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Effective use of mobile phone application for supporting health care

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Abstract

This research aims to apply innovative technology to support the health of Thai people. In the present day, technology has become a part of our daily lives in the form of devices such as computers, smartphones and other gadgets. Innovative technologies allow people to make their lives easier. The technologies have been rapidly adopted and applied with a wide variety of both hard and soft skills. The purpose of this research is to study the effective use of mobile phones to support user health. A prototype of a mobile application to promote Thai people's health was developed. It consists of three main parts: a) to promote healthy food consumption for individuals, b) to support appropriate work outs for individuals, and c) to aid people to quit smoking. The control group of participants was trained to use the prototype application whilst the experimental group learned to use the prototype by themselves. The participants selected for the experiment differ in gender and age, have different education and job backgrounds and also unequal monthly earnings. 33.82% of trained users could use the application and achieve the objectives of parts 1 and 2. For part 3, there were a total of 19 participants in the group who were smokers, 15% of them were able to use the application successfully and achieve the objectives. We compared the effectiveness of the participants who were and were not trained in how to use the application. Moreover, we used a questionnaire to collect data and feedback on the use of the application in order to support the outcome of the three main parts. The questionnaire was selectively distributed and there were 12 respondents. In order to gain insights into the participants' use of the application, open and closed questions were employed in the questionnaire. The questions covered the subjects of Usability, Availability, Reliability, Accessibility, and Performance. The results revealed that the participants had positive attitudes towards the use of this mobile application. They agreed that the application encouraged and motivated them to improve their health. A number of other possible approaches for further investigation have been identified. In this paper, we also provide the research outcomes and what needs to be done to improve the approach in order for it to be more beneficial. We intend to extend the prototype to cover all activities in daily life. Using sophisticated visualization techniques will help to make the application work more efficiently as well.

Keywords: Thai health, Health care, Mobile application, Android

1. Introduction

Health care professionals use medical devices and applications for many purposes, which can be grouped under five broad categories: administration, health record maintenance and access, communications and consulting, reference and information gathering, and medical education [1-2]. There are many uses for mobile devices and medical applications, for example, communications and consulting, reference and information gathering, clinical decision-making, patient monitoring, etc.

In addition, personal health records (PHRs) are "an Internet-based set of tools that allows people to access and coordinate their lifelong health information" [3]. The spectrum of PHRs ranges from health care organization-tethered applications that build on a patient's existing electronic health record to 'stand-alones' in which the patient supplies the bulk of medical information to the PHR [4]. However, in Thailand, current medical devices and applications are mainly used by health care professionals [5]. In other words, all PHRs aim to increase patient

access to personal health information in a secure fashion [6]. There are a number of potential benefits to PHRs. Patients can use PHRs to view personal health information, a traditionally burdensome task. It would be convenient for patients if they can review laboratory test results, confirm medication lists, follow links to credible health information online, and communicate with providers.

Currently, there is web-based software or mobile applications that have been introduced to help maintain and improve the state of people's health [7-11]. Some applications (or software) allow users to monitor a wide range of health parameters such as information about blood pressure, height, and weight. On the other hand, there is some software that was developed for a particular purpose. One of the most common is software that can only monitor blood pressure and weight. Cardiovascular diseases and diabetes are also taken into account. The software is based on scientific evidence that was prepared with the participation of medical doctors. Consequently, non-medical professionals may not understand and cannot benefit from their own personal health information [7,10]. Additionally, those applications/software have diverse objectives for users; however, users are not satisfied by some particular functions. The trend is to emphasize the coordination and integration of care, and the use of appropriate information, communication, and education technologies in connecting patients, caregivers, physicians, nurses, and others as a healthcare team where the health system supports and encourages cooperation between team members. There are some research focusing on the use of mobile phone application to support patients' healthcare [12-15]. However, these applications are not available in the Thai language and are only offered for specific purposes. According to a previous study [16], it was found that Thai people were ranked 64th out of 88 countries for English language skills. Thai people scored an average of 48.5 of 100 points for English language skills, which is a low level of proficiency. Therefore, the use of the applications in English language for supporting their healthcare are not fully effective. In this work, an application in Thai language for supporting users' healthcare is developed.

Nowadays, technology has become a part of our daily life in many forms, for example, computers, smartphones or other mobile devices. The technology has been rapidly adopted and applied in a wide variety of both hard and soft skills. This research aims to apply innovative technology to support Thai people's health. We studied the patients' ability to apply innovative technology to support their health.

In particular, we focused on the effectiveness of being trained about how to use a mobile application to support healthcare. First, we compared the use of the mobile phone application by users who have been trained how to use the application and those who have not been trained. A group of participants was set up who have different demographic characteristics i.e. age, gender, education background, and social economic status. Second, we assessed by developing a mobile application to support Thai people's health. The prototype was developed in the Thai language in order to specifically support Thai users. It consisted of three main parts: i) supporting healthy food consumption for individuals, ii) offering work-out guides for individuals, and iii) aiding people to quit smoking.

2. Materials and methods

2.1 Participants

The study included patients and individuals who received care. The group of participants consisted of patients diagnosed with diabetes and asthma, and individuals with good health. They were both male and female and aged 18 years and over and had appointments at the Internal Medicine Unit at a hospital in Bangkok. The sample was selected from the population by block random sampling. There were three criteria: 1) could take medicine by themselves (the patient or caregiver is the person who prepares the drug), 2) could read, speak, write, and communicate in Thai, 3) had a smartphone and can use basic mobile phone applications. The control group of participants was trained to use our proposed prototype application.

The sample size was calculated by using the G Power program [13] with the level of confidence at .05 and the power of test at .9. The effect size group was calculated to get d = 1.56 and f = .8. Therefore the size of the influence group was determined, and the sample size was calculated to be 24 persons. However, we planned to prevent losses in the sample group during the study by increasing the sample size by 40 percent. The sample size of the control and experimental groups was 34 persons.

2.2 Study design

With the available opensource software and tools, we initially proposed to implement a prototype of the mobile application on android platforms [17]. The application prototype was applied to the sample group. The control group of participants was trained to use the prototype while the experimental group learnt to use the prototype by themselves. User documentation was provided to both groups. The study compared the effectiveness of the use of the mobile application to support their healthcare for trained and non-trained users. The participants were allowed to access their personal health records and use the prototype for three months.

Moreover, we performed observations and used a questionnaire to collect data and feedback on the use of the application. The questionnaire consisted of two sections i.e. to collect participant's profile and 5 main items (Usability, Availability, Reliability, Accessibility, and Performance). The participants were requested to respond to the questionnaire after three months of use. The questionnaire was reviewed by two medical doctors. However, the questionnaire was considered in terms of content coverage and accuracy by 5 experts whose expertise was related to information technology. The data were tested by using Cronbach's alpha coefficient [18] with a 0.81 confidence value. The questionnaire was paper-based and answered by participants after the use of the prototype for three months. The questionnaire consisted of open and closed questions. The questions were in regard to the use of the application. The questions concerned the Usability, Availability, Reliability, Accessibility, and Performance of the application. The questionnaire had two main parts; Section A and Section B. In section A, the questionnaire defines the goal of the research and outlines the main parameters to be investigated. In section B, each main parameter had several questions in which the participants were required to answer appropriately. The answer for each question was based on the following: 0 - Very poor (0%); 1 – Poor (20%); 2 –Fair (40%); 3 – Good (60%); 4 - Very good (80%); and 5 – Excellent (100%).

The prototype consisted of three main parts: i) supporting healthy food consumption for individuals, ii) offering work-out guides for individuals, and iii) aiding a user to quit smoking. As shown in Figures 1 and 2, the usecase diagrams present the functions of the application. Part 1 consisted of the main functions: a) PHR managing allowed a user to create his/her own personal health record and update the record later, b) BMR calculating assisted a user in calculating information about his/her BMR, TEDD, c) nutrition planning assisted a user to make a plan for appropriate nutrition regarding his/her profile (this function included calculating suggested the number of calories consumed), d) alerting users about the number of calories consumed by the user, and e) profile viewing allowed a user to view his/her own profile and PHR. Part 2 consisted of the following main functions: a) activity managing allowed a user to create an activity he/she was going to do and update the record later which concerned the calories used, b) BMI/BMR calculating assisted a user in calculating information about his/her BMI/BMR, c) work-out planning assisted a user in making a plan for work outs or exercise (this function included calculating used calories), d) alerting users about the number of calories used and e) activity viewing allowed a user to view his/her own activities each day.

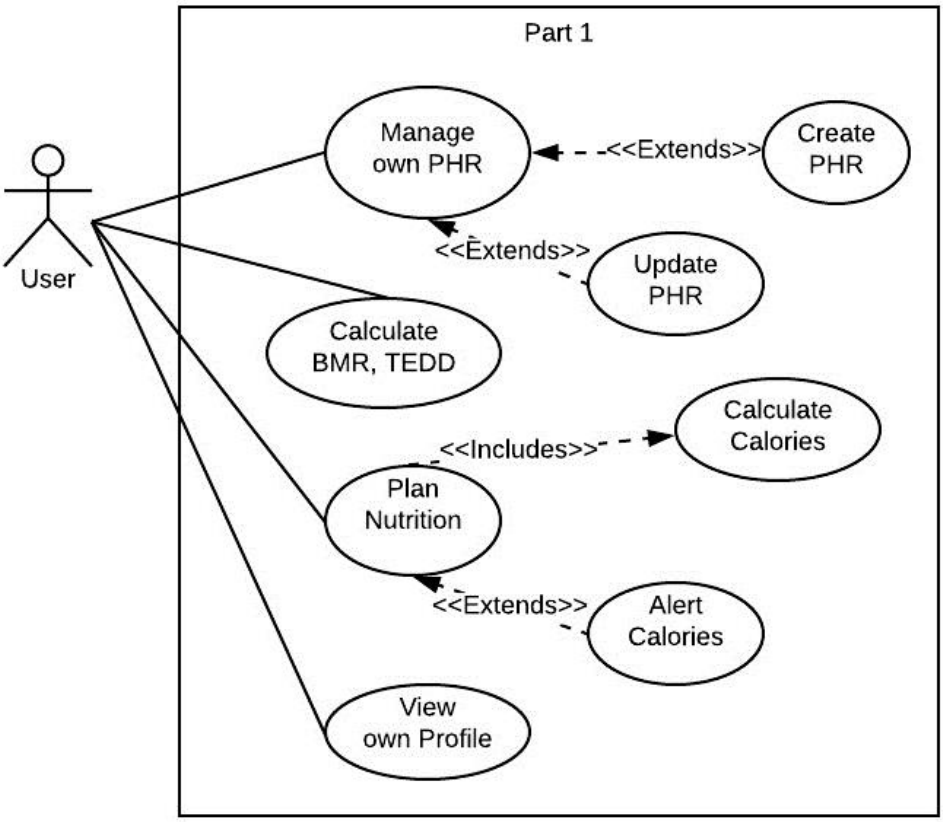

Figure 1 A use case diagram presenting the functions in part 1.

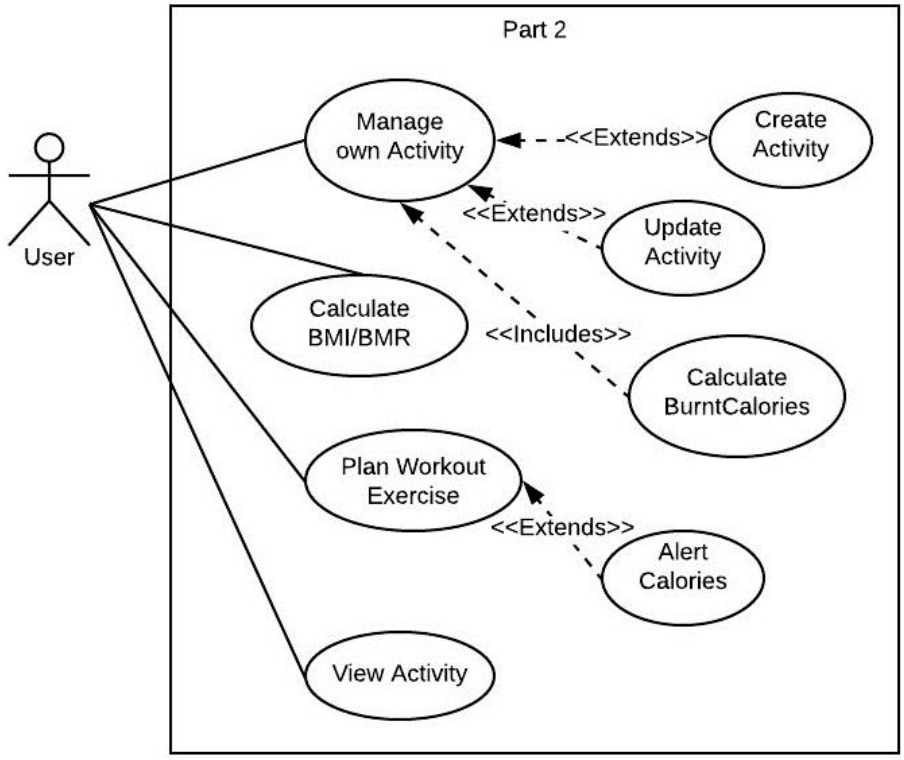

Figure 2 A use case diagram presenting the functions in part 2.

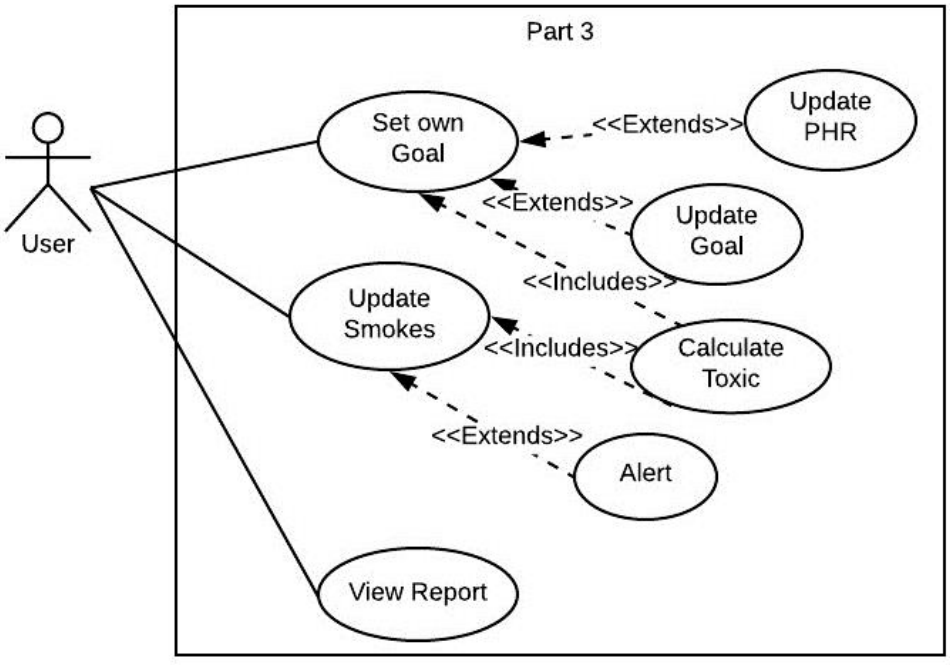

Figure 3 A use case diagram presenting the functions in part 3.

As shown in Figure 3, the use case diagram presents the main functions of part 3. It consisted of: a) *goal setting* which allowed a user to set his/her own goal to quit smoking by specifying the period of time for the quitting process and to update the goal (this function also analyzes his/her personal health record and displays the profile), b) *smoking updating* allowed a user to record an instance of smoking (one cigarette per update) and the application then calculated the toxicity of smoking one cigarette and gave an alert, and c) *reporting* allowed the user to view his/her own smoking record per day.

Additionally, the user interface (UI) design was implemented. In this paper, we present only parts of the UI design due to the space constraint, and provide examples of UI screens in English l. As shown in Figure 4, the first part of the application is presented. For the first part, the application consisted of Home screen and a screen for obtaining user information. This part of the application calculates the energy needs per day based on individual's height and weight.

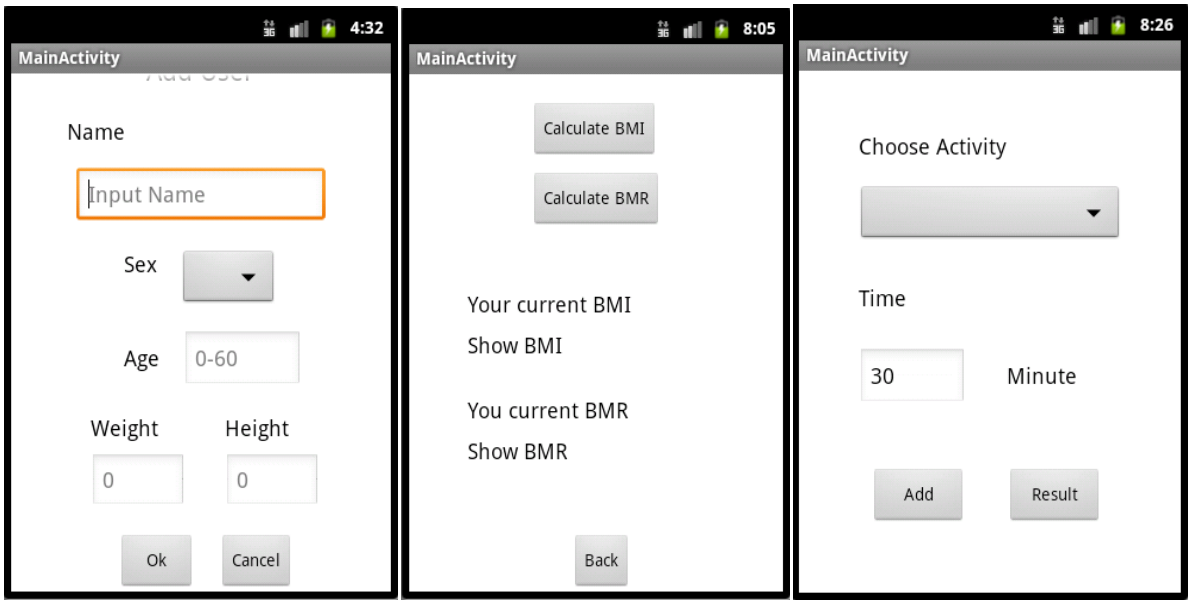

Figure 4 Examples of user interface screens for the application's part 1.

For the second part, as shown in Figure 5, the application consisted of screens in order to assess the working-out of individuals each day. The assessment analyzes the user's personal health record in order to obtain a guided list of activities and practices. This part of the application calculates the BMI and BMR of an individual based on height and weight. The application also collects data about the activities that the user performed each day.

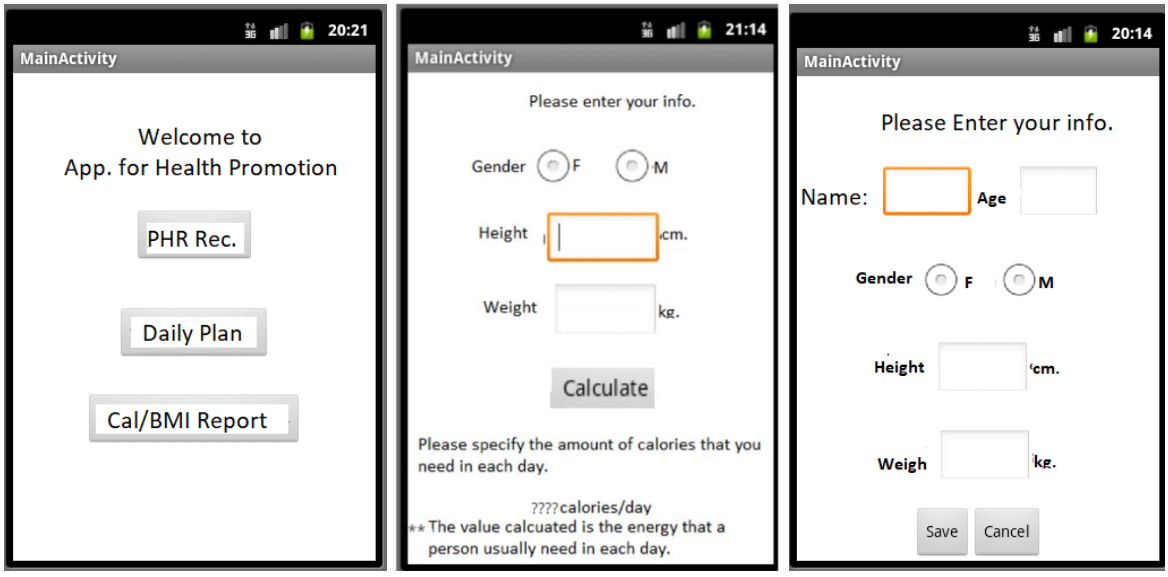

Figure 5 Examples of user interface screens for the application's part 2.

For the third part, as shown in Figure 6, the application consisted of a smoking recording screen. The application allows an individual to record the number of cigarettes by pressing a button for each cigarette. The application calculates the amount of nicotine and tar that an individual consumes. The individual then receives the information about the total number of cigarettes, and the amount of nicotine and tar consumed. Moreover, the application allows the individual to set the maximum number of cigarettes in the application. The application

could remind the user about the number of cigarettes that the individual has smoked and the limitation for each day. This application assists the individual by reminding the user about the number of cigarettes that have been smoked to assist the user in limiting consumption. As shown below, the application pops up a warning screen when the individual has smoked more than the limit. The application allows the user to reset the limit for smoking each day. This application was designed to remind the user about their smoking and personal health.

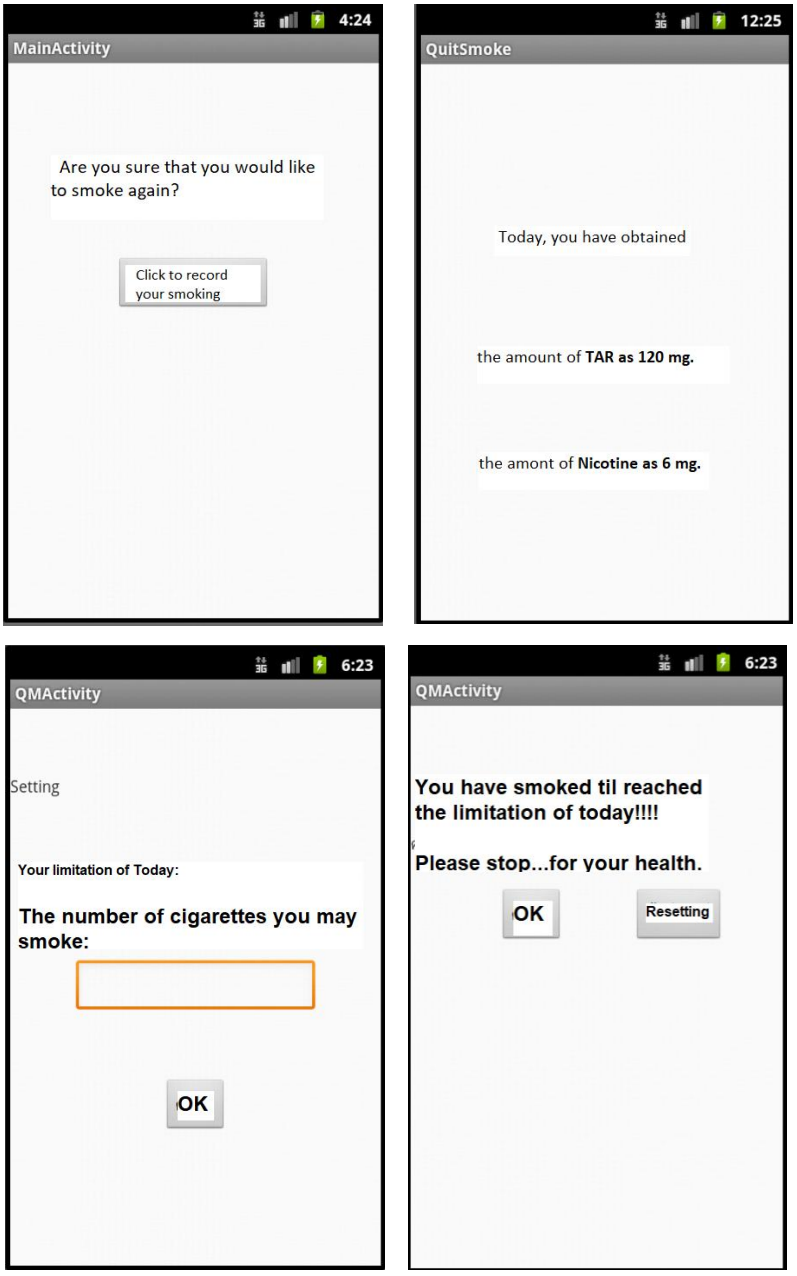

Figure 6 Examples of user interface screens for part 3.

3. Results and discussion

We identified a group of participants who have experience with medical services and their personal health information. We used mean and statistics to analyze and compare the control and experimental sample groups. As shown in the Table 1, we proposed to adopt the criteria to compare personal profiles [19]. We obtained participants' personal profiles i.e. age, gender, education background, and social economic status. The percentage of males in the sample groups was 41.18 and 47.06, respectively. The sample group was mainly students, who had had secondary education and earned less than 15,000 baht per month. The difference of personal profiles between two groups (experimental and control groups) was calculated by Fisher's Exact Test and Chi-Square.

The p values are not less than 0.05. The result can be implied that there is no significance between two groups for each factor i.e. gender, age, education background, and monthly income. It shows very low proportions for each characteristics different between two groups.

Table 1 Comparison of personal profiles with results for the experimental and control groups.

	Experimental Group (n = 34)	Control Group (n = 34)	
Characteristics	Number (Percentage)	Number (Percentage)	*P* Value
Gender			0.625
Female	20 (58.82)	18 (52.94)	[Chi-Square]
Male	14 (41.18)	16 (47.06)	
Age			0.890
18-35 (47)	24 (70.59)	23 (67.65)	[Fisher's Exact Test]
36-50 (18)	8 (23.53)	10 (29.41)	
51-65 (2)	1 (2.94)	1 (2.94)	
> 65 (1)	1 (2.94)	0 (0)	
Education Background			0.807
Primary school	1 (2.94)	0 (0)	[Fisher's Exact Test]
Secondary school	18 (52.94)	20 (58.82)	
Graduate school	15 (44.12)	14 (41.18)	
Job Background			1.000
Students	18 (52.94)	19 (55.88)	[Fisher's Exact Test]
White collar	15 (44.12)	15 (44.12)	
Blue collar	1 (2.94)	0 (0)	
Monthly Income			0.836
< 15,000 Baht	20 (58.82)	19 (55.88)	[Fisher's Exact Test]
15,000 – 30,000 Baht	4 (11.76)	5 (14.71)	
30,001 – 70,000 Baht	7 (20.59)	5 (14.71)	
> 70,001 Baht	3 (8.82)	5 (14.71)	

Note. Data presented as number (percentage); difference between group was calculated by Fisher's Exact test and Chi-Square.

Additionally, we determined the number of participants who had achieved the objectives for each application after three months. In particular, we considered the participants who could follow and complete part 1 of the application about a healthy daily diet, and for part 2 for those who regularly work out. In addition, there were a total of 19 participants in the group who were smokers. They were requested to apply part 3. We also considered participants who could be disciplined and follow the steps in the application in order to give up cigarettes. As shown in Table 2, the number of participants who used the application and achieved the objectives of each part is presented. It was found that 52.94% of, the experimental group achieved the part 1 goals. which was more than the control group (14.71%). Similarly, the participants in the experimental group that achieved the goals of part 2 was 44.12% and for part 3 was 22.22% which were both more than the control group (23.53% and 10.00%, respectively).

Table 2 The number of participants who achieved the application's objectives.

	Experimental Group (n = 34) Number (Percentage)		Control Group (n = 34) Number (Percentage)		
Part	Achieved	Not achieved	Achieved	Not achieved	*P* Value Fisher's Exact Test
1	18 (52.94)	16 (47.06)	5 (14.71)	29 (85.29)	0.002
2	15 (44.12)	19 (55.88)	8 (23.53)	26 (76.47)	0.123
3	2 (22.22)	7 (77.78)	1 (10.00)	9 (90.00)	0.020

Moreover, the results showed that only one third (33.82%) of all participants applied prototype parts 1 and 2, and achieved the objectives. The rest of the participants (66.18%) applied prototype parts 1 and 2, but did not achieve the objectives. However, the study indicated that gender could give different results of successful use of the application. The results showed that 28.95% of female participants applied prototype parts 1 and 2 and achieved the objectives, compared with 40% of the male participants who applied prototype parts 1 and 2 and achieved the objectives. Moreover, age was a factor that yielded different results for successful use of the application. Participants achieved the objectives differently according to age. 38.3% and 34.04% of the 18-35 age

group successfully completed the objectives of parts 1 and 2, respectively. 27.78% and 16.67% of the 36-50 age group successfully completed the application objectives for parts 1 and 2. For participants who were in the groups of 51-65 and more than 65 years old, none could achieve the objectives of parts 1 and 2. However, the study indicated that education background did not significantly affect the results for different levels of participants' background. Most of participants (for parts 1 and 2) were students who had graduated from high school. Additionally, monthly income did not influence the successful use of the application. The number of successful participants was evenly distributed between different groups of monthly income persons. The study did not find significant differences between different income groups. For example, in a middle income group (15,000-30,000 Baht per month), 55.55% achieved the objective of Part 1; however, only 33.33% achieved the objective of Part 2. In addition, there were 19 participants who were smokers. The result showed that most of them had failed to quit. However, 3 of them had successfully achieved the objective of Part 3.

The questionnaire was also employed to collect feedback on the use of the prototype application. The questionnaire was selectively distributed and there were 12 respondents, which accounts for 18% of the experimental group. Examples of the questions and results are shown in Table 3. The levels of satisfaction were *Excellent* (4 points), *Good* (3 points), *Fair* (2 points), *Bad* (1 point), and *None* (0 point). The table shows the number of persons who assessed their satisfaction in regard to the use of the application. For example, 25.00% of the respondents understood the content of the healthy food menu at the excellent level. The average score ($\bar{X}$) was calculated by the product of the number of respondents and the satisfaction level points, divided by the total number of respondents. The average score for Question 1.1 was 3.00, which implies that the users could understand the content of the healthy food menu described in the application well. The average score for Question 1.2 was 3.33, which indicates that the users could reduce the problems of preparing nutrition by using the application well. The average score for Question 1.3 was 3.17, which indicates that the application could motivate the users to consistently consume healthy food well. The results indicate that the participants had positive attitudes towards the use of the mobile application. They agreed that the application supported their health and motivated them to improve their health. Based on a total of 20 questions, 12 respondents gave quite similar feedback on the application. The average score of 20 questions from 12 respondents was 2.71 which indicates that the users were fairly satisfied by the application.

Table 3 Examples of the questions on user satisfaction for the mobile phone application in supporting their health.

Question	Number of Respondents (Percentage)						Meaning
	Excellent (4)	Good (3)	Fair (2)	Bad (1)	None (0)		
1.1 You understand the content of healthy food menu based on the application.	3 (25.00%)	7 (58.33%)	1 (8.33 %)	1 (8.33%)	0 (0%)	3.00	Good
1.2 The application reduces problems in preparing diet nutrition.	8 (66.67%)	2 (16.67%)	1 (8.33%)	0 (0%)	1 (8.33%)	3.33	Good
1.3 The application encourages and motivates a user to consistently consume healthy food.	4 (33.33%)	6 50.00%)	2 (16.67%)	0 (0%)	0 (0%)	3.17	Good

4. Conclusions

Many hospitals in Thailand still lack sophisticated information-based systems due to some practical difficulties. This research focused on individuals who have experience in medical services and recalling their personal health information. We proposed a mobile phone application to view personal health records (PHRs) so that people can manage and benefit from their own health records. The application prototype was developed in order to investigate the proposed application and obtain feedback about use. The results of this study supported the research hypothesis. It was found that the number of the experimental group participants who achieved the objectives when using the application was higher than the control group. The study indicated that obtaining information and training people how to use the application correctly would be more effective. It was also found that the number of participants who achieved their healthcare objectives was less than the number that did not which implies that only a proportion of users were influenced by the mobile phone application. The application may not be very helpful for potentially quitting smokers since only 15.89% of participants consistently followed the steps to quit cigarettes. In addition, it was found that the level of user satisfaction on the use of mobile phone

application was good which indicates that the participants had positive attitudes towards the use of the mobile application.

Additionally, a number of possible directions for further investigations have been identified. We plan to tackle some limitations. For example, the application prototype was only available on android mobile phones which caused the sample group to be unequal. Also, the prototype had limitations in regard to specific functions. We intend to extend the application to cover all activities of daily life and its use could be extended to provide other information that may benefit the user's health. Some sophisticated techniques for data visualization could further support the use of the application. Also, we plan to make a larger size of sample size in order to identify the factors or personal characteristics relevant to the achievement of application's objectives.

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