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Original Article

Comparison of a New Noninvasive Jos CVD Risk App and ASCVD Estimator Plus App for Prediction of Atherosclerotic Cardiovascular Disease (ASCVD) Risk in Sub-Saharan African Adult Populations

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Abstract

Background and objectives: Various risk engines exist for predicting future cardiovascular disease. We developed a noninvasive cardiovascular disease risk app which appeared to work well for us without need for invasive tests. This is an attempt to compare its predictive accuracy with an already existing widely used risk engine.

Methods: We used data partly generated in our earlier study on resistant hypertension. Between May and October 2021, those who were still attending care had abdominal height, blood pressure, weight, and height measured. Body surface index was derived from height and weight. Information on sex, family history of cardiovascular disease, alcohol use, physical inactivity, smoking, and diabetes history, total, and high-density lipoprotein cholesterol was extracted from the records. Data as appropriate were imputed into our new app and the atherosclerotic cardiovascular disease risk estimator app of the American Heart Association. The results were compared.

Results: Fifty-two patients with complete data were studied. Both methods strongly correlated positively ($R = 0.805$, $p = 0.000$), showing equivalence. Risk levels determined by both methods agreed on high cardiovascular disease risk in 21(40.30%) and intermediate risk in 22 (42.31%) patients. Four patients were classified as high risk and as medium risk by the established American Heart Association app. Five were at intermediate risk with our app and at low risk with the American Heart Association app.

Conclusions: In 43 cases (82.69%), both tools agreed on cardiovascular disease risk prediction. In nine there was a tendency for the American Heart Association app to put patients in a lower risk category. This tends to delay the initiation of appropriate preventive or curative measures. Given the total dependence on anthropometric and historical indices, it is felt that our new method is cheaper and should be more widely deployed in preventive cardiology.

Keywords: Abdominal height; Body surface index; Risk engine; Accuracy; Comparison.

Abbreviations: AH, abdominal height; ASCVD, atherosclerotic cardiovascular disease; BSI, body surface index; CVD, cardiovascular disease; F, female; M, male.

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Introduction

It has been identified that continuous updates to primary prevention guidelines of cardiovascular disease (CVD) have resulted in better risk factor control.[1] This in turn has significantly contributed to the reduction in mortality rates of atherosclerotic (AS) CVD leading to stroke in the USA alone by 33.7% during the period 2003 to 2013.[2] However, despite this highly impressive reduction in CVD mortality rates in recent decades, ASCVD still remains the major preventable cause of mortality and morbidity in developed and developing countries including sub-Saharan Africa.[3] The

European guidelines on CVD prevention recommended using a probabilistic tool that includes traditional CVD risk factors such as family history of cardiac diseases, smoking status, physical inactivity, and alcohol use.[4] This is because lifestyle modifications can greatly contribute to the reduction of CVD risk levels in both cardiac as well as noncardiac patients.[5] Other risk factors such as age, sex, obesity level as well as systolic and diastolic blood pressure can be used to determine individual ASCVD risk levels.[6] Identifying ASCVD at an early-stage subclinical level is therefore very helpful in clinical practice either for preventive or therapeutic intervention.[7] However, in epidemiological studies, it is very cumbersome to transport ultrasound systems with portable generators to examine the carotid arteries of people, especially in rural areas where the electricity supply is not readily available or unreliable in most of the sub-Saharan African countries. Therefore, there is a need to address this issue to find a suitable and clinically acceptable solution so that people who are at high, moderate, and low risk of ASCVD in both urban and rural areas can be easily screened with less cost and stress in epidemiological studies.

We previously reported that two newer obesity anthropometric indices, body surface index (BSI), which is the ratio of body mass and body surface area, and abdominal height (AH) measured with an abdominometer, proved to be superior and clinically acceptable for ASCVD risk assessment in our study population compared with ultrasonically measured carotid intima-media thickness. They did better for general and central obesity respectively than the widely used Body Mass Index and Waist Circumference.[8,9] In a different research investigation of over 1,500 individuals, it was also confirmed that AH measured by the abdominometer conceptualized by one of the authors was superior to body mass index and waist-to-hip ratio in evaluating CVD risk in sub-Saharan Africa.[10,11] Also, we have reported a 10-risk factor algorithm in the form of an app in our design of an ASCVD risk screening tool called the Jos CVD risk app based on the cutoff values obtained by receiver operating characteristic curves.[12] These values are 39.5 years, 21.75 cm, 37.5 kg/m^2, 121.5 mmHg, and 73.5 mmHg for age, AH, BSI, and systolic and diastolic blood pressure, respectively.[12] Other risk factors used in our app are physical inactivity, smoking status, alcohol use, sex, and family history of CVD. Here, we excluded any invasive clinical investigations such as fasting blood glucose and total cholesterol in risk estimation normally found in other existing screening tools widely used in clinical practice. Moreover, this is the only fully noninvasive ASCVD screening tool that also applies obesity anthropometric indices in risk evaluations to the best of our knowledge.

To test the comparability of our new tool, we compared the outcomes of our newly designed Jos CVD risk app with the ASCVD risk estimator plus app of the American College of Cardiology using a consecutively recruited cohort of patients who participated in a larger study on treatment resistance in our cardiology clinic at Jos University Teaching Hospital, Jos, Nigeria.[12] This was to determine the strengths and weaknesses of our designed Jos CVD risk app among the patients.

Materials and methods

This study used data generated in the course of a previous larger cross-sectional study conducted between May 2019 and April 2020 on the prevalence and predictors of resistant hypertension among patients attending the cardiology clinic at Jos University Teaching Hospital, Jos, Plateau State, for which ethical clearance was given by the Jos University Teaching Hospital Ethics and Research Committee. This study conformed to the ethical guidelines of the Declaration of Helsinki as revised in 2013, and written informed consent was obtained from each patient before enrolment. The cardiology clinic of Jos University Teaching Hospital receives patients with cardiac diseases needing specialist care from the general outpatient clinics of the hospital and medical practitioners in Plateau State and adjoining catchment states with a joint population of about 10 million. The unit also provides clinical, electrocardiographic, echocardiographic, Holter monitoring, and ambulatory blood pressure monitoring services. The hospital is a 580-bed hospital providing clinical and research services in all aspects of medicine to cater to the training needs of undergraduate medical students, postgraduate doctors in residency, and programs allied to medicine such as pharmacy, radiography, physiotherapy, and medical laboratory science. In the primary study, hypertensives underwent a full metabolic panel that included blood glucose and a full lipid profile. On follow-up between May and October 2021, in a cross-sectional comparative fashion, those who attended were rescreened and had their AH measured as previously described.[11] They were basically hypertensives with various comorbidities in different combinations, excluding those with secondary hypertension, stroke, myocardial infarction, congestive cardiac failure, pregnancy and puerperium, chronic kidney disease needing dialysis, or acute renal failure. Fifty-two (33 women and 19 men) had complete biochemical data and were within 40 and 79 years of age required for risk evaluation using the ASCVD estimator plus app of the American College of Cardiology. This constitutes the group being reported. Patients from the larger study who were on follow-up but younger than 40 or older than 79 years of age (to satisfy the conditions for use of the ASCVD estimator plus app) and with incomplete relevant biochemical data were excluded. Figure 1 is the flow chart of enrollment/exclusion of reported cohorts. For each enrolled patient, the status of physical activity, alcohol use,

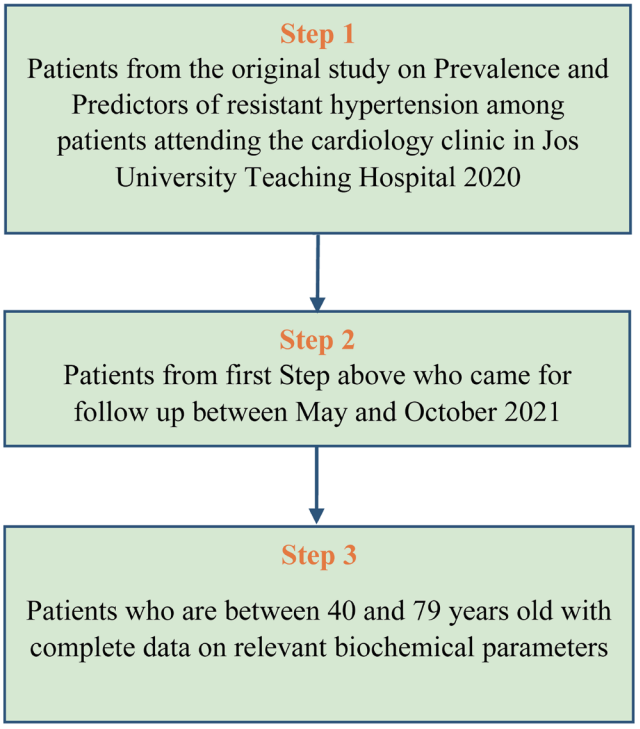

Fig. 1. Flowchart of patient selection.

Table 1. Sociodemographic profile of the study population

Variable	Frequency, *n*	Percentage
Age in years		
<45	5	9.6
45–64	35	67.3
>65	12	23.1
sex		
M	19	36.5
F	33	63.5
Weight class		
Normal	6	11.5
Overweight	19	36.5
Obese	27	51.9
Alcohol use		
Yes	6	11,5
No	46	88.5
Physical inactivity		
Yes	13	25
No	39	75
Family CVD history		
Yes	48	92.3
No	4	7.7

CVD, cardiovascular disease; F, female; M, male.

cigarette smoking, family history of CVD, and glucose and lipid results were extracted from the records and documented. On the follow-up visit, both body mass and height were measured using a stadiometer. Patients were kept in the clinic while systolic and diastolic blood pressures were measured in the standard fashion with a mercury blood pressure apparatus and appropriate sized cuff. BSI was computed using the formula given by Ferreira and Duarte.[13]

$$\text{BSI} = \frac{\text{body mass (kg)}}{\text{body surface area (m}^2\text{)}}$$

$$\text{where body surface area} = \left[\frac{\text{body mass} \times \text{height}}{3600}\right]^{\frac{1}{2}}$$

For each patient, data on AH, BSI, systolic blood pressure, diastolic blood pressure, sex, family history of cardiovascular disease, alcohol use, physical inactivity, and smoking were manually imputed into the Jos CVD risk app on a smartphone. The risk level of each of the patients was determined in three categories (high, intermediate, and low). For the same patients, data already extracted from the records were used to determine CVD risk using the ASCVD risk estimator plus app of the American College of Cardiology. Age, sex, race, total cholesterol, high-density lipoprotein cholesterol, systolic blood pressure, diastolic blood pressure, use of antihypertensives, diabetes status, and smoking status were imputed and CVD risk was determined. Data were manually collated before entering into the spreadsheet which was then electronically exported to SPSS Version 22 (IBM Corp., Armonk, NY, USA) for analysis. These two groups of data (derived from the use of the Jos CVD risk app and the ASCVD estimator plus risk app of the American College of Cardiology) were compared and also subjected to Pearson correlation using the same software.

Table 3. Comparison of risk levels determined by the Jos CVD risk app and the ASCVD risk app of 52 hypertensive patients attending the cardiology clinic in Jos University Teaching Hospital

Jos CVD app risk	ASCVD estimator plus risk	*N*	Percentage
High	High	21	40.38
Intermediate	Intermediate	22	42.31
High	Intermediate	04	07.69
Intermediate	Low	05	09.62

ASCVD, atherosclerotic cardiovascular disease; CVD, cardiovascular disease.

Results

The cohort was made up of 52 patients, 33 women, and 19 men with a mean age of 56.96 years. Table 1 shows their sociodemographic profile. The majority were middle aged, obese, and with a positive family history of cardiovascular disease. Table 2 shows the correlation between the Jos CVD risk app and the ASCVD estimator plus risk app. Both correlated significantly at $p < 0\ 01$. The implication is that either was useful in predicting cardiovascular disease risk. Table 3 shows the comparison of risk levels determined by the Jos CVD risk app and the ASCVD risk app of 52 hypertensive patients attending the cardiology clinic at Jos University Teaching Hospital. On the high risk classification, both were in agreement in 21 patients (40.38%), and for the intermediate risk classification, there was concordance in 22 patients (42.31%). Four patients (7.69%) were considered at intermediate risk by the

Table 2. Correlation between the Jos CVD risk app and the ASCVD estimator plus app risk

Risk assessment		Jos CVD app risk	ASCVD estimator plus risk
Jos CVD app	Pearson correlation	1	0.805**
	Significance (2-tailed)		0.000
	N	52	52
ASCVD estimator plus app	Pearson correlation	0.805**	1
	Significance (2-tailed)	0.000	
	N	52	52

**Correlation is significant at the 0.01 level (2-tailed) as *p*-value = 0.000. ASCVD, atherosclerotic cardiovascular disease; CVD, cardiovascular disease.

ASCVD risk estimator and at high risk by the new Jos CVD risk app. Five patients (9.62%) were considered at low risk by the former and at intermediate risk by the latter.

Discussion

From Table 2, it can be seen clearly that there was a very strong correlation (R = 0.805) between the Jos CVD risk app and the ASCVD estimator plus the American College of Cardiology. This confirms that the Jos CVD risk app was a good substitute, especially for sub-Saharan Africa. The need for risk engines designed with a population in view has been advocated to avoid the need to recalibrate when a risk engine is being used outside the populations where it was designed.[14] We also compared the risk classification levels (low, intermediate, and high) of the 52 patients between the two apps. Of the 52 patients who participated in this study, 21 were high risk in both apps and 22 were intermediate risk in both apps. Only nine patients had different risk levels. The implication is that 43/52 (82.69%) patients were accurately classified by our Jos CVD risk app without any invasive investigation being carried out. The patients attending the cardiology outpatient clinic had increased blood pressure (140/90 mmHg or above) or were controlled on treatment. Some were found to have hyperglycemia or hypercholesterolemia or both in addition to hypertension. As a result of the treatment received over a period of time, some of these patients had decreased values for clinical or laboratory investigations for these disease conditions than the initial values. This can be the reason for different risk categories recorded for the nine patients between the two apps. Jos CVD risk app is entirely noninvasive and the risk classifications of the ASCVD estimator plus app are more dependent on invasive laboratory investigations. Interestingly this study found that over 80% of the patients had the same results from the two apps when compared. Where there was discordance in the classification, the Jos CVD risk app put patients in a higher risk class ensuring that some intervention is put in place. Mis-classification of the risk of disease with dire consequences is to be deprecated as intervention tends to be delayed or ignored.[12]

Study strengths and weaknesses

This study was limited by the small sample size and the convenient sampling method used. It was also a single center study of people of one racial background, making it restrictive in external validity. At best it should be seen as an exploratory study deserving widespread use to confirm utility. Another weakness is in the area of patient data privacy if used in the future on the personal phones of health care providers. However, being clinicians, they are bound by ethics to treat patient data with confidentiality. Its strength however is that it hearkened to the call of coming up with risk engines for specific populations rather than using those determined for other populations without recalibration. The new Jos CVD risk app also is user-friendly being embedded in a smart device and not require information derived from invasive procedures; and is an effort to find solutions for a resource-limited environment.

Future directions

The abdominometer, which measures AH, a measure of central adiposity, needs to be made more portable and user-friendly as a first step toward making the use of the Jos CVD risk app more attractive and widespread. It would then be piloted on a larger scale and in multiple sites to increase external validity. Finally, it should become a reliable tool in public health programs geared toward mitigating the morbidity and mortality consequences of cardiovascular diseases; at least in sub-Saharan Africa.

Conclusions

We conclude that the Jos CVD risk app had a high degree of accuracy in predicting the risk level of cardiovascular diseases in sub-Saharan Africa. It had a slight superiority over the American College of Cardiology ASCVD estimator plus app, especially considering that no blood results requiring phlebotomy were utilized. As the American College of Cardiology ASCVD estimator plus is not designed with Black African populations in sub-Saharan countries in mind, we believe that the Jos CVD risk app in smartphones can be easily and conveniently adopted to carry out primary screening for cardiovascular diseases in both urban and rural areas at no cost to the general populace.

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Conflict of interest

The authors report no conflict of interest related to this publication.

Author contributions

Data collection (AS, GS), statistical analysis (AS), writing (AS, BO), conceptualization and supervision (BO), and contribution of the computer algorithm (NG, DV).

Ethical statement

Written informed consent was obtained from each patient before enrolment and the study was approved by Research and Ethics Committee, Jos University Teaching Hospital. This study conformed to the ethical guidelines of the Declaration of Helsinki as revised in 2013.

Data sharing statement

The data used in support of the findings of this study are available on reasonable request from the first author, Dr. Anil Sirisena, at shallom2k3@yahoo.com.

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