Key Potentials of mHealth for Community-Based Early Detection of Cardiovascular Disease During the COVID-19 Pandemic

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Abstract

Background

The epidemiological transition from infectious to non-communicable disease (NCD) is characterized by an increasing incidence of cardiovascular disease (CVD). The Coronavirus Disease 2019 (COVID-19) pandemic has led to a significant decline in NCD screening and treatment activities in health centers. This study aims to revive and expand the coverage of NCD control programs, from the elderly to productive age groups, through the use of mHealth for the early detection of CVD, which is also provides health promotion media that is easily accessible.

Methods

This research is an operational study to develop a community-based early detection mechanism for CVD using mHealth during the COVID-19 pandemic in the Babakan Madang sub-district, Bogor district.

Results

The use of the mHealth application supported by community participation is proven to be able to reach the productive age population significantly (87.1%) in the Babakan Madang sub-district. The mHealth application simplifies CVD risk predictions so that it can be used by the public during the COVID-19 pandemic.

Conclusion

This application is also very well accepted by the community and is able to provide personalized health promotions.

1 Introduction

The epidemiological transition from infectious to non-communicable disease (NCD) has been characterized primarily by increased mortality from cardiovascular disease (CVD). CVD is currently one of the leading causes of death, accounting for about one-third of all deaths worldwide, four-fifths of which occur in developing countries (1). In Indonesia, the main cause of morbidity and mortality is CVD; it is responsible for one-third of all deaths (2). Some of the main risk factors for CVD are metabolic factors associated with hypertension, diabetes mellitus, and hypercholesterolemia. In 2018, the Indonesian Basic Health Research showed that the proportion of the most common diseases was hypertension at 63.5%, diabetes mellitus at 5.7%, heart disease at 4.5%, and stroke at 4.4% (3). The Indonesian Basic Health Research (2007, 2013, and 2018) has reported an increasing trend in the prevalence of hypertension, diabetes mellitus, and stroke in Indonesia (4). Observing the development of the CVD problem in

Indonesia, which the COVID-19 pandemic has exacerbated, it is necessary to prepare more responsive public health efforts to control CVD.

The most effective management of CVD is focused on screening and early detection of preventable risk factors. The availability of quality data related to CVD risk factors will contribute to the prevention and determination of appropriate treatment from an early stage. Studies have shown that preventing disease and death from CVD will not be effective without population-based risk factor investigations and strengthening public awareness about CVD prevention (5–7). The data regarding the distribution of CVD risk factors in the community is currently insufficient to be used to determine the appropriate intervention. Therefore, a community-based early detection mechanism for CVD risk factors needs to be developed to strengthen the disease control program.

Addressing this problem, the Government of Indonesia has actually implemented a community-based control program under the health center at the sub-district level. The main target of the program so far is the elderly. However, this program was underutilized. It was marked by low coverage, and since the Coronavirus Disease 2019 (COVID-19) outbreak, this NCD control activity has almost stopped. The research at Muara Bungo Health Center showed that the NCD control program's coverage was very low, namely 5.7%, far from the national target that had been set at 100% (8). The COVID-19 pandemic state has led to a significant decline in NCD screening and treatment (9). Thus, the research question is, how can NCD control activities be reactivated so that early detection in the community during the COVID-19 pandemic can be conducted properly?

This research seeks to develop an early detection mechanism supported by information technology in the form of mobile devices, which can be implemented independently by the productive age to the elderly population. The risk factors self-assessment mechanism, where there is no laboratory examination or physical measurement, is expected to be a good solution to predict CVD in the community (10). The novelty of this research is that it provides self-detection mechanisms and tools that are easily accessible to the public, especially during a pandemic and even after the pandemic is over.

This study has three aims. First, it intends to reactivate and expand the coverage of NCD control from the productive age group to the elderly. Second, it will provide early detection tools for CVD in the form of mHealth, and third, it will offer health promotion media that can be accessed personally on mHealth.

2 Methods

This research is an operational study that consists of the following four steps:

2.1 Building a Community-Based Participatory Program

At this stage, voluntary-based health workers (known as cadres in Indonesia) have been prepared to reach out and encourage community members' active participation in the early detection of CVD.

The cadres were recruited by the NCD program manager at the health center. In the Babakan Madang sub-district, 18 cadres were recruited to work in nine villages (two cadres cover each village). This research has provided training to selected cadres on the tasks that must be conducted. The researchers have prepared a WhatsApp Group (WAG) for each village as a means of communication and weekly monitoring. Researchers, NCD program managers, and cadres hold regular online meetings to monitor the progress of implementing early detection in the community.

2.2 Using mHealth as an Early Detection Tool

Selected respondents independently conducted the early detection of CVD by filling out an online form using the mHealth application. Respondents were selected by cadres with the criteria of residents aged 15 years and over, who resided in the Babakan Madang sub-district, had a cellphone equipped with WhatsApp, and were willing to fill out a self-assessment form. The mHealth application was previously developed using the Kobo toolbox platform to provide an online self-assessment form, where questions were adopted and modified from the WHO Stepwise Instrument (11).

2.3 Cardiovascular Disease Risk Assessment

The CVD risk assessment was performed by calculating a risk index based on behavioral indicators using the simple risk score (EZ-CVD) (10). The risk index is calculated automatically in the mHealth application based on the weighted results of the risk factor indicators according to the respondent's answer. The results of this risk index calculation are categorized into high risk (score $\geq$ 20%) and low risk (score $<$ 20%). The risk index can be read directly by respondents via mHealth. The risk assessment data were then analyzed descriptively to assess mHealth's ability to detect risk factors for CVD in the community.

2.4 Evaluation of Community-Based Early Detection of CVD

The evaluation is conducted qualitatively using several techniques: (1) focus group discussion when the implementation of the activity is still ongoing in November 2020 and at the end of the research in December 2020, (2) weekly reports by cadres on achievements and obstacles during implementation submitted through the WAG, and (3) reports from respondents regarding their responses to the use of the application, which are submitted through mHealth.

3 Results

The results obtained are presented based on the research steps that have been implemented as follows:

3.1 Building a Community-Based Participatory Program

The main result of this activity is the establishment of a community-based participatory program that ensures the functioning of cadres to reach out to community members. The health center has selected 18 cadres spread across nine villages, whose task is to reach and encourage community members to use the mHealth application. The process has been performed with intensive coordination between the researchers, the Bogor District Health Office, and all health centers in the Babakan Madang sub-district.

All selected cadres were given explanations and training for two days on the concept and work plan of research, how to use mHealth, and the use of social media to reach community members.

At this stage, a communication network has been built in which a WAG is prepared for each village consisting of two cadres and the researchers. The WAG functions as a medium for coordination, supervision, and communication between cadres and researchers. To ensure the quality of research activities, monitoring was conducted once a month. For the mHealth application to be properly accessed by the public during the COVID-19 pandemic, an active role of cadres is needed to explain and constantly encourage community members to use the mHealth application through communication using WhatsApp.

3.2 Using mHealth as an Early Detection Tool

The results illustrate that the mHealth application is suitable for use by the community as an early detection tool for CVD during the COVID-19 pandemic. Out of the 829 respondents contacted by the cadres via WhatsApp messages, their response rate to using the mHealth application was relatively high, with an average of 53% (442 respondents) (see Fig. 1). Out of the nine villages, six had high response rates, ranging from 61–71%. Only three villages had low response rates below 50%.

The reasons for those who did not use the mHealth application, among others, admitted that it was difficult to use, they could not access the Internet, or they did not understand the contents of the self-assessment form questions.

3.3 Cardiovascular Disease Risk Assessment

This study found that mHealth has been able to show respondents' risk predictions for suffering from CVD in the next 10 years. Overall, mHealth can detect that around 78.7% of respondents are at low risk (with a score of < 20%) and approximately 21.3% of respondents are at high risk (with a score of ≥ 20%) of experiencing CVD (Table 1). The indicators used to predict the CVD risk index are age and gender. Based on the results of calculating the risk index using the mHealth application, it is known that the average age of respondents who have high risk is 36 years (age range 25 to 44 years). Men have a higher risk of developing CVD than women.

Table 1
Characteristics of Respondents Using the mHealth Application Based on the CVD Risk Index in the Babakan Madang Sub-District

Characteristics of Respondent	Overall (n = 442)	Predicted 10-years CVD Risk	
		Low Risk (< 20%) (n = 348)	High Risk (≥ 20%) (n = 94)
Age, mean (IQR)	32 (24–40)	31 (23–38)	38 (25–44)
Age (years), n (%)*	120 (27.1)	100 (83.3)	20 (16.7)
15–24	132 (29.9)	112 (84.8)	20 (15.2)
25–34	133 (30.1)	101 (75.9)	32 (24.1)
35–44	45 (10.2)	29 (64.4)	16 (35.6)
45–54	12 (2.7)	6 (50.0)	6 (50.0)
55–63			
Sex, n (%)*	112 (25.3)	39 (34.8)	73 (65.2)
Male	330 (74.7)	309 (93.6)	21 (6.4)
Female			
Level of Education, n (%)	5 (1.1)	4 (80)	1 (20)
Never Attended School	15 (3.4)	14 (93.3)	1 (6.7)
Not-completed in Primary	88 (19.9)	72(81.8)	16 (18.2)
Primary School	105 (23.8)	87 (82.9)	18 (17.1)
Junior High School	184 (41.6)	138 (75.0)	46 (25)
Senior High School	45 (10.2)	33 (73.3)	12 (26.7)
Tertiary (University)			

* CVD Risk Index Calculation Indicator

Characteristics of Respondent	Overall (n = 442)	Predicted 10-years CVD Risk	
		Low Risk (< 20%) (n = 348)	High Risk (≥ 20%) (n = 94)
Profession, n (%)	184 (41.6)	169 (91.8)	15 (8.2)
Unemployed	31 (7.0)	28 (90.3)	3 (9.7)
Student	9 (2)	5 (55.6)	4 (44.4)
Civil Servant	4 (0.9)	2 (50)	2 (50)
Farmer	66 (14.9)	36 (54.5)	30 (45.5)
Laborer	58 (13.1)	37(63.8)	21 (36.2)
Entrepreneur	90 (20.3)	71 (78.9)	19 (21.1)
Others			
* CVD Risk Index Calculation Indicator			

The mHealth application is equipped with a feature that can calculate a risk index. The indicators used to calculate the risk index are smoking behavior, alcohol consumption, history of diabetes, history of hypertension, and history of heart attack in the family. Based on the results of the risk index assessment, it is known that a small proportion of respondents are smokers, namely, 71 respondents (16.1%), and 90% of them are high risk (Table 2). All respondents who have a history of diabetes mellitus are predicted to have a high risk of suffering from CVD in the next 10 years.

Table 2
Distribution of Respondents' Risk Factors Using the mHealth Application Based on the CVD Risk Index in the Babakan Madang Sub-District

Risk Factors, n (%)	Overall (n = 442)	Predicted 10-years CVD Risk	
		Low Risk (< 20%) (n = 348)	High Risk (≥ 20%) (n = 94)
Smoking*	335 (75.8)	331 (93.4)	22 (6.6)
Never	36 (8.1)	28 (77.8)	8 (22.2)
Former	71 (16.1)	7 (9.9)	64 (90.1)
Current			
Alcohol	419 (94.8)	343 (81.9)	76 (18.1)
Never	12 (2.7)	4 (33.3)	8 (66.7)
Former	11 (2.5)	1 (9.1%)	10 (90.9)
Current			
Physical Activity	61 (13.8)	119 (77.8)	34 (22.2)
Seldom/Rare	228 (51.6)	177 (77.6)	51 (22.4)
Sometimes	153 (34.6)	52 (85.2)	9 (14.8)
Often/Very often			
Dietary Fruits and Vegetables	300 (67.9)	235 (78.3)	65 (21.7)
1–2 Servings/day	142 (32.1)	113 (79.6)	29 (20.4)
> 2–3 Servings/day			
History of Diabetes Mellitus*	21 (4.8)	0 (0)	21 (100)
Yes	421 (95.2)	348 (82.7)	73 (17.3)
No			
History of Hypertension*	62 (14.0)	39 (62.9)	23 (37.1)
Yes	380 (86.0)	309 (81.3)	71 (18.7)
No			

* CVD Risk Index Calculation Indicator

Risk Factors, n (%)	Overall	Predicted 10-years CVD Risk	
	(n = 442)	Low Risk (< 20%) (n = 348)	High Risk (≥ 20%) (n = 94)
Family History of Premature Myocardial infarction (MI)*	34 (7.7)	17 (50)	17 (50)
Yes	408 (92.3)	331 (81.1)	77 (18.9)
No			
* CVD Risk Index Calculation Indicator			

3.4 User Response of the mHealth Application in the Community (Qualitative Analysis)

Of the total of 82 users of the mHealth application, 47 respondents (70%) gave positive responses. As many as 18 respondents (22%) reported that the mHealth application was useful and informative, while 39 (48%) of them showed positive appreciation for the application. Besides functioning as early detection, mHealth can also provide health promotion messages regarding NCD prevention. In this regard, respondents acknowledged that the mHealth application was useful, informative, and well accepted (Table 3).

Of the total participants who gave responses, 25% gave critical responses indicating that the questions were difficult to understand (7%) or that they were too numerous and wordy (18%). The rest, a small proportion of respondents (4%), gave suggestions for improvements to the mHealth application in the future.

Table 3
Qualitative Review

Selected Themes (N = 82)	n	%	Representative Quotations
Positive Sentiment Increased awareness and informative	18	22%	By filling in this form, I have more knowledge. Very useful. Very good and helps for a healthy lifestyle. I want to live a healthy life.
Barriers Hard to understand the questions	6	7%	The question is difficult to understand. The question needs to be simplified.
Suggestions Not agree with online mechanism	1	1%	Actually, through this online filling, (I) don't agree because some don't have a cellphone.

4 Discussion

4.1 **The extent to which early detection of CVD can be applied starting from productive age to the elderly in the COVID-19 pandemic situation**

To date, the NCD control program at the health center is a public service aimed at the elderly and has not been able to reach the productive age group, considering that this group is still active and has high mobility (8, 12). Research conducted by Subhah et al. (2019) showed that the participation of the productive age population (15–45 years) in NCD prevention was only 45.38%. However, prevention at an early age, namely in young adults, will be more efficient than the cost of treatment for the elderly (13).

The use of the mHealth application, which is supported by community-based participatory programs, is proven to be able to reach a high proportion (87.1%) of the productive age population. Through previous research, this study can be further developed because of the support system that has been established in the form of a community-based health information system, which is supported by community empowerment and the use of mHealth (14). Community empowerment appears to be an essential factor in the successful use of mHealth for early detection (15–18).

The COVID-19 pandemic condition, which limits mobility, has motivated this research to build online communication via WhatsApp, starting from researchers, cadres, to community members, who are then encouraged to carry out self-assessments using mHealth. Henry et al.'s (19) research stated that WhatsApp is a form of innovation that can support community-based communication during an emergency outbreak.

4.2. The extent to which the features in the mHealth application can perform early detection of CVD

The risk index analysis in the mHealth application refers to the EZ-CVD risk score, which consists of six risk predictor items. It has several advantages compared to the recommended guidelines for the risk score for Atherosclerotic Cardiovascular Disease (ASCVD) (20). By referring to the EZ-CVD risk score, this mHealth application develops a self-assessment and does not require laboratory testing as early detection to predict CVD risk. Furthermore, Mansoor et al. (2019) argued that the inability to access comprehensive examinations is a major limitation that has the potential to result in many patients being missed for CVD risk assessment and receiving recommendations for preventive therapy. A similar study conducted at LMIC showed a slightly higher risk prediction value using a Community Health Workers-based (CHW-based) model for CVD screening (see Fig. 2) (21). The results of the analysis of the risk score on the mHealth application meanwhile show a proportion of CVD risk that is more or less comparable to the results of EZ-CVD and ASCVD (see Fig. 2) (10, 21). Even the mHealth figures for which no laboratory tests were done had a proportional level close to that of ASCVD, which has a high sensitivity for identifying future CVD occurrence of around 80%, with a fairly high specificity (69%) and a positive predictive value (17%) (23). These findings indicate that at least the mHealth application can be used easily by community members to provide CVD risk predictions. In the future, of course, it is necessary to undertake further research to show the extent of the sensitivity and specificity of this application as a tool for the early detection of CVD.

4.3 The extent to which the mHealth application can serve as a source for health promotion

This study obtained feedback from 82 respondents. It was found that 70% of them acknowledged that the mHealth application was useful in providing health promotion suitable for their individual needs. The mHealth applications can be classified into two categories: applications designed for disease management and applications that can support changes in the user's health behavior (24). Currently, the mHealth application is increasingly being used as a tool to promote changes in user behavior to prevent NCDs (25). Besides being designed to detect CVD risk, the mHealth application is also designed to provide information on health conditions and follow-up recommendations for CVD prevention and control for its users. Research conducted by Handayani et al. (26) showed the factors that determine the successful use of the mHealth application in Indonesia, one of which is the availability of relevant information according to user needs. It seems that the features in the mHealth application are proven to be acceptable to users, especially its ability to provide personal information that is given directly to each user.

Limitations

The study population was the community of the Babakan Madang sub-district, who were selected purposively by cadres. Hence, the results of this study could not be generalized to other community groups. Furthermore, several potential CVD risk factors requiring physical and laboratory examinations were not included in this study. We rely on self-assessment results for behavioral risk factors reported by respondents via the mHealth application. This can lead to misclassification of the diagnosis in some

individuals who may have an undiagnosed condition. However, this mHealth application is used as an early detection method to identify individuals who require preventive therapy and follow-up recommendations according to the CVD risk calculation in the next 10 years.

Conclusions

The implementation of mHealth that is supported by community-based participatory programs is able to reach the productive age group of 15–45 years, compared to the existing CVD control program that is only able to reach the elderly group (over 45 years). The mHealth application developed in this study is equipped with a CVD risk calculation that can make predictions with a proportion of the risk index comparable to ASCVD, which has high sensitivity and specificity compared to other detection tools. In fact, the mHealth application is proven to be able to simplify CVD risk assessment without using a laboratory, so that people can undertake risk self-assessments even though they have to stay at home because of the COVID-19 outbreak. In addition, mHealth is equipped with a health promotion feature of providing information and follow-up recommendations for users according to their CVD risk index.

Abbreviations

ASCVD	Atherosclerotic Cardiovascular Disease
COVID-19	Coronavirus Disease 2019
CVD	Cardiovascular Disease
EZ-CVD	A Simple Risk Score for CVD
mHealth	Mobile Health
MI	Myocardial infarction
NCD	Non-Communicable Disease
WAG	WhatsApp Group

Declarations

Ethical Clearence and Consent Participate

This research has obtained ethical permission from the ethics commission in the Public Health Faculty Universitas Indonesia register number 538/UN2.F10.D11/PPM.00.02/2020.

The authors confirm that all methods were carried out in accordance with relevant guidelines and regulations.

Informed consent to participate was obtained from all participants and parents of participants and for the participants under 18 years of age, online informed consent was obtained from their parents.

Consent for publication

Not applicable.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding this article or research.

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Authors' contributions

The study was designed by KNS, RK, and RJ. The fieldwork and data collection were supervised by KNS, RK, RJ, DZ, LH, and RY. The analysis was performed by RJ, DZ, YH, and RT, with input and guidance from KNS, and RK. The first draft of the paper was written by KNS, RK and RJ, and all authors reviewed various versions. The authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

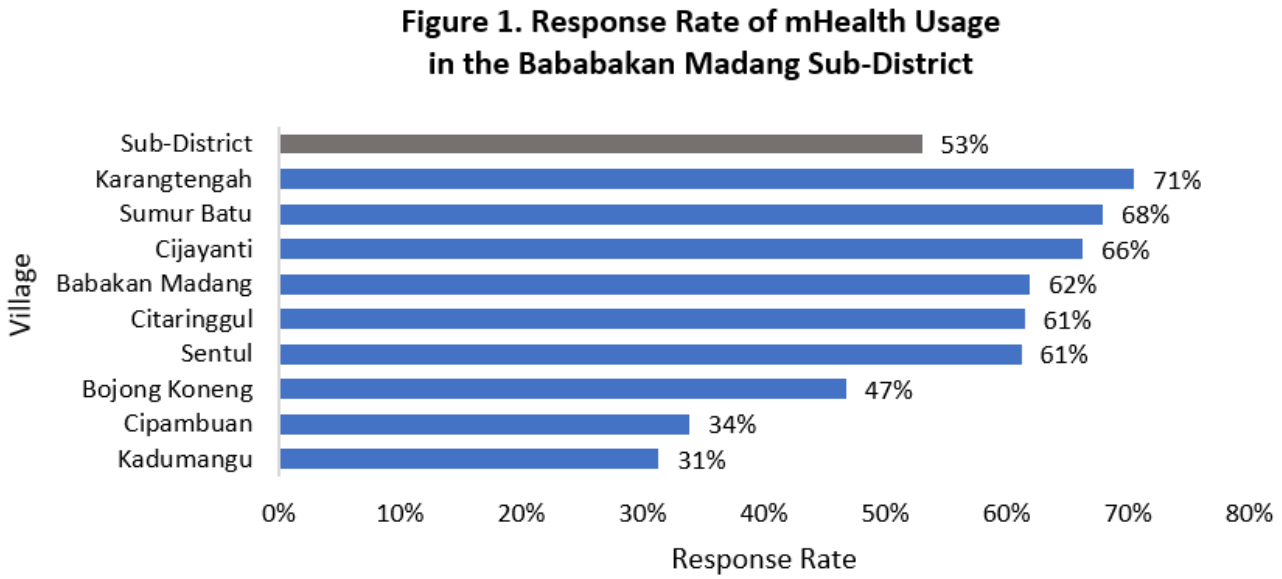

Figure 1

Response Rate of mHealth Usage in the Bababakan Madang Sub-District

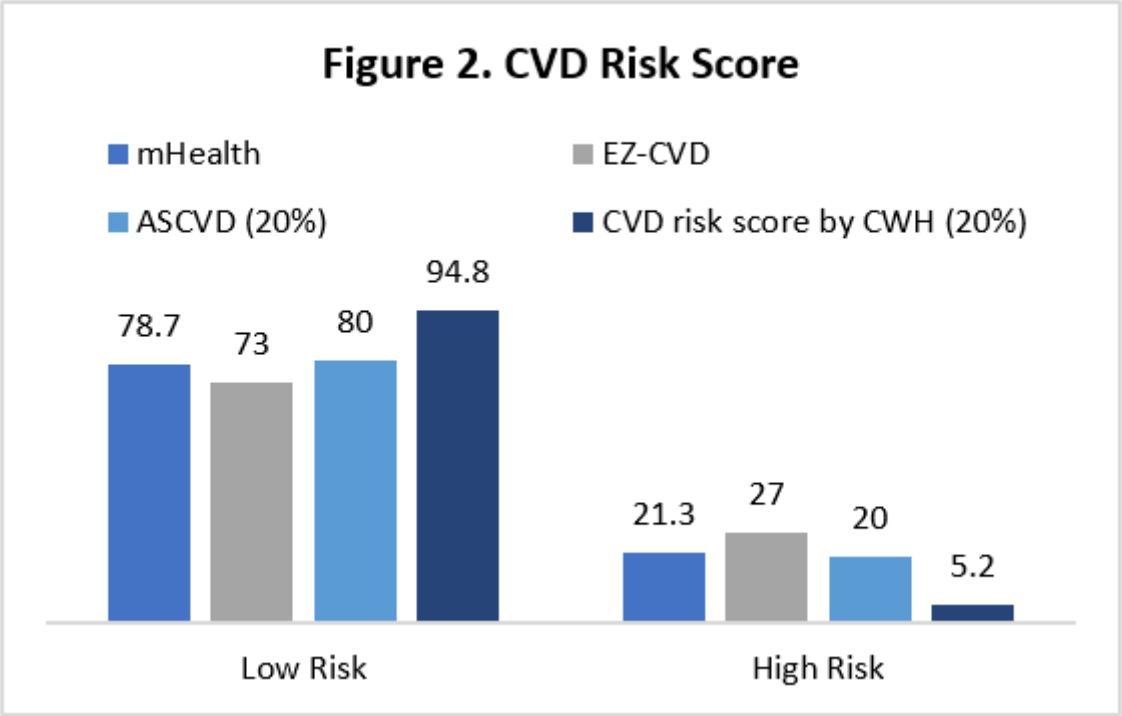

Figure 2

CVD Risk Score