Developing a Smartphone Application for Pregnant Women in Royan Cord Blood Bank

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Abstract— Cancers are one of the largest mortality groups in Iran, while some of these cancers can be treated with umbilical cord blood stem cell transplantation. This study was conducted to design and develop a mobile-based application to increase the level of awareness of pregnant women about the benefits of storing their child's umbilical cord blood stem cells and its use in the treatment of some cancers. For an information needs assessment, library resources have been searched and a needs assessment questionnaire was provided to 7 managers and physician of Royan cord blood bank. Based on the results, the application was developed in MIT App Inventor environment and finally, its satisfaction and usability were evaluated by the users. After determining the need for information elements in the questionnaire and data analysis, the application was designed with the capabilities of pregnancy education, online medical counseling, laboratory services, medical questionnaire, contract prohibitions, reminders, etc. The average evaluation of satisfaction and usability by managers, physicians, and pregnant women (as users) was 81.23 and was at a "very good" level. Considering the welcome of the new generation in the use of smartphones, the use of applications will play an important role in increasing the level of awareness of pregnant women and facilitating their access to services 24/7.

Keywords— Medical Information, Cord Blood Stem Cells, Pregnant Women, Smartphone Application

I. Introduction

Some diseases are considered a serious threat to human life and are not easily curable or, if treatable, require very high time and cost. Cord blood stem cells have been used to transplant patients for nearly 30 years because stem cells have the potential to cure approximately 80 diseases [1]. The capabilities of stem cells include the treatment of diseases, their differentiation into other required cells, the production of vital organs, and the knowledge of tissue engineering, etc. Stem cells can self-renew and differentiate into different types of cells, including blood, heart, nerve and cartilage cells, to regenerate and repair various tissues in the body, and damaged cells [2].

The gross mortality rate due to non-communicable diseases based on the data of the country's population database until the beginning of 2019, was an average of 4.7 per thousand population [3]. The mortality rate in the group of cancers and tumors is 11.3%. Comparing the three groups of "cardiovascular diseases", "cancers and tumors" and "diseases of the respiratory system", which have the highest mortality rate in the country, it can be concluded that from the age of 10 to 74 years of age are dangerous [10]. The most common group of diseases with a very significant difference that led to mortality was the group of cancers and tumors, and from the age of 75 to 100 years and above, the other two groups of diseases had the highest risk. Therefore, regarding the reports by the National Organization for Civil Registration, Ministry of Interior of Iran that shows the life expectancy is 75.5 years for women and 72.5 years for men in 2019, the group of cancers and tumors can be the first group of death in Iran [4].

Some of the group of diseases that can be treated by umbilical cord blood stem cells include stem cell disorders, acute leukemia, chronic leukemia, lymphocyte deficiency diseases, inherited erythrocyte abnormalities, congenital immune system disorders, inherited platelet defects, plasma cell disorders, Hereditary diseases are Alzheimer's disease, diabetes, Parkinson's, spinal cord injuries, heart attacks and strokes, liver diseases, and muscular dystrophy [7]. Therefore, it is very important to pay attention to the storage of umbilical cord blood stem cells to support the treatment of the disease [8-9].

One of the main tasks of stem cell cord blood banking organizations in the world is to raise the awareness of pregnant women about the benefits of storing their child's umbilical cord blood stem cells for use in the treatment of some diseases in the future, using appropriate medical information media [5].

Nowadays, the use of mobile-based applications is one of the most desirable media of medical information, so organizations need to develop the appropriate platforms for this purpose to educate and inform pregnant women [6].

In a study by Janine A Sommer et al. in 2017, found that health information technologies are constantly expanding and allowing more and more people to receive information and control their health condition. Based on the need to implement an application for pregnant women in the Personal Health Record (PHR) of Hospital Italiano de Buenos Aires (HIBA), an Australian survey was carried out to measure the use and utility of a pregnancy application (pregnancy app). The results were broadly in agreement with the reference values. The survey was distributed through social networks (Facebook and twitter) during September 2016. They obtained 235 responses from Spanish-speaking women, mostly Argentinian. In conclusion, it could be observed that a pregnancy app offers the possibility of a greater follow-up and provides reassurance to the pregnant women who uses it [12].

In a study by Budi Wiweko et al. (2019), found that Indonesia still has a high maternal mortality rate. There were 305 mothers mortality of 100.000 live births in 2015. The rate was far below MDG's target. One of the strategies to reduce the rate was to ensure mothers could gain access to excellent health services and reliable health information about pregnancy, delivery, and reproductive health. Therefore, they developed a smartphone-based reproductive health application named Jakarta Reproduksi Sehat (JAKPROS) which provides three sections, including prenatal care, cervical cancer prevention, and reproductive health. This application contains educational materials, question and answer forums, a hotline with health services center, and important information about reproductive health. In short, this application has everything that is important for pregnant mothers and women in general. They acknowledge that many diseases main risk factor was lack of education, therefore increasing the pregnant women knowledge could decrease high - risk pregnancy, and for the long-term purpose could decrease the maternal mortality rate [11].

II. METHODS

This study is an application-development study and its purpose is to design and develop a mobile-based application to increase the level of awareness of pregnant women about the benefits of storing their child's umbilical cord blood stem cells and its use in the treatment of some cancers. Three different steps were performed. First, information needs assessment design based on library studies and interviews with managers and physicians of Royan cord blood bank and in blood bank agencies in 24 provinces of the country were conducted, which led to the construction of a questionnaire with 35 questions included 9 questions related to personal information of pregnant women, 17 questions related to contract prohibitions and 9 questions about reminders and follow-ups. Its content validity was confirmed by 26 managers, experts and physicians and Cronbach's alpha was calculated to measure the internal consistency of the questionnaire items and its reliability. The obtained alpha was between 0.8 and 0.9, which was evaluated as good. In the second phase, the application was developed in the MIT App Inventor development environment. In the third stage, QUIS questionnaire was used to evaluate and determine the satisfaction and usability of the application in terms of overall response to the application (6 questions), application screen (4 questions), application information and terminology (6 questions), application capabilities (5 questions) and ability to learn from the application (6 questions) [16].

III. RESULTS

The purpose of this study is to design and develop an Android-based application for pregnant women referring to the Royan cord blood bank. The data used in this study were collected through a search of library resources in the field of stem cells, guidelines of the World Cord Blood Bank (NetCord-FACT Standards) [4] and a survey of managers, physicians and related specialists. Required elements and data items include three areas of necessity and importance of family identity information, the need for information related to medical questionnaires and contract prohibitions, such as previous pregnancy and infertility records, history of abortion, underlying diseases Motherhood, surgery, medication, etc., as well as the necessity and importance of information about reminders and follow-ups were on the application. The results are given in the table 1 [8].

IV. EVALUATION

In the above table, to evaluate the content validity, the two content validity ratios of CVI and CVR were used quantitatively. To determine the CVR, a questionnaire was first given to the physicians and experts to examine each item in terms of "necessary", "useful but unnecessary" and "unnecessary" with a 3-part Likert scale.

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}} \qquad (1)$$

ne is the number of experts who answered the "necessary" option and N is the total number of experts. To examine CVI, three criteria of "simplicity", "specificity (relevance)" and "transparency (clarity)" with a 4-part Likert scale were considered [9].

Table 1 - Evaluation of the validity of the questionnaire

Dimension	Row	Criteria	Exclusive CVI	Clarity CVI	Simplicity CVI	Average (items) CVI	Necessity CVR	Average (areas) CVI	Average (areas) CVR
The need for family personal information in the application	1	Father's Name and Surname	1	1	1	1	1	0.955	0.922
	2	Mather's Name and Surname	1	1	1	1	1		
	3	Father's date of birth	0.93	0.96	1	0.963	0.9		
	4	Mother's date of birth	1	1	1	1	1		
	5	Parents' education level	0.83	0.93	0.86	0.873	0.9		
	6	Parents' field of study	0.83	0.86	0.91	0.866	0.8		
	7	Location (city-region)	1	1	1	1	1		
	8	Father's employment status	0.86	0.93	0.91	0.900	0.7		
	9	Mother's employment status	1	1	1	1	1		
The need for family clinical information in the application	10	Is cord blood stored for any other child? The reason?	0.96	0.93	1	0.963	1	0.960	1
	11	History of abortion (cause/frequency/week of abortion) or child death (cause of death/age)	0.93	0.96	0.96	0.950	1		
	12	History of infertility (duration of infertility/cause)	1	0.93	1	0.976	1		
	13	History of assisted reproductive techniques (egg/sperm/donated embryo or surrogate uterus)	0.93	0.93	1	0.953	1		

Category	No.	Description							
The need for information on underlying and genetic diseases in the application	14	History of organ or tissue transplant in mother or father	0.93	1	1	0.976	1		
	15	Existence of a person with incurable disease/Existence of a history of hereditary and genetic disease, immune/metabolic system/Blood and malignant, etc., in the family and first-degree relatives	0.93	1	0.96	0.963	1	0.958	1
	16	History of abnormal Pap smear/Intrauterine blood transfusion/Chemotherapy/Radiation therapy, etc. in the mother	0.91	0.93	1	0.946	1		
	17	Abnormal results in tests such as HIV/HTLV/VDRL-RPR	0.96	0.89	1	0.950	1		
The need for drug information in the application	18	History of Reproductive Assistance Albumin Serum/IVIG Serum Intravenous Immunoglobulin /Corton Prednisolone or Betamazone	0.96	0.93	1	0.963	1		
	19	History of continued use of injecting drug/bodybuilding supplements in the father and use of female complementary drugs other than prenatal vitamins and iron and calcium compounds	0.96	0.96	0.93	0.950	1		
	20	History of receiving tetanus/rabies/BCG/measles /MMR vaccine in the last year before pregnancy or lifelong hepatitis B vaccine	0.96	1	1	0.986	1	0.967	1
	21	History of drug use for infectious diseases such as gynecological infections/urinary tract infections /cytomegalovirus, etc.	0.99	0.93	1	0.973	1		
	22	History of drug use for infectious diseases such as gynecological infections/urinary tract infections /cytomegalovirus, etc.	1	0.96	0.93	0.963	1		
The need for surgical records information in the application	23	Sampling history and FNA	0.93	1	1	0.976	1		
	24	History of thyroid nodule (nodule)/thyroid surgery	1	0.96	1	0.986	1	0.969	1
	25	Gynecological surgery	0.93	1	0.93	0.953	1		
	26	Cupping/Tattooing/Tattooing/Microbuilding etc.	0.96	0.93	1	0.963	1		
The need for information about reminders and follow-ups in the application	27	Reminder to attend 8 weeks of pregnancy preparation training classes	0.96	1	1	0.986	1		
	28	Reminder of exercise/walks during pregnancy	0.89	0.93	0.96	0.926	0.9		
	29	Reminder of filling out a medical questionnaire online	0.96	0.96	1	0.973	1		
	30	Environmental bleeding reminder (tests¬ninth month of pregnancy)	1	0.96	1	0.986	1		
	31	Reminders to send and receive operating room blood collection kits	0.93	0.93	0.96	0.940	1	0.962	0.977
	32	Reminder of delivery of blood collection bag to Royan service	0.96	0.89	0.93	0.926	0.9		
	33	Follow-up Complete the baby health form 3 months after delivery	1	1	0.96	0.986	1		
	34	Follow-up upload of death certificate in case of child death	1	0.93	1	0.976	1		
	35	HLA follow-up, 6 months postpartum	0.93	0.96	1	0.963	1		

At this stage based on the results, a stem cell information application developed in MIT App Inventor development environment [9] for Android smartphones to inform pregnant women who refer to Royan Cord Blood Bank. Picture 1 shows the menu of the application.
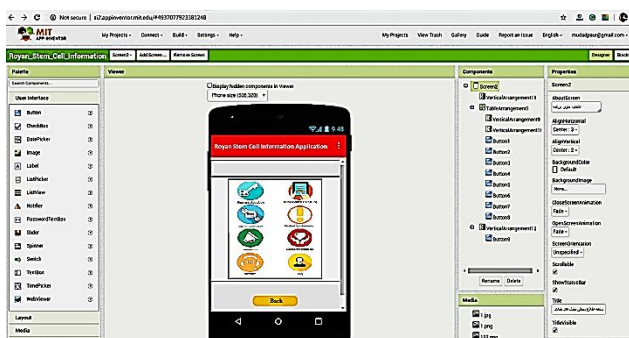

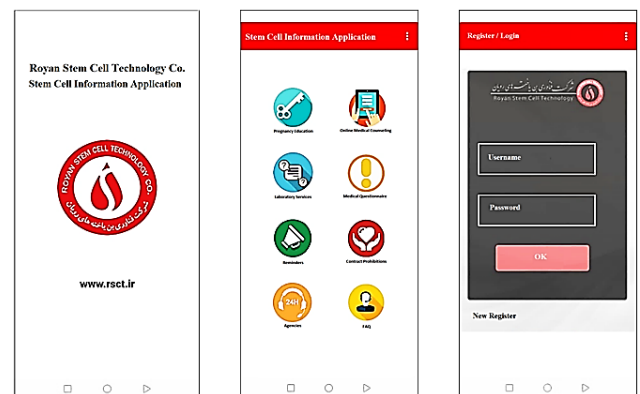Figure 1: Application menu in the development environment

Figure 2: Application UI

V. RESULTS

After developing, to test the application, it was provided to the evaluators to install the application on their smartphone and use it for a week. Then, the satisfaction and usability of the application was evaluated through the QUIS questionnaire [7].

The total number of evaluators was 26, including managers such as CEO of Royan Cord Blood Bank, Director of Medical Services, Consulting physicians, Quality Manager, CRM Officer, Director of Technical Information Management Committee from Takhte Jamshid hospital as a guest (totally 6 men and 1 woman), experts of Royan cord blood bank, including the technical director of laboratories, network security manager, hardware manager, and software manager of Royan cord blood bank (totally 4 men) and 15 selected physicians and experts from pregnant women who were referred to Royan cord blood bank.

- Inclusion criteria for experts, being a physician or paramedical degree related to the field of stem cells.

Evaluators were asked to evaluate the Usability of the Application in term of Learning (6 questions), Screen (4 questions), Terminology and Application Information (6 questions), Application Capabilities (5 questions), and in terms of Overall Reactions to the Application (6 questions) [15]. The results of the evaluators' evaluation are shown in the following charts.
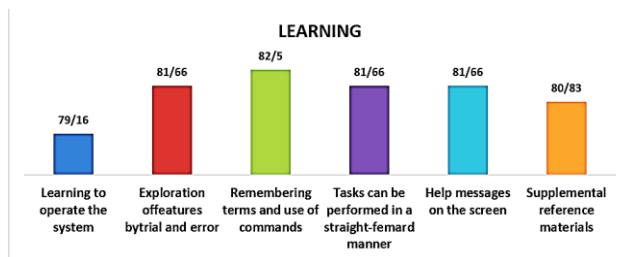

Chart 1. Evaluating the Usability of the Application - in term of Learning

Chart 1 shows the evaluators' average score for term of Learning. The score was 81.24 and since it was in the range of 80 to 100, so it can be concluded that the evaluators have rated the Learning as "Very Good".
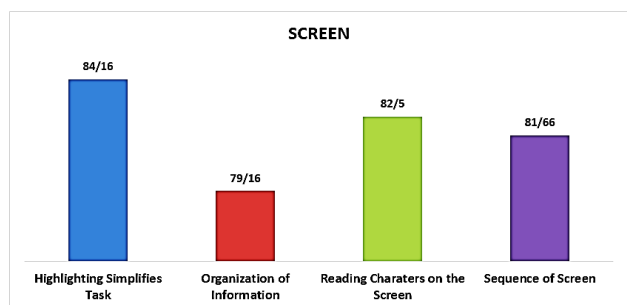

Chart 2. Evaluating the Usability of the Application – in term of Screen

Chart 2 shows the evaluators' average score for Screen. The score was 81.87 and in the range of 80 to 100, it can be concluded that the evaluators rated the Application Screen as "Very Good".
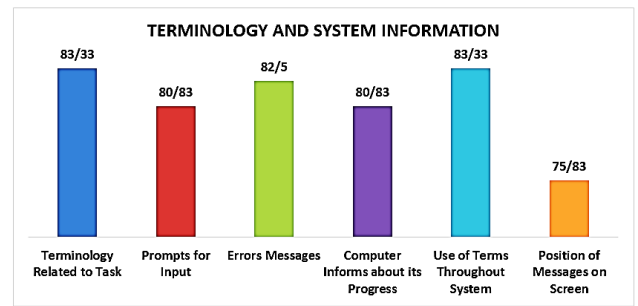

Chart 3. Evaluating the Usability of the Application – Terminology and Application Information

Chart 3 shows the average score of evaluators for term of Terminology and System Information. The score was 81.10 and in the range of 80 to 100, so evaluators rated this term as "Very Good".
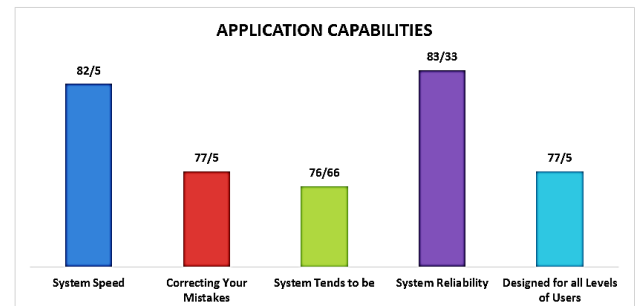

Chart 4. Evaluating the Usability of the Application – Application Capabilities

Chart 4 shows the average score for Application Capabilities. The score was 79.49 and in the range of 60 to 80. Evaluators rated this term as "Good".
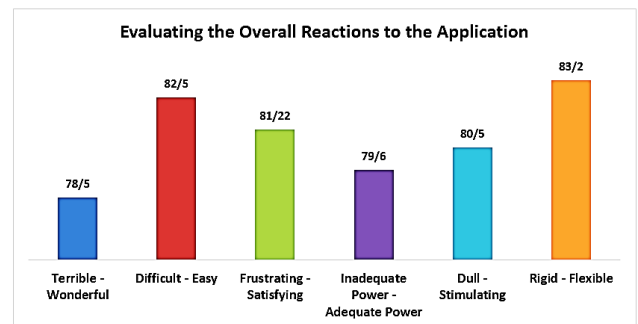

Chart 5. Evaluating the Overall Reactions to the Application

Chart 5 shows the evaluators' Overall Reactions to the Application. Average score for this term was 80.92, as "Very Good".

- According to the results shown in the charts 1-5, the average of the total evaluation by the evaluators in the items, is 81.23 and as "very good".

VI. DISCUSSION AND CONCLUSION

This study was conducted to design and develop an application for smartphones based on the Android operating system, in order to increase the awareness of pregnant women about the benefits of storing their child's umbilical cord blood stem cells and its usage in the treatment of some diseases. For an information needs assessment, library resources have been searched and a

needs assessment questionnaire was provided to 7 managers and physician of Royan cord blood bank. Based on the results, the application was developed in MIT App Inventor environment and finally, its satisfaction and usability were evaluated by the users. After determining the need for information elements in the questionnaire and data analysis, the application was designed with the capabilities of pregnancy education, online medical counseling, laboratory services, medical questionnaire, contract prohibitions, reminders, etc. The average evaluation of satisfaction and usability by managers, physicians, and pregnant women (as users) was 81.23 and was at a "very good" level.

In the 2020 study by Salina et al., The goal was to increase the knowledge of pregnant women about fetal growth during pregnancy using an Android-based application. The study included 90 pregnant women and 30 women in the first trimester, 30 women in the second trimester and 30 pregnant women in the third trimester were randomly selected. Pregnant women were given a fetal growth questionnaire as a pre-test, then pregnant women were trained in fetal growth using an Android-based learning app. They were then asked to read and answer the post-test questionnaire. McNemar statistical test was used to assess the knowledge of pregnant women and the results showed that 72.3% of pregnant women benefited from a significant increase in knowledge through an Android-based application [13].

A study by Lisa Maria et al. 2015, found that gestational diabetes (GDM) and blood sugar control are essential for pregnant women, and that the Pregnant + app was designed for smartphones. Satisfaction with the application was assessed among 22 pregnant women using questionnaires and interviews by a public health nutritionist from mothers who referred to 5 outpatient clinics in Oslo, Norway. Findings showed that 21 of the 22 mothers in the study were satisfied with the design of the information application by answering the questionnaire and the satisfaction rate of the application was about 95.4% [14].

- In present study, the results of the evaluation show the high level of user satisfaction with the application due to the possibility of accessing to a 24/7 service and providing telemedicine technology in order to reduce costs, and capabilities such as online consultation for pregnant women and so on.

- One of the limitations of this study is the development of this application just for android operating system, which can lead to a lack of service to users of other operating systems such as iOS and Microsoft Surface. In addition, the application also supports APIs 14 and 15, versions of android 4.0.1–4.4.4 (Ice Cream Sandwich version) and above.

- Still, pregnant women from more than 18 countries have stored their children's umbilical cord blood stem cells in the Royan cord blood bank. Due to the flexibility and ability to add more activities to the application, it is suggested that the possibility of medical tourists be added. So the application can meet

international standards and more pregnant women from abroad would come to Royan to store their children's umbilical cord blood stem cells.

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