



The Correlation between Thai Cardiovascular Risk Score and the Multi-Ethnic Study of Atherosclerosis (MESA) Risk Score in Thai Populations

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Vajira Med J. 2022; 66(2): 125-36

<http://dx.doi.org/10.14456/vmj.2022.13>

Abstract

Objective: The purpose of this study was to examine the relationship between the Thai cardiovascular risk score (TCVRS) and the Multi-Ethnic Study of Atherosclerosis (MESA) risk score and predictors of high CAC score in Thai adults without a history of atherosclerotic cardiovascular disease.

Methods: This is a cross-sectional study assessing chest computed tomography scan patients without established atherosclerotic disease in Vajira Hospital, Thailand from July to December 2018. The TCVRS, MESA, and CAC scores were analyzed to estimate coronary heart disease risk. The predictive factors for the high CAC score were assessed by using univariate and multivariable analysis.

Results: The total of 84 patients were enrolled (mean age, 55.1 years and female, 65.5%), mostly zero CAC (46.4%). The correlation of TCVRS and MESA risk score was stronger than FRS and MESA risk score by $r = 0.818$; $p < 0.001$ and $r = 0.747$; $p < 0.001$, respectively. The agreements were acceptable with mean difference = -0.73 , $SD = 0.242$ and -3.78 , $SD = 0.539$, respectively. In multivariate analysis, diabetes mellitus (odds ratio [OR]: 28.39, 95% CI:1.92-420.09; $p = 0.015$) and age ≥ 60 years (OR: 38.26, 95% CI:13.76-389.49; $p = 0.002$) were independent risk factors to predict high CAC.

Conclusion: There is a strong correlation between TCVRS and MESA risk score in Thai populations, but the MESA risk score may have a lower estimated coronary heart disease risk in Thai patients, especially in patients with multiple risk factors for coronary heart disease. Diabetes mellitus was the strongest predictor of high CAC.

Keywords: Thai cardiovascular risk score, Multi-Ethnic Study of Atherosclerosis (MESA), Coronary artery calcium (CAC), Predictor, Correlation, Coronary heart disease (CHD)



ความสัมพันธ์ระหว่างการทำนายความเสี่ยงต่อการเกิดโรคหลอดเลือดหัวใจโดยใช้คะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทยและคะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา MESA ในผู้ป่วยไทย

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Vajira Med J. 2022; 66(2): 128-36

<http://dx.doi.org/10.14456/vmj.2022.13>

บทคัดย่อ

วัตถุประสงค์: จุดประสงค์ของการศึกษาเพื่อประเมินความสัมพันธ์ระหว่างคะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทย (Thai cardiovascular risk score) เทียบกับคะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของผู้ป่วยจากการศึกษา MESA (the Multi-Ethnic Study of Atherosclerosis) และหาปัจจัยเพื่อพยากรณ์กลุ่มผู้ป่วยคะแนนแคลเซียมในหลอดเลือดหัวใจสูงในผู้ป่วยไทยซึ่งไม่มีประวัติโรคหลอดเลือดหัวใจ

วิธีดำเนินการวิจัย: การศึกษานี้เป็นการศึกษาแบบตามขวาง ประเมินอาสาสมัครที่ไม่เคยได้รับการวินิจฉัยว่าเป็นโรคหลอดเลือดแดงแข็ง และได้รับการตรวจภาพรังสีคอมพิวเตอร์ของหน้าอก ในคณะแพทยศาสตร์วชิรพยาบาล ตั้งแต่ 1 กรกฎาคม 2561 ถึง 31 ธันวาคม 2561 วิเคราะห์คะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทย, คะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจของผู้ป่วยหลายเชื้อชาติจากการศึกษา MESA และ คะแนนแคลเซียมในหลอดเลือดหัวใจ วิเคราะห์ปัจจัยเสี่ยงของการมีคะแนนแคลเซียมในหลอดเลือดหัวใจสูงด้วยการวิเคราะห์ข้อมูลแบบตัวแปรเดียว และแบบหลายตัวแปร

ผลการวิจัย: กลุ่มอาสาสมัครจำนวน 84 คน (อายุเฉลี่ย 55.1 ปี และเพศหญิงร้อยละ 65.5) ส่วนใหญ่คะแนนแคลเซียมของหลอดเลือดหัวใจเท่ากับศูนย์ (46.4%) เมื่อเทียบคะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทยกับคะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา MESA พบว่ามีความสัมพันธ์ระดับสูง และความสัมพันธ์สูงกว่า เมื่อเทียบคะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา FHS กับการศึกษา MESA (ค่า r เท่ากับ 0.818; $p < 0.001$ และ ค่า r เท่ากับ 0.747; $p < 0.001$ ตามลำดับ) โดยยอมรับความแตกต่างเฉลี่ยเท่ากับ -0.73, ส่วนเบี่ยงเบนมาตรฐานเท่ากับ 0.242 และ ความแตกต่างเฉลี่ยเท่ากับ -3.78, ส่วนเบี่ยงเบนมาตรฐานเท่ากับ 0.539 ตามลำดับ) จากการวิเคราะห์ปัจจัยเสี่ยงแบบหลายตัวแปรพบว่า เบาหวาน (OR: 28.39, 95% CI:1.92-420.09; $p = 0.015$) และอายุมากกว่า 60 ปี (OR: 38.26, 95% CI:13.76-389.49; $p = 0.002$) เป็นปัจจัยเสี่ยงอิสระในการพยากรณ์คะแนนแคลเซียมของหลอดเลือดหัวใจระดับสูง



สรุป: คะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทย และคะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา MESA มีความสัมพันธ์กันระดับสูงในการทำนายความเสี่ยงต่อการเกิดโรคหลอดเลือดหัวใจในประชากรไทย แต่คะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา MESA อาจจะต่ำกว่าโดยเฉพาะอย่างยิ่งผู้ป่วยที่มีหลายปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจ เบาหวานเป็นปัจจัยพยากรณ์คะแนนแคลเซียมของหลอดเลือดหัวใจเกี่ยวข้องมากที่สุด

คำสำคัญ: คะแนนความเสี่ยงการเป็นโรคหลอดเลือดหัวใจของประชากรไทย, คะแนนความเสี่ยงของการเป็นโรคหลอดเลือดหัวใจจากการศึกษา MESA, คะแนนแคลเซียมของหลอดเลือดหัวใจ, การทำนาย, โรคหลอดเลือดหัวใจ

Introduction

Coronary heart disease (CHD) is a major global problem and cause of morbidity and mortality worldwide. Despite a reduction in mortality rates in recent decades, coronary artery disease is still responsible major leading cause of death in Thailand and developing countries. Early diagnosis of asymptomatic adults by identifying and controlling known and established cardiovascular risk factors should be made to reduce cardiovascular morbidity and mortality. Great efforts are invested in primary prevention and the asymptomatic population which is classed as low-risk, intermediate-risk, and high-risk for appropriate risk modification. The high-risk population will gain more benefits from intensive risk control than the low-risk population. However, there are several available risk scores. The Framingham risk score (FRS) is also one of the most well-known models to estimate the 10-year cardiovascular risk of an individual and stratify cardiovascular risk in the United States¹. However, some populations, such as intermediate-risk, could not use the Framingham risk score to predict risks accurately². Coronary artery calcium is a better indicator of coronary heart disease risk factor prediction than the Framingham risk score (FRS). These findings suggest that the coronary artery calcium combined with FRS makes it possible to predict the occurrence of CHD better and allows for effective risk prevention³. Thus, other tests such as coronary artery calcium scoring combined with the Framingham risk score in asymptomatic adults may provide prognostic information better than either method alone.

Coronary calcium quantified by computed tomography (CT) is a specific marker of coronary atherosclerosis. The risk factors associated with coronary calcification are age, sex hypertension, diabetes, dyslipidemia, and smoking³. The coronary artery calcium (CAC) score was developed by the determination of the volume of calcium and mass calcium score with the Agatston method⁴⁻⁶. The coronary artery calcium score ≥ 80 Hounsfield units (HU) had 74% specificity and 89% sensitivity

to predict the risk of acute coronary syndrome and mortality within 3.6 years. From the Multi-Ethnic Study of Atherosclerosis (MESA), The CAC score combined with established traditional risk factors from the Framingham heart study showed significant improvement in the risk stratification to predict coronary heart disease^{3,5-12}. For the net reclassification improvement (NRI) in the intermediate-risk persons, 16% were reclassified to high risk, while 39% were reclassified to low risk⁹. In the very low-risk persons, the probability of identifying persons with clinically significant levels of coronary artery calcium is low but becomes greater in low and intermediate-risk persons⁷.

Thai cardiovascular risk score (TCVRS), based on an EGAT study¹⁵, was used to estimate the 10-year risk for atherosclerotic cardiovascular disease in the Thai population without previous atherosclerotic cardiovascular disease. This estimator could be used without blood testing, required waist circumference and height, or use with blood testing.

This study determines the correlation between Thai cardiovascular risk score (TCVRS) and Multi-Ethnic Study of Atherosclerosis (MESA) risk score in Thai people without a history of atherosclerotic cardiovascular disease.

Method

Study design

A cross-sectional cohort study determines the correlation between Thai cardiovascular risk score (TCVRS) and 10-year risk of coronary heart disease using the MESA risk score in Thai populations. This study was conducted at Vajira Hospital from July to December 2018.

All patients scheduled to evaluate chest computed tomography scans were selected and eligible for inclusion criteria will be assessed to measure coronary artery calcification with ECG-gated cardiac computed tomography (CT). An unenhanced low-dose CT scan by Philips Ingenuity 128-slide CT scanner is routinely performed

in patients undergoing cardiac CT for coronary calcium score. After CT scans, the post-processing data will be analyzed using the HeartBeat-CS software application. Agatston score is a semi-automated tool to calculate a score based on the extent of coronary artery calcification detected by CT scanning, finally interpreted data by the radiologist.

Baseline characteristics (age, sex, body weight, body mass index, history of smoking, current medications, underlying disease, vital signs, and laboratory data), TCVRs estimator, the MESA: 10-year coronary heart disease estimator, and coronary artery calcium score were analyzed.

All participants had provided written informed consent. Study protocols were approved by the institutional review board at Navamindradhiraj University.

Study population and endpoints

The eligibility of candidate patients was based on the following criteria: 1) adult patients aged > 18 years; 2) scheduled to evaluate computed tomography scan with contrast from July to December 2018; 3) patients who have agreed to undergo a computerized coronary artery calcium scan.

The exclusion criteria were: 1) established atherosclerotic diseases (ischemic stroke, ischemic heart disease, carotid artery stenosis, and peripheral arterial disease); 2) tachycardia (heart rate > 100 bpm); 3) pregnancy or breastfeeding; 4) immunocompromised patients (inherited and acquired immunocompromised diseases, including HIV patients, neutropenia, bone marrow, and organ transplantation); 5) solid and hematologic malignancies.

Definition

The TCVRs categories:

- Low risk (< 10%), intermediate risk (10 to < 20%), high risk (\geq 20%)

The FRS categories according to ASCVD risk:

- Low risk (< 7.5%), intermediate risk (7.5 to < 20%), high risk (\geq 20%)

The coronary artery calcium score categories:⁹

- Zero (0), low (1-100), intermediate (101-300), and high (>300)

The primary endpoint was a correlation between Thai cardiovascular risk score and Multi-Ethnic Study of Atherosclerosis risk score in Thai adults without a history of atherosclerotic cardiovascular disease. The secondary endpoints included predictive factors for high CAC and the correlation between the Thai cardiovascular risk score and The Framingham risk score.

Statistical analysis

The data were analyzed using the STATA software, version 13. Discrete variables were presented as percentages for categorical variables and means with standard deviations for the continuous variable. Univariate and multivariate logistic regression models evaluated the risk factors associated with high coronary calcium scores. The correlation was analyzed by Pearson correlation and Bland-Altman plot to determine the association between Thai cardiovascular risk score and 10-year risk of coronary heart disease using the MESA score combined with a coronary artery calcium score. P-values of less than 0.05 were statistical significance.

Results

Baseline characteristics

We identified 84 chest computed tomography scans performed in adults without established atherosclerotic diseases. The participants included in the analysis mainly were female (65.5%), and the mean age was 55.1 ± 15.8 years. Patients were previously diagnosed with hypertension (39.3%), dyslipidemia (34.5%), diabetes mellitus (11.9%), and 9.5% were current smokers. All the characteristics of the participants included in the study are detailed in Table 1.

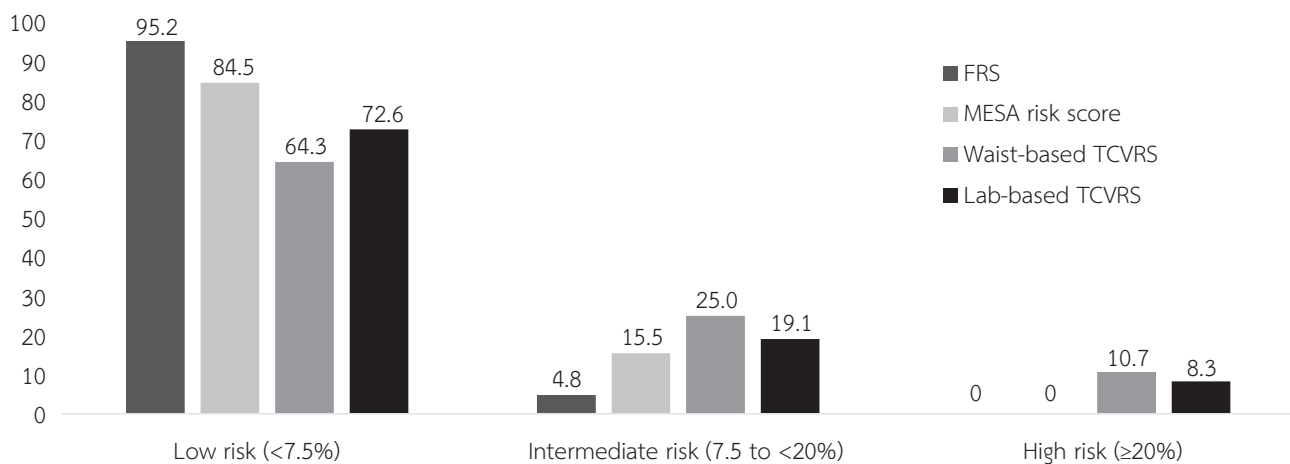
Table 1:

Baseline characteristics of study participants

Demographics	All participants (n = 84)	CAC score		P-value*
		0 (n = 39)	> 0 (n =45)	
Female	55 (65.5%)	28 (71.8%)	27 (60.0%)	0.257
Age (year), mean (SD)	55.1±15.8	46.1±15.0	63.2±11.5	0.128
Family history of CHD	3 (3.6%)	1 (2.6%)	2 (4.4%)	0.643
BMI (kg/m ²), mean (SD)	22.4±4.2	22.1±4.0	24.5±10.8	0.501
Current smoker	8 (9.5%)	1 (2.6%)	7 (15.6%)	0.051
Underlying disease				
Hypertension	33 (39.3%)	7 (17.9%)	26 (57.8%)	<0.001
Dyslipidemia	29 (34.5%)	10 (25.6%)	19 (42.2%)	0.111
Diabetes mellitus	10 (11.9%)	1 (2.6%)	9 (20.0%)	0.014
Medications				
HMG-CoA reductase inhibitor	23 (27.4%)	7 (17.9%)	16 (35.5%)	0.071
Antiplatelets	10 (11.9%)	2 (5.1%)	8 (17.8%)	0.074
Beta-blockers	11 (13.1%)	1 (2.6%)	10 (22.2%)	0.008
ACEIs or ARBs	15 (17.9%)	4 (10.3%)	11 (24.4%)	0.090
Calcium antagonists	16 (19.0%)	3 (7.7%)	13 (28.9%)	0.014
Diuretics	7 (8.3%)	0 (0.0%)	7 (15.6%)	0.010
Systolic blood pressure (mmHg)	126.7±14.6	124.0±13.0	129±16.0	0.175
Diastolic blood pressure (mmHg)	74.3±10.2	72.8±8.4	76±12.0	0.580
Laboratory investigation				
Total Cholesterol (mg/dl), mean (SD)	200.6±38.7	200.9±42.2	200.4±35.7	0.242
LDL Cholesterol (mg/dl), mean (SD)	118.4±34.9	122.5±43.0	115.6±28.4	0.214
HDL Cholesterol (mg/dl), mean (SD)	61.5±14.6	62.2±15.0	60.9±14.6	0.257
Triglyceride (mg/dl), mean (SD)	101.5±41.3	101.3±45.0	101.7±39.1	0.248
HbA1C (mg/dl), mean (SD)	5.9±0.6	5.7±0.4	7.43±9.3	0.009
BUN (mg/dl), mean (SD)	13.6±4.2	13.2±3.8	14±4.4	0.763
Creatinine (mg/dl), mean (SD)	0.8±0.3	0.7±0.4	0.8±0.4	0.332

Most participants had a likely low risk for coronary heart diseases. During the study period, no participants had cardiovascular events. The coronary artery calcium score was calculated in all 84 participants and showed that patients had 39 (46.4%) in zero CAC, 26 (31.0%) in low, 9 (10.7%) in intermediate, and 10 (11.9%) in high CAC. Based on the Framingham risk score assessment alone, the patients were 80 (95.2%) in low-risk, 4 (4.8%) in intermediate-risk, and no high-risk patients. Following the MESA risk score using FRS with CAC score, 10 of 80 (12.5%) low-risk patients in FRS were reclassified as intermediate-risk, while 1 of 4 (25.0%) of the intermediate-risk patients were reclassified as low-risk patients, as illustrated in Figure 1. According to the laboratory-based Thai cardiovascular risk score (TCVRS), 54 of 84 participants were classified as low risk, 21 of 84 (25.0%) as intermediate risk, and 9 of 84 (10.7%) as high risk.

The FRS and MESA risk scores assessment tends to have a lower risk estimation than the Thai cardiovascular risk score (TCVRS) in the Thai people, as illustrated in Figure 2. According to the comparison of lab-based TCVRS and MESA risk scores comparison, 10 of 71 (14.1%) participants in the low-risk group of MESA risk score were reclassified as a high-risk and intermediate-risk group of lab-based TCVRS, 1 of 71 (1.4%) participant in the low-risk group of MESA risk score was reclassified as a high-risk group, and 9 of 71 (12.7%) participants in low-risk group of MESA risk score was reclassified as an immediate-risk group of lab-based TCVRS respectively. 6 of 13 (46.2%) participants in the intermediate-risk group of the MESA risk score were reclassified as high risk of lab-based TCVRS.

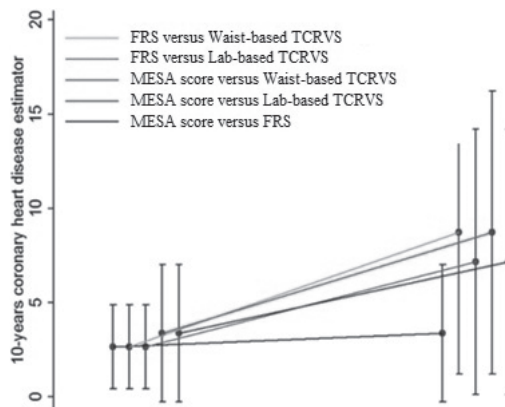


Abbreviations: FHS, Framingham risk score; MESA risk score, the Multi-Ethnic Study of Atherosclerosis risk score; TCVRS, Thai cardiovascular risk score.

MESA categories according to ASCVD risk: risk (< 7.5 %), Intermediate risk (7.5 to <20%), High risk (≥20%)

TCVRS categories: Low risk (< 10 %), Intermediate risk (10 to <20%), High risk (≥20%)

Figure 1: Coronary heart disease risk categories by using the Framingham risk score, MESA risk score, and Thai cardiovascular risk score



Abbreviations: FHS, Framingham risk score; MESA, the Multi-Ethnic Study of Atherosclerosis risk score; TCVRS, Thai cardiovascular risk score

Figure 2: Trend of coronary heart disease estimated risk in each estimator

The correlation between various risk assessment methods was performed by Pearson’s correlation. The FRS and MESA risk score were strongly correlated ($r = 0.818$; $p < 0.001$). The agreement between both risk estimators was plotted by Bland& Altman and seems to be good as well, with a mean difference = -0.73 and $SD = 0.242$. The correlation and agreement are shown in Figure 3.

The correlation between the lab-based TCVRS and MESA risk score were strong correlation ($r = 0.747$; $p < 0.001$). The agreement was good as well with mean difference = -3.78 and $SD = 0.539$.

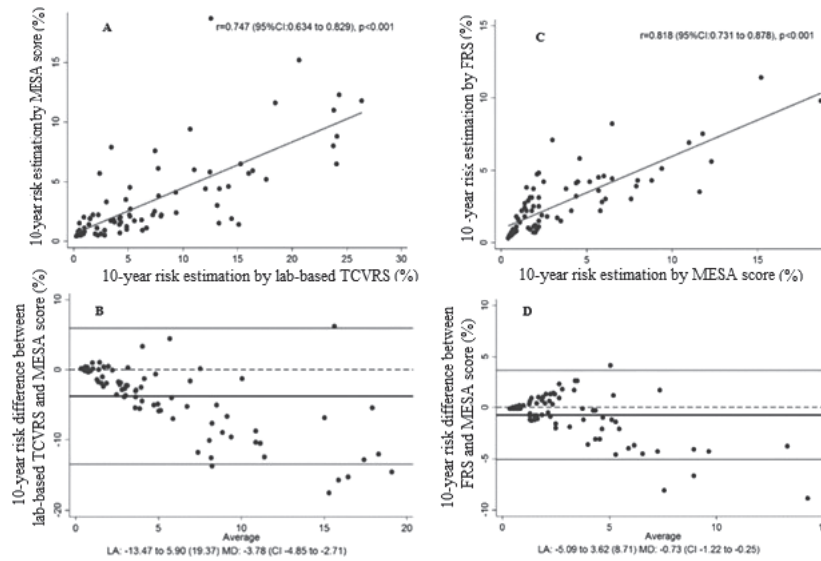
According to this data, although TCVRS had a strong correlation and agreement with FRS and MESA risk scores, but seems to be that the MESA risk score may have a lower estimated CHD risk in patients, especially in patients with multiple risk factors for coronary heart disease.

In the univariate analysis, diabetes mellitus was the strongest factor to predict high CAC (OR 17.50, 95% CI: 3.5-86.5, $p < 0.001$). The age ≥ 60 years (OR 13.4, 95% CI: 1.6-113.1, $p=0.017$) and level of glycosylated hemoglobin ≥ 6.5 (OR 5.8, 95%CI: 1.14-29.0, $p=0.034$) were also risk factors to predict high CAC.

Multivariate logistic regression analysis was performed to determine the independent predictive factors related to high CAC and showed diabetic mellitus and age ≥ 60 years were independent predictive factors for high CAC (Table 2).

Discussion

According to 2018 AHA guidelines on the management of blood cholesterol, primary intervention in intermediate-risk patients should initiate active physical activity, change in lifestyle, and combined with a moderate-intensity statin to reduce coronary heart disease risk. Otherwise, high-risk patients may have to use more intensive therapy strategies. The MESA risk score was developed to predict a 10-year CHD risk score accurately by adding the CAC score. Although the MESA study enrolls patients from various ethnic backgrounds, Asians account for 12% of the total. The external validity of the general population will be questioned, particularly among the Thai people³. The Thai cardiovascular risk score is another developed clinical risk assessment tool for the Thai people based on an EGAT study¹⁵. Our study evaluates the MESA risk score, which was developed by combining FRS and CAC scores to reclassify the risk of coronary heart disease and determine the correlation between the MESA risk score and TCVRS.



A- Linear regression analysis and Pearson’s coefficient between lab-based TCVRs and MESA risk score,
 B- Bland-Altman agreement between lab-based TCVRs and MESA risk score,
 C- Linear regression analysis and Pearson’s coefficient Correlation between FRS and MESA risk score,
 D- Bland-Altman agreement Correlation between FRS and MESA risk score
 Abbreviations: FHS, Framingham risk score; MESA, the Multi-Ethnic Study of Atherosclerosis risk score;
 Lab-based TCVRs, Laboratory-based Thai cardiovascular risk score; r = Pearson’s coefficient of correlation

Figure 3: Correlation between lab-based TCVRs and MESA risk score

Table 2:

Univariable and Multivariable predictors of coronary artery calcium

Variables	Univariable analysis			Multivariable analysis		
	OR ¹	95% CI	p-value	Adjusted OR ²	95% CI	p-value
Age ≥ 60 (years)	13.4	1.6-113.1	0.017	28.39	1.9-420.1	0.015
Female	2.0	0.4-10.2	0.418			
FH of CHD	4.6	0.4-56.1	0.236			
BMI ≥ 23 (kg/m ²)	0.8	0.2-3.6	0.814			
Diabetes mellitus	17.5	3.5-86.5	<0.001	38.26	3.8-389.5	0.002
Hypertension	2.1	0.5-8.5	0.298			
Dyslipidemia	2.7	0.7-10.8	0.172			
Current smoker	0.4	0.1-3.7	0.437			
HMG-CoA reductase inhibitor	2.4	0.6-9.7	0.234			
Antiplatelets	2.4	0.4-13.6	0.324			

Table 2:

Univariable and Multivariable predictors of coronary artery calcium (Continued)

Variables	Univariable analysis			Multivariable analysis		
	OR ¹	95% CI	p-value	Adjusted OR ²	95% CI	p-value
Beta-blockers	4.2	0.9-20.1	0.073			
ACEIs or ARBs	2.6	0.6-12.0	0.212			
Calcium antagonists	2.4	0.5-10.8	0.259			
Diuretics	1.4	0.2-13.5	0.751			
Blood pressure > 140/90 mmHg	2.2	0.5-9.8	0.310			
Total Cholesterol ≥ 200 mg/dl	1.3	0.3-5.2	0.725			
HDL Cholesterol < 50 mg/dl	1.3	0.2-6.7	0.798			
Triglyceride ≥ 150 mg/dl	2.1	0.4-11.7	0.399			
HbA1C ≥ 6.5%	5.8	1.1-29.0	0.034			

Abbreviations: OR, Odds Ratio; CI, confidence interval

¹Crude Odds Ratio estimated by Binary logistic regression analysis.

²Adjusted Odds Ratio calculated by Multiple logistic regression analysis (backward stepwise method) adjusted for age and diabetes mellitus.

The principal findings of the study were the following. First, the intermediate-risk group is the most interesting group for risk reclassification. The MESA study showed that the MESA risk score could reclassify the intermediate-risk group into low and high-risk groups. 39% of participants in the intermediate-risk group were reclassified as low risk and 16% as high risk. However, our research found that the MESA risk score reclassified 25% of the intermediate-risk group as low risk but not high risk. As a result, the main participants in the cohort were low risk than in the MESA study and the lifestyles of Thai people are different from western people⁵. Our study also demonstrated that 12.5% of low-risk participants were reclassified as an immediate risk but not as high risk. Second, the correlation between the MESA risk score and the laboratory-based TCVRs was stronger than the correlation between the FRS and MESA risk scores. Increased CHD risk predicted by TCVRs was almost certainly associated with a more significant mean difference than low risk. The waist circumference-based and laboratory-based Thai CV risk scores were classified as high-risk at 10.7% and 8.3% of

total participants, respectively, but no high-risk patients were identified using FRS or MESA risk scores. According to this data, it seems to be that MESA risk scores may have a lower estimated CHD risk than TCVRs in Thai people, especially patients with multiple risk factors for coronary heart disease. Finally, age, gender, hypertension, diabetes, dyslipidemia, and smoking were all independent predictors of high CAC in a previous report. This study showed that only aged ≥60 years and diabetes mellitus were significantly associated with high CAC.

According to the study finding, MESA risk scores and FRS in Thai people may have underestimated cardiovascular risk in the Thai population. The Thai cardiovascular risk scores may be the most appropriate method for coronary heart disease risk estimation in Thai people.

Limitations

This study has several limitations. First, we included a small population for analysis because many patients met exclusion criteria and had a short study period. Second, patients had no

cardiovascular events. Therefore, both specificity and sensitivity were not evaluated.

Conclusions

There is a strong correlation between TCVRS and MESA score in Thai populations, but the MESA score may be lower estimated CHD risk in Thai patients, especially in patients with multiple risk factors for coronary heart disease. Diabetes mellitus was the strongest predictor of high CAC.

Acknowledgements

The authors would like to thank the staff of the Radiology Division, Vajira hospital, for coronary artery calcium data retrieval. This study was supported by the Navamindradhiraj University research fund.

Potential conflicts of interest

The authors declare no conflict of interest.

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