

Developing Mobile Application for Predicting Risk of Cardiovascular Event among People with Diabetes: Design and Pilot Study

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Abstract

Aims: The study aim is to develop a mobile application (app) design for predicting the risk of cardiovascular event and conducts a pilot study.

Methods: The mobile app design was developed on the basis of evidence from World Health Organization (WHO) and International Society of Hypertension (ISH). The workflow had four steps, namely; data entry, conversation and processing, risk identification, and education. The development process involved interface designing, coding, debugging, and pilot testing. Cross-sectional approach for pilot testing was conducted by using system usability scale.

Results: Main features of the Decardia app, namely, icon categories, input slots, risk identification outcomes, and education windows, were developed. The app is available in Android platform and in offline mode, compact, accurate, efficient and users involvement for education. The pilot outcomes indicated excellent (60%), acceptable (95%), and grade A+ with an average overall score of 87. Almost all components of usability testing showed positive results with scores ranging from 3 to 3.95 (out of 4).

Conclusions: The Decardia app evaluates patient's risk level of cardiovascular event and empowers their risk reduction behavior. The pilot study indicated positive outcomes, supporting the usability of the Decardia app.

Keywords: cardiovascular event, diabetes, design, mobile health, risk of cardiovascular, screening

Introduction

Asia Pacific region contributes the greatest prevalence of diabetes. In Southeast Asia, diabetes was identified among 85 million people in 2017 and is projected in approximately 151 million people in 2045¹.

Data from the Ministry of Health Indonesia shows that 12.2 million people have diabetes, and the number will grow in the following year². Diabetes is also responsible for 1.6 million deaths and is the sixth cause of death³.

Most diabetic people die due to cardiovascular complication. American Heart Association reported that 65% of diabetic people die because of heart attack and stroke⁴. Furthermore, people with diabetes are at high-risk of having cardiovascular attack⁵. Thus, initiatives of early detection and risk reduction are critical. The WHO publishes a guideline for evaluating and controlling fatal cardiovascular occurrence for the next 10 years. Risk of cardiovascular event is assessed by considering

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individual data which are designated in the risk prediction chart^{6,7}. The existing tool helps people with diabetes and health care workers (HCW) to understand their risk of cardiovascular incident.

Risk prediction is proposed for primary care settings and hospitals, and the chart is available in simple form. Risk identification is considerably self-deciding, time consuming, and potentially confusing. Therefore, most clinicians ignore detection due to limited time, and few people with diabetes evaluate their risk. Ignorance of cardiovascular risk level may contribute to the further development of stroke and heart attack^{6,7}. HCW and diabetes people should focus on specific risk level and undertake action to decrease the risk.

The guideline for cardiovascular event risk is available in manual and English versions, which may be impractical for diabetes population in Indonesia. In addition, recommendations related to risk reduction are available, but they are written in complicated and medical languages, which may be inapplicable for diabetic people^{6,7}. Therefore, the guideline must be simplified. Diabetes people and HCW need an ingenious but understandable tool to evaluate their risk of cardiovascular event. Developing a mobile app as an assessment device for helping diabetes people and HCW can be an appropriate solution. Therefore, researchers decided to develop a mobile app to calculate the cardiovascular risk level among people with diabetes. Furthermore, the app is expected to promote healthy lifestyle among diabetes people.

The objective of this research is to describe the development process of mobile app, namely, Decardia for assessing risk of cardiovascular event among diabetes people. Thus, the primary outcome is a Decardia design for diabetic people. In addition, the pilot study outcomes among clinicians are presented as preliminary results.

Methods

Study Design

The development process of the Decardia app originated from literature on assessing the cardiovascular risk level among people with diabetes. A comprehensive search was conducted using proxy and academic databases. Researchers identified available and

applicable tools and applied a widely used instrument model from WHO/ISH^{6,7}.

Researchers applied the cross-sectional design among clinicians in primary healthcare (PHC) in Yogyakarta. Clinicians were invited to appraise the Decardia app on September 2019. All physicians and nurses in charge in PHC were requested to use the Decardia app.

Instruments

The development of the Decardia app was based on the WHO/ISH risk prediction chart. To conduct the usability testing, researchers used system usability scale (SUS).

The risk level of cardiovascular incidents were identified then classified on the basis of the WHO/ISH risk prediction chart. It is commonly and widely used instrument in assessing the fatality or non-fatality of cardiovascular event (heart and stroke attack) in the next 10 years. Risk prediction level is based on age, gender, SBP, smoking status, non-fasting blood cholesterol, and presence/absence of diabetes^{6,7}.

The WHO/ISH risk prediction chart is available in 14 epidemiological sub regions with and without blood cholesterol data and with and without diabetes^{6,7,8}. The WHO/ISH risk prediction chart Southeast Asian Region (SEAR) B is used in Indonesia^{7,8}. The instrument can modestly grade the cardiovascular risk level among the high-risk population. The instrument is also recommended when assessing the risk level in PHC or hospitals. The chart uses five colors for four risk stratifications; green for low (< 10%), yellow for moderate (10%–19%), orange for high (20%–29%), and red/dark red for very high-risk (\geq 30%). To develop the Decardia app, the researchers used the SEAR B chart for diabetic people with cholesterol data^{6,8}.

SUS was employed to identify subjective testing for product usability. SUS is expansively used to test various systems and apps in a relatively short time, including software, hardware, websites, and mobile platforms. SUS is a simple tool that consists of 10 questions, with a five-point response scale: strongly disagree (0) to strongly agree (4). To compute the scores, items 1, 3, 5, 7, and 9 should be minus 1, whereas the rest items

must be 5 minus the item score. Summing up the 10 item scores and multiplying them by 2.5 generated the total score. SUS has ranging scores 0-100, and 68 is perceived as the average score⁹⁻¹¹.

The SUS scores are also translatable to letter grades which are helpful for presentation and communication^{9,10,12}. Bangor et al.¹³ and Brooke¹¹ suggested converting SUS scores into adjective rates (good, poor, etc.) and acceptability ranges.

Mobile App Development

Decardia was developed using Android platform, considering the major smartphone users in Indonesia¹⁴. Supporting software for Android, namely, Java Development Kit, Android software development kit, and Integrated Development Environment (IDE), were first installed. Android Studio was selected as IDE it has complete features. Mind mapping was then made to determine the Decardia app specification and workflow. Considering the evidence, four steps of the app workflow were generated: a) data entry, b) conversion and processing, c) risk level identification (output), and d) education (Figure 1).

The Decardia app workflow starts by inputting patients' data (age, cholesterol level, SBP, gender, and smoking status) into the app. Patients' data can determine specific cardiovascular risk levels by processing an algorithm as the guideline from the WHO/ISH risk prediction chart^{6,7,8}. In a short time, the outcome of processing phase can show the cardiovascular risk level. Four grades (low, moderate, high, and very high-risk) indicate risk levels according to the guideline. Based on users' risk level, they are guided to the education windows, which provide information on recommended actions to reduce their risk level and prevent cardiovascular occurrence.

The development process of the Decardia app consists of four phases: interface designing, coding, debugging, and pilot testing. An interface user was designed for the Decardia app features, such as cover display, dashboard, input slots, risk classification level, and education windows by using Adobe experience design. For simplification, diabetes users only entered their age, cholesterol level, and SBP. Gender and smoking status were available as optional icons. Thus, users could

directly choose an icon as their condition. Researchers then built program coding by using Android Studio to assure the algorithm for determining the cardiovascular risk level through the WHO/ISH risk prediction chart. Debugging was performed to check whether errors or bugs existed. If so, then the coding process was repeated until the problems/errors disappeared. The researchers checked and tried the Decardia app for pilot testing.

Ethical Concern

The UGM ethical committee granted ethical approval. Clinicians received material for testing, including trial of the Decardia app, and signed a consent form for participation. Only research team could access data.

Clinical Evaluation and Testing

Usability testing was performed among clinicians in PHC. This test was a validation phase to explore their evaluation on the Decardia app. Researchers requested permission from the local government and PHC for data collection. Clinicians were approached during working hours by previous appointments. The research team introduced the Decardia app and allowed clinicians to operate it. Clinicians received research project description and were asked for their voluntary participation. Only those who agreed signed the form and continued data collection. All the participants needed to complete SUS regarding their immediate response to the Decardia app.

Data Analysis

The analysis focused on the presentation of pilot study outcomes. The average SUS score, grading letter, acceptability range, and adjective rating were presented. To gain further information for the overall score and each score, data were described using the radar chart using excel spreadsheet.

Results

The Decardia Outlook and Mode

The Decardia app cover displays a heart and a start button. It shows the risk prediction level of cardiovascular event among diabetic people. The main features of the Decardia app are icon categories (gender- and smoking-based), input slots (age, cholesterol, and SBP), risk classification, and education windows (Figure 2).

The Decardia app is also available in offline mode. To use this app, users must download and install it from Google Play (<https://play.google.com/store/app/details?id=com.app.decardia>) by using a smartphone (minimum series 4.0.3 or above). Users should then open the app, select a category, input current data, and press the “count risk” button to obtain the risk level of cardiovascular event within the next 10 years. Last, the education windows show recommendations for users.

The Decardia App Features

The Decardia app features focus on the risk level prediction of cardiovascular event. This app also provides education windows for diabetes people. It empowers patients to reduce and maintain their risk level. The app is also applicable for HCW in assessing the risk level of cardiovascular event and educating diabetes people.

Pilot Study of Usability Testing

The usability testing was conducted among clinicians for a month. Twenty clinicians were recruited

from PHC. The average score is 87, indicating an “excellent” adjective rating and an acceptable outcome. For the grading scale, the score of 87 is equal to grade B (Figure 3)^{11,13}. Sauro and Lewis recently presented the new grading scale on the basis of the dataset percentile and made another detail option of grading scale^{9,10,12}. Using this standard, the pilot study outcome indicated grade A+ (84.1–100). Among all participants, most respondents indicated acceptable (95%) and excellent (60%), supporting the overall score of the perceived usability of the Decardia app (Table 1).

A detailed score of the subjective usability testing was indicated for each component. The original score close to number 4 showed the highest score among all components. The detailed score of the Decardia app is available in the radar chart (Figure 4). Among all components, the highest and lowest score were convenient (3.95 of 4) and well integrated (3 of 4), respectively.

Table 1 Distribution of the Decardia app scores (n=20)

Acceptability range			Adjective rating		
Category	n	%	Category	n	%
Unacceptable (0–50)	0	0	OK (52–72)	1	5
Marginal (51–70)	1	5	Good (73–84)	7	35
Acceptable (71–100)	19	95	Excellent (85–99)	12	60

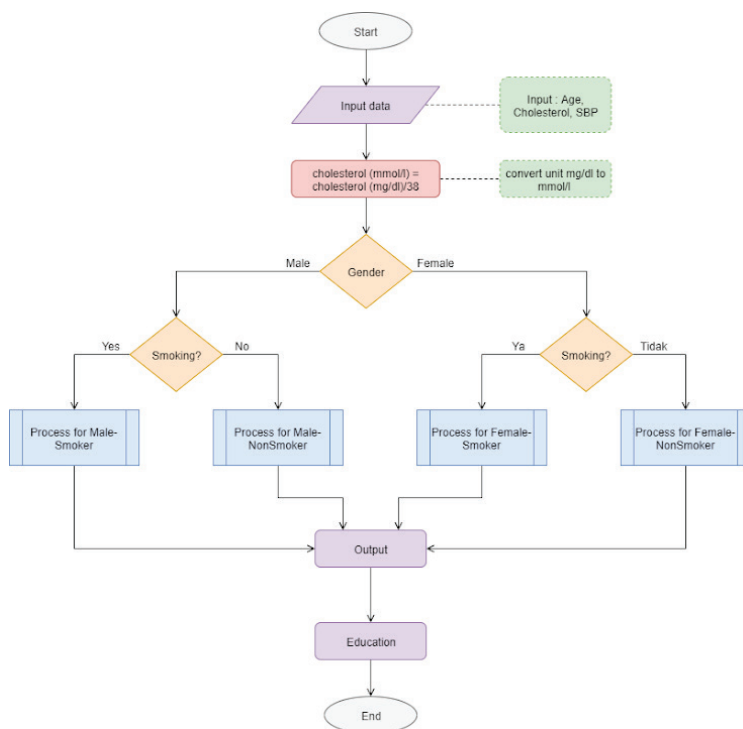


Figure 1. The Decardia app workflow.

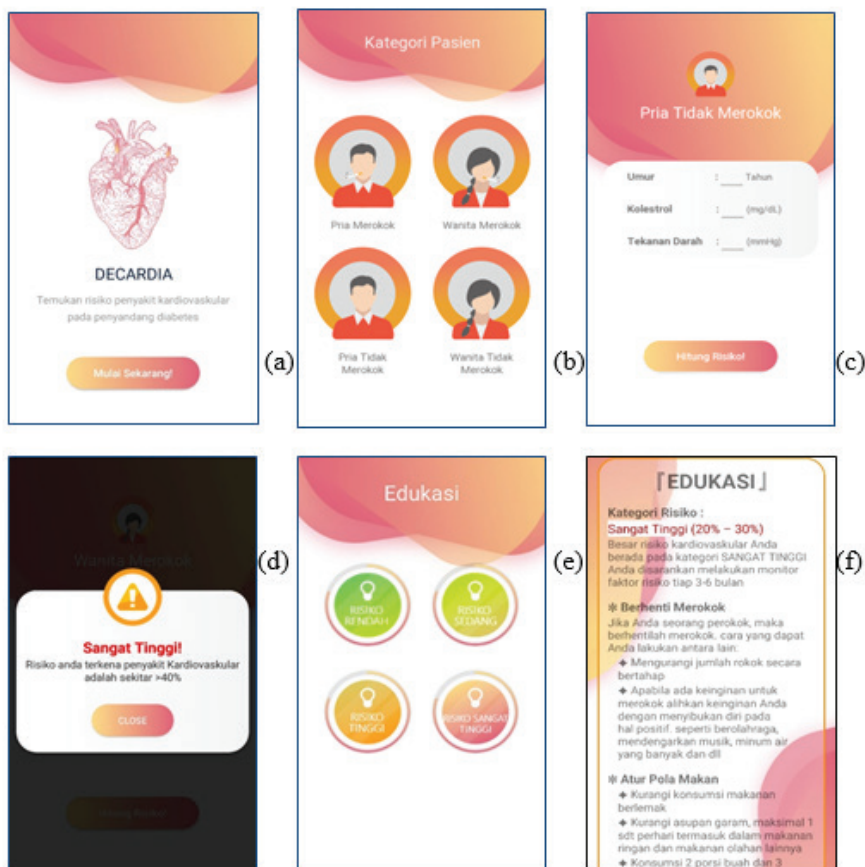


Figure 2. Display design of the Decardia app (Indonesian), (a) cover display, (b) dashboard of icon category, (c) input slots, (d) risk classification outcome, (e) education windows option, (f) education windows.

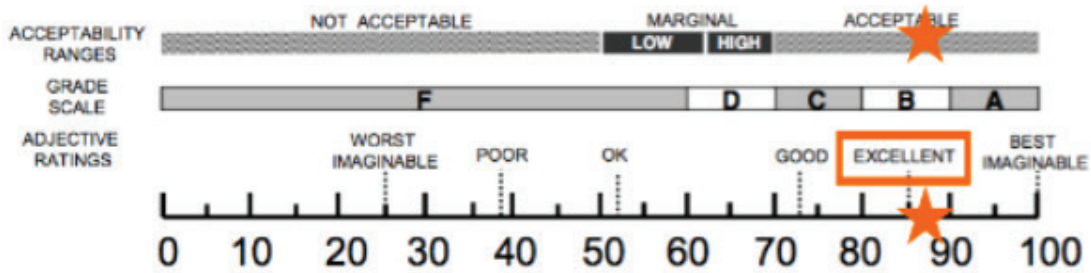


Figure 3. The Decardia app outcome.

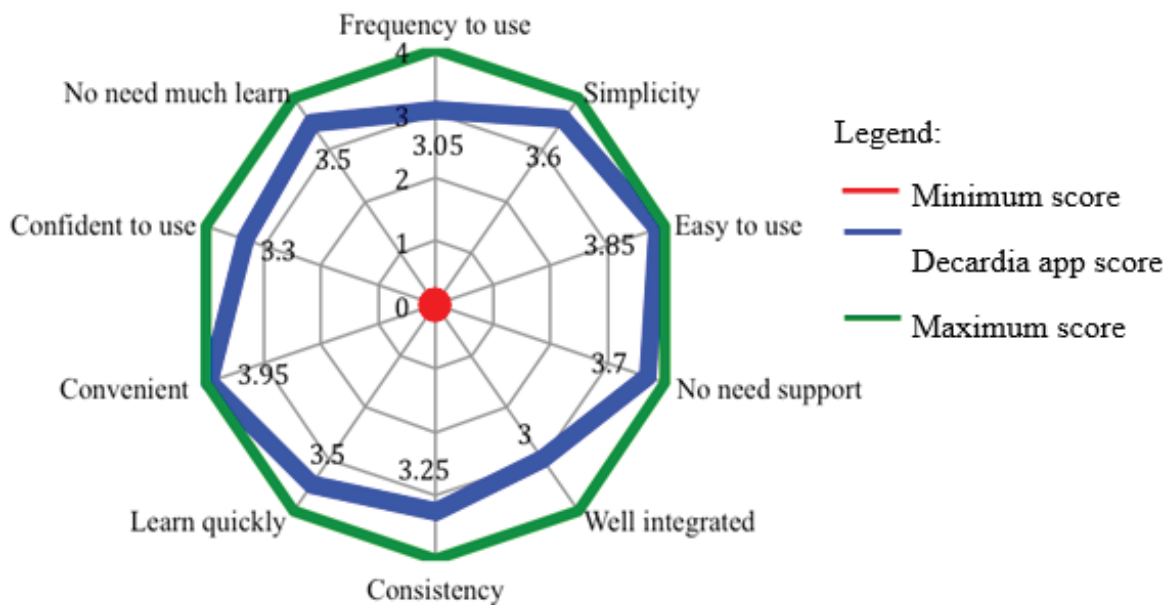


Figure 4. Radar chart of the Decardia app.

Discussion

The Decardia app is available in the Android platform. The app focuses on risk identification and education for engaging diabetic people to reduce their risk. Clinicians’ subjective usability indicated positive outcomes (acceptable, excellent, and grade A+). They were satisfied with the Decardia app. The development and pilot study invited clinicians as app users. Such an invitation is a part of a design-based research approach that concerns user involvement during the developing phase¹⁵. Clinicians were involved to understand their agreement, engagement, and perception. Such an involvement is also an appropriate approach to introduce

the Decardia app among the prospected users¹⁶.

User perception on the Decardia app was also explained in the usability testing in the pilot study. The overall score indicated positive and good outcomes where the score of 87 showed an acceptable outcome (70–100) for acceptability range and an excellent indicator (80–90) for adjective rating. Clinicians’ appraisal on how the Decardia app works as a relatively new system was also confirmed^{9,11–13}. Interestingly, the grading letter labels had points B and A+ for the same score. Both grading scales depended on the custom standard. Bangor et al.¹³ and Brooke¹¹ preferred grade B for the scoring range between 80 and 90. The standard was defined as

the general school grade with the average of 70, which indicates a passing grade. By contrast, Sauro and Lewis presented a different grading scale^{9,10,12}. They graded scores by using the SUS percentile with an average score of 68 and provided further detailed labels (Table 1). Therefore, the outcome was grade A+ (84.1–100). Both grading systems have their own reason, but researchers agreed to apply Sauro and Lewis' grading scale because it is realistic, detailed, and easy to communicate among stakeholders^{9,10,12}.

The Decardia app is established to assist risk identification and educate risk reduction behavior. The app can be developed for other platforms and without cholesterol data. The Decardia app is only doable in the Android platform. Diabetes people and educators must consider Android phones to use the Decardia app. The risk prediction chart from WHO/ISH is also available without cholesterol data⁶. The Decardia app only provides risk assessment by utilizing cholesterol data. The app systems also need improvement for “data saving” features, which thus become comparable and recordable.

Conclusions

The Decardia app is available in Google Play. The app has four steps of workflow: data entry, conversion and process, risk level identification, and education. Decardia app primarily suggests diabetic people to evaluate their risk level of cardiovascular event and empowers them for risk reduction. The app is compact, accurate, efficient, has education windows, and is available in offline mode. However, Decardia app cannot store data, is only Android-based, and only manually inputs data. The pilot study revealed satisfactory outcomes (87 of 100) and indicated excellent, acceptable, and grade A+ results. Moreover, all components obtained scores ranging between 3 and 3.95, indicating positive outcomes. The Decardia app helps people with diabetes and health care providers in assessing their cardiovascular risk level and educating them about risk reduction behavior.

Conflicting of Interest: None

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