistency and standards: icons are always used consistently for the same purpose on all pages;
- Error prevention: reducing user error, by preventing him from entering letters in the numbers field;
- Recognition rather than recall: offering help option instead of providing long or many tutorial(s);
- Aesthetic and minimalist design: Use appropriate colors and limit the content to be focused on each page's goal;
- Help users recognize, diagnose, and recover from errors: When the user enters wrong data such as the password, a message appears informing the user that the entered data is incorrect without any error codes.

3.3. Implementation

In this research project, the application was developed using Android Studio, which is an open-source program that allows users to develop applications for Android system devices and facilitates the development of multilingual applications. Similarly, it provides multiple entry points, and could adapt to different devices (Developers, 2020). It is important to note that the Android Studio uses java code to develop. In addition to that, the team members use PHP language to connect MySql Database with Android Studio. The application consists of the following pages:

1. Registration/login - Child, Parents, Healthcare experts:
    - The new user must register by filling out all the requirements to complete the registration, which are parent's name, child name, child age, child sex, e-mail, password, password specific for a parent; this must be done by the parents/ caregivers. It is important to note that parent/caregiver is responsible to sign up for their children;
    - For healthcare experts, the new user must register by filling out all the requirements to complete the registration, which are expert name, expert sex, a specialty of expert, proof, e-mail, password;

- For login, the user must login by filling out all the requirements (e-mail, password), which could be done by any users (parent/caregiver, children, healthcare expert).

2. Entering/viewing the blood sugar level and calculating the A1C/cumulative blood sugar level: this feature is for calculating the A1C/cumulative sugar level, the parent enters the average blood sugar level during the previous three months, then after that, the application calculates the A1C following this equation:

- Glucose in mg/dL: $A1C = \frac{46.7 + average-blood-gluces}{28.7}$;
- Glucose in mmol/L: $A1C = \frac{2.59 + average-blood-gluces}{1.59}$.

If the A1C is less than 7, it is considered good, which mean the patient's sugar level is under control (Aljojo et al., 2020).

3. Communicating with each other: this feature was added to assist children to quickly adjust with the disease and to communicate with other diabetic children, as well as for the parent/caregiver and healthcare experts:
    - The parent/caregiver can communicate with other parents/caregivers;
    - Parents/caregivers also can communicate with healthcare expert to get answers to some questions and concerns;
    - For children, they can first communicate with other children when they move to the chatting feature. Also, they can share their blood sugar level with other children to motive themselves and other. Thus, the child can see his blood sugar level and choose the time at which the glucose was measured and choose if he/she wants to share his blood sugar level with friends, if the child chooses to share his sugar level with his friends 5 points will be added in his/ her account as a reward. Then, the sugar level store in the sugar level page.
4. Entering/viewing the time of insulin injections: the parent should enter the data (unit of insulin injection, time of insulin injection, and type). The data will be stored in the insulin injection page to keep the patient's history record and access to it at any time.
5. Displaying grocery stores' name and location: stores that provide products diabetics. The user (parents/caregivers and healthcare expert) must log in and then should choose the stores, then the information of the stores will display including the location.
6. Displaying information and educational videos about diabetes: when the user (parent/caregiver, children, and healthcare experts) logs in, he/she can view educational videos and text information about diabetes.
7. Adding educational videos: this is designed to increase parent/caregiver and children awareness about the disease, which can help in adjustment. The healthcare experts must log in and then go to the educational videos tab and enter video URL, as well as select if this content is especially for parent/caregiver or children.

3.4. Testing

This is a very important phase for ensuring that the application is functioning correctly and meet the users' expectations/expected results without any error (Aljojo *et al.*, 2020). In this phase, performing unit testing and integration testing is necessary for achieving the goal of an errorless application. Each unit in the code and individually compare it with the expected result (Kulik and Mahler, 1989). Integration testing is mainly used to test the interaction among several components when carrying out any function (Aljojo *et al.*, 2020). Moreover, the functionality of the application was tested to ensure its interaction.

4. Findings and discussion

The findings from Ana Alsukary application indicate that there are no errors on the applications as all components interact correctly and match the expected results. Table 2 shows some examples of the tests performed.

Table 2. Some examples of performed testing cases

Unit Testing No.	Description	Input data	Expected results	Actual results	Pass/ Fail
1	Checks that there is no missing field when filling in the parent/caregivers OR child registration data	Parents Name: نورا محسن Child Name: وليد بدر Child Age: 9 Child Gender: ذكر E-mail: Password: 123 The parent's password: 123	"يجب تعبئة جميع الحقول" "You have to fill in all the fields" The above message will appears.	"يجب تعبئة جميع الحقول" "You have to fill in all the fields" message appears.	Pass
2	Verifies that the user data is inserted in the database.	Parents Name: نورا محسن Child Name: وليد بدر Child Age: 9 Child Gender: ذكر E-mail: nouraalsanibi@gmail.com Password: 123 The parent's password: 123	"تم التسجيل بنجاح" the "Subscription is successfu" above message will appear.	"تم التسجيل بنجاح" "Subscription is successful" message appears.	Pass
3	Verifies that the child age range is between 6-13.	Parents Name: نورا محسن Child Name: وليد بدر Child Age: 3 Child Gender: ذكر E-mail: nouraalsanibi@gmail.com Password: 123 The parent's password: 123	"التطبيق متاح للأطفال من عمر ٦ الى ١٣ سنه" "The app is allowed for children aged 6 or older" the above message will appear.	"التطبيق متاح للأطفال من عمر ٦ الى ١٣ سنه" "The app is allowed for children aged 6 or older" message appears.	Pass
4	Checks that all required data are correctly entered.	E-mail: nourasainbi@gmail.com Password: 123	Move it to the user page	Move it to the user page	Pass

5	Verifies that the email and password are correctly entered.	E-mail: noura Password: 123	“ البريد الإلكتروني أو الرقم السري غير صحيح” “Email or password is not correct” The above message will appear.	“ البريد الإلكتروني أو الرقم السري غير صحيح” “Email or password is not correct” message appears.	Pass

Figures 3 also show the results of another performed tests.

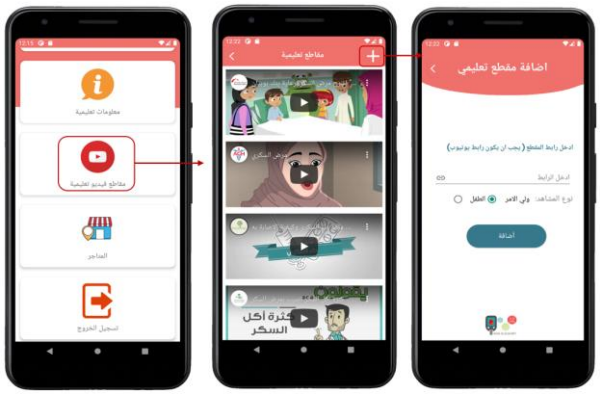

Figure 3. Adding an educational video by healthcare expert

A test for validating the application’s usability was conducted on one focus group (9 parents/caregivers/healthcare experts). The duration of the test on the focus group was 60 minutes. Using snowball technique, parents/caregivers that have at least one diabetic child were recruited. The participants’ characteristic is shown in Table 3.

Table 3. Participants’ characteristic

Age Range	20-35
Parents/caregivers (Female)	5
Parents/caregivers (Male)	2
Healthcare Experts (Female)	2
Parents’/caregivers’ Educational Level	All have bachelor’s degree

A night before the focus group session, the participants received a video of the application and were asked to take notes if there was something unclear. Each participant was assigned a number, in order to protect their privacy and their children’s privacy. On the day of the group session, they were asked questions regarding the app design, layout, and content. This session was not officially recorded; it was only used for taking notes. The discussion was conducted in Arabic, the participants’ native language. The feedback regarding the design and layout was positive.

For example, Participant 1 reported that he enjoyed the design and colour, Participant 3 was positively impressed by the color and coziness of the app, and Participant 6 stated that the application was very easy to use. When questions about the content were asked, most of the participants expressed satisfaction with the features. This is particularly the case for the communication feature that allows parents to chat with other parents/caregivers to support each other. Also, they love the children communication feature, as one of the participants reported.

“When the doctor diagnosed my little boy, who is 7 years old, with diabetes I was shocked… My boy could not understand what this means, he was struggling and thought he is the only child

who has diabetes… I think, having such an app, will assist several children in understanding their condition and adjusting to their new lifestyle…" Participant 5.

Many participants also appreciated the availability of listing the grocery stores that provide diabetes' products such as snacks and chocolate since they sometimes do not know where to get specific groceries. Providing a localisation function would be an asset for finding the closest stores to the location of the user, as stated by Participant 7, which finds this kind of service life-saving. The healthcare experts who participated on this session were also satisfied with the application, especially with the availability of uploading educational videos for children and/ or parents/ caregivers.

To the best of the authors' knowledge, the Ana Alsukary application is the first Arabic app that serves local parents/caregivers and children (aged 6-13) with diabetes. It also provides some important services that are missing in similar applications, such as communication and grocery store information. As reported by most participants, these two services/functionalities will assist both parents/caregivers and their children to quickly adjust with the new health condition to move on with their life. This application could be used by diabetic children who have been recently diagnosed with this disease, and by their parents/caregivers or by other old patients since all the embedded features (A1C auto calculation, communication, insulin injection entering and viewing time, grocery stores list in Saudi Arabia, educational videos and text information uploading by healthcare experts and viewing by all users) can be used by both categories.

There are numerous research studies in the health psychology and behavior change which examine the relationship between social support and health. These studies show that social support from family members or another person is an important factor that helps in adjustment, recovery, health maintenance, etc. (DiMatteo, 2004). Having social support from family members, relatives, and friends, as studied in the literature before targeting different diseases, such as cancer (Rizalar *et al.*, 2014), would assist those patients to adjust to and live with illness, and to understand the disease as this current study focuses on.

5. Conclusion and future work

The Kingdom of Saudi Arabia is ranked 4th worldwide in terms of the incidence rate of diabetes, recording 33.5 incidences per 100,000 individuals. This clearly shows that developing solutions to help diabetic patients, including children, is essential and urgent. While there are existing mobile applications developed to help diabetic children and their parents, there are some shortcomings in these applications. This research developed the Ana Alsukary application to address such gaps. In particular, the newly developed application allows parents/caregivers and children to communicate with one another, respectively. It also lists the grocery stores that sell diabetes products in Saudi Arabia.

As a direction for future work, there are many other features that could be added as a part of the communication services, such as allowing children under their parents/caregivers' supervision to do some physical activities with their friends from the application. This is important and can be part of the way to improve and maintain diabetic children's health. Using image processing techniques may also be used in this feature to minimize the parents'/caregivers' effort and to prohibit any inappropriate physical activities. Additionally, it will get the necessary IRB approval from King Abdulaziz University (KAU) located in Jeddah city, Saudi Arabia, to run the experiment to evaluate the application's effectiveness using two groups (the control group and the intervention group).

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