

# Cardiovascular risk score predictive accuracy and subclinical atherosclerosis correlation in the Indian population: A cross-sectional study



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## ABSTRACT

**Background:** Estimation of the risk of future atherosclerotic cardiovascular (CV) events is an important step in the primary prevention of CV events. However, the relative accuracy of the various currently available CV risk scores is not validated in Indians. **Aims and Objectives:** The study was done to compare the accuracy of three clinically relevant CV risk assessment algorithms in the South Indian population and to validate the risk scores by correlating with the measures of subclinical atherosclerosis. **Materials and Methods:** This cross-sectional study was conducted among patients attending a chest pain clinic at a Tertiary care center in South India. The study included subjects  $\geq 30$  years of age, with no previous coronary artery disease (CAD) and major cardiac illness. Totally 110 subjects were included in the study. Detailed clinical evaluation and routine investigations were done. The 10-year CV risk for each subject was calculated using the three risk scores – Framingham, American College of Cardiology/American Heart Association (ACC/AHA), and Q risk score. The risk scores of all patients were then correlated with their corresponding carotid intima-media thickness (CIMT) measured using carotid Doppler and coronary angiography results. **Results:** The mean age of the study population was  $51.45 \pm 9.01$  years and the majority of them were females (57.2%). CAD patients demonstrated significantly increased CIMT. There was a significant positive correlation ( $P < 0.001$ ) between all three risk scores and carotid intimal medial thickness. As the carotid intimal medial thickness increases, the risk scores also increased (as shown by Pearson's correlation coefficient). Similarly, all three risk scores also showed a significant positive correlation ( $P < 0.001$ ) with the severity of CAD as assessed by CAG (as shown by one-way analysis of variance). The ACC/AHA score was the best score with a slightly higher accuracy of 69.9% than that of Q risk score (69.5%). The accuracy of Framingham's score was found to be 68.3%. **Conclusion:** ACC/AHA and Q risk score may be the most appropriate CV risk assessment algorithm for use in Indian populations at present. However, large-scale prospective studies are needed to confirm these findings.

**Key words:** Cardiovascular risk assessment; Subclinical atherosclerosis; Risk prediction

## INTRODUCTION

Cardiovascular diseases (CVDs) remain the leading cause of morbidity and mortality worldwide, imposing a substantial burden on healthcare systems and economies. According to the global burden of disease study, CVDs are responsible for approximately 32% of all global

deaths and 17.9% of global disability-adjusted life years, making it the leading cause of death worldwide across all regions and age groups.<sup>1</sup> Accurate estimation of the risk of atherosclerotic cardiovascular (CV) events is pivotal in the clinical management of patients presenting with suspected CV disease. The ability to quantify CV risk not only facilitates objective assessment of the severity of

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the illness but also serves as a crucial tool for effective communication with patients and their families regarding the potential implications of their condition.<sup>2</sup>

Various CV risk scoring systems have been developed and validated across different populations to aid in risk assessment. Among the widely utilized models are the Framingham risk score, the World Health Organization/International Society of Hypertension CV disease risk prediction charts, and the American College of Cardiology/American Heart Association (ACC/AHA) risk calculator.<sup>3,4</sup> However, a notable gap exists in the applicability and validation of these models in the Indian context. India harbors a unique epidemiological profile characterized by a high burden of CV risk factors and a surge in the incidence of CVDs.<sup>5</sup> Despite this, none of the currently available CV risk prediction models have been specifically tailored to Indian data or prospectively validated in Indian populations. Consequently, there remains uncertainty regarding the accuracy and applicability of these models in predicting CV risk among individuals of Indian descent.

A comprehensive approach is needed to improve our understanding of how well-existing CV risk assessment tools perform in the Indian context and their ability to predict subclinical atherosclerosis. This will enable the development of more effective risk stratification and management strategies tailored to this population. Therefore, this study was to address this critical gap in knowledge by comparing the accuracy of three clinically relevant CV risk assessment algorithms – the Framingham risk score, ACC/AHA score, and Q risk score – in a South Indian population. In addition, we sought to correlate the risk estimates derived from these algorithms with two well-established measures of subclinical atherosclerosis: Carotid intima-media thickness (CIMT) and coronary angiography (CAG).

### Aims and objectives

To determine the Predictive Accuracy of the CV risk scores for assessing future CV events. Correlation of CV risk scores with the measures of subclinical atherosclerosis.

## MATERIALS AND METHODS

### Study design and setting

This was a cross-sectional analytical study, conducted at a tertiary care center in Tamil Nadu, South India.

### Inclusion criteria

Subjects included in the study were aged 30 years and above, with no previous history of coronary artery disease (CAD) or major cardiac illness.

### Exclusion criteria

Exclusion criteria comprised individuals not meeting the age requirement or with a previous history of significant cardiac disease and those who are not willing to undergo CAG.

### Sample size calculation

Sample size calculation was performed based on data from a previous study,<sup>6</sup> which reported a correlation coefficient of 0.27 between CIMT and Framingham scores. With the assumption of the same correlation, a 95% confidence level, and 80% power, the calculated sample size for the study was 110.

### Sampling technique and data collection

Consecutive sampling was employed to recruit subjects from the chest pain clinic at the tertiary care center. Written informed consent was obtained from each participant before data collection. A semi-structured questionnaire was administered to collect data on sociodemographic characteristics, clinical history, and CV risk factors. This included information on age, gender, and blood test results. Subsequently, CV risk scores were calculated for each participant. Trained personnel ensured standardized administration of the questionnaire and clinical evaluations to minimize bias and enhance data quality.

### Ethical consideration

Ethical approval for the study was obtained from the institutional review board. Informed consent was obtained from all participants before their inclusion in the study. Confidentiality and privacy of participant's data were strictly maintained throughout the study process.

### Study tool

Detailed clinical evaluation and routine investigations were done for all subjects. In addition, carotid Doppler was done to measure CIMT, and CAG was performed to detect subclinical atherosclerosis. CIMT was measured using Doppler ultrasonography, a non-invasive imaging technique that allows for the assessment of early atherosclerotic changes in the carotid arteries. CIMT was measured following the standard protocol. The distal common carotid artery (CCA) was imaged on both sides using 7.5 MHz probe. The CCA was imaged in a plane known as the TUNING FORK VIEW which showed the bulb and the distal CCA with its bifurcation simultaneously. Finer adjustments in the probe positions were done to ensure the double lines of Intima and Adventitia were seen clearly. Further angle adjustments of 45° were done both anterior and posterior to the first image and values obtained. The six values thus obtained (three on each side) were averaged and used for analysis. CAG was then performed in all patients to detect the

presence of subclinical atherosclerosis since CAG is the gold standard for evaluating CAD. According to the CAG reports, patients were categorized into three groups – Normal coronaries: No CAD group, <50% stenosis: Minimal CAD, >50% stenosis – Significant CAD.

The CV risk for each subject was calculated using three risk scores: Framingham, ACC/AHA, and Q risk scores. The Framingham risk score is a widely used tool for estimating the 10-year risk of developing coronary heart disease based on multiple risk factors, including age, gender, cholesterol levels, blood pressure, smoking status, and diabetes. The ACC/AHA risk score is another validated tool for assessing CV risk and guiding preventive interventions. It incorporates similar risk factors as the Framingham risk score but may utilize updated risk equations and thresholds to estimate an individual's risk of developing atherosclerotic CVD events, including myocardial infarction and stroke. The Q risk score is a risk prediction algorithm developed specifically for the UK population but has been adapted and used in other countries as well. It estimates the 10-year risk of developing CV events based on various risk factors, including age, gender, ethnicity, smoking status, blood pressure, cholesterol levels, diabetes, and body mass index (BMI).

Using these risk assessment models, the 10-year CV risk estimates were derived and then categorized into three – <10%: low risk, 10–19.9%: moderate risk, and ≥20%: high risk.

### Statistical analysis

Data were compiled using Microsoft Excel and analyzed using SPSS (Statistical Package for Social Sciences) Version 23. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as percentages and frequencies. The correlation of predictor scores was assessed using Pearson's correlation test. The association between variables was determined using one-way analysis of variance. Receiver operating characteristic curve analysis was performed to identify the predictor score with the best accuracy in predicting CV risk. A  $P < 0.05$  was considered significant.

## RESULTS

Demographic, anthropometric, and laboratory profiles of the study participants are depicted in Table 1. The mean (standard deviation) age of the participants was 51.45 ( $\pm 9.01$ ) years, with females comprising 57.2%. The average BMI was 27.03 ( $\pm 5.18$ ) kg/m<sup>2</sup>, while the waist circumference averaged at 91.10 ( $\pm 11.06$ ) cm and the waist-hip ratio at 0.86 ( $\pm 0.62$ ). Fasting lipid levels were

measured with a mean of 141.24 ( $\pm 35.63$ ) mg/dL, High-density lipoprotein at 39.48 ( $\pm 9.64$ ) mg/dL, triglycerides at 149.76 ( $\pm 68.03$ ) mg/dL, and low-density lipoprotein (LDL) at 73.55 ( $\pm 40.87$ ) mg/dL. The Framingham scores, ACC/AHA Score, and Q risk score, which are indicators of CV risk, were observed at means of 6.81 ( $\pm 5.30$ ), 5.09 ( $\pm 3.09$ ), and 8.27 ( $\pm 6.36$ ), respectively.

Table 2 shows the average predictor scores of the study population. The mean values obtained were a Framingham score of 6.81, ACC/AHA score of 5.09, and Q risk score of 8.27, respectively.

Table 3 presents the correlation of CIMT with Framingham scores, ACC/AHA scores, and Q risk scores. The correlation coefficients indicate a weak positive correlation between CIMT and Framingham scores ( $r=0.389$ ,  $P < 0.001$ ) (Figure 1). However, a moderate positive correlation was exhibited between CIMT and ACC/AHA score ( $r=0.411$ ,  $P < 0.001$ ), and Q risk score ( $r=0.506$ ,  $P < 0.001$ ) (Figures 2 and 3).

Table 4 depicts the association between CAG report findings and Framingham score, ACC/AHA score, and Q risk score. The mean (standard deviation) Framingham score for Normal CAG reports was 4.77 ( $\pm 3.61$ ), increasing to 6.20 ( $\pm 4.37$ ) for minimal CAD, and significantly higher for single vessel disease (14.18 $\pm 9.29$ ), double vessel disease (8.86 $\pm 4.26$ ), and triple vessel disease (9.70 $\pm 6.38$ ) ( $P < 0.001$ ).

**Table 1: Distribution of demographic, anthropometric, and laboratory parameters (n=110)**

Parameter	Mean (standard deviation)
Age in years	51.45 $\pm 9.01$
Males, n (%)	47 (42.8%)
Females, n (%)	63 (57.2%)
Body mass index (kg/m <sup>2</sup> )	27.03 $\pm 5.18$
Waist circumference (cm)	91.10 $\pm 11.06$
Waist-hip ratio (cm)	0.86 $\pm 0.62$
Fasting lipid (mg/dL)	141.24 $\pm 35.63$
HDL (mg/dL)	39.48 $\pm 9.64$
Triglycerides (g/dL)	149.76 $\pm 68.03$
TC/HDL	3.62 $\pm 0.92$
LDL (mg/dL)	73.55 $\pm 40.87$
FBS (mg/L)	124.86 $\pm 55.02$

HDL: High-density lipoprotein, LDL: Low-density lipoprotein, FBS: Fasting blood sugar, TC: Total cholesterol

**Table 2: Average predictor scores in the study population**

Predictor scores	Values (n=110) (mean $\pm$ standard deviation)
Framingham scores	6.81 $\pm 5.30$
American College of Cardiology/ American Heart Association Score	5.09 $\pm 3.09$
Q risk score	8.27 $\pm 6.36$

**Table 3: Correlation of CIMT with Framingham scores, ACC/AHA score, and Q risk score (n=110)**

Correlation of CIMT	Correlation coefficient (r)	P-value
Framingham scores	0.389	<0.001
ACC/AHA score	0.411	<0.001
Q risk score	0.506	<0.001

ACC/AHA: American College of Cardiology/American Heart Association, CIMT: Carotid intima-media thickness

**Table 4: Association of CAG report with Framingham score, ACC/AHA score, and Q risk score (n=110)**

Coronary angiography report	Mean (standard deviation)		
	Framingham score	ACC/AHA score	Q risk score
Normal	4.77±3.61	2.25±2.46	4.85±4.50
Minimal coronary artery disease	6.20±4.37	4.97±5.64	8.19±6.94
Single vessel disease	14.18±9.29	9.16±7.60	12.46±6.85
Double vessel disease	8.86±4.26	9.22±7.86	13.45±9.06
Triple vessel disease	9.70±6.38	9.38±8.70	13.36±9.24
P-value	<0.001	<0.001	<0.001

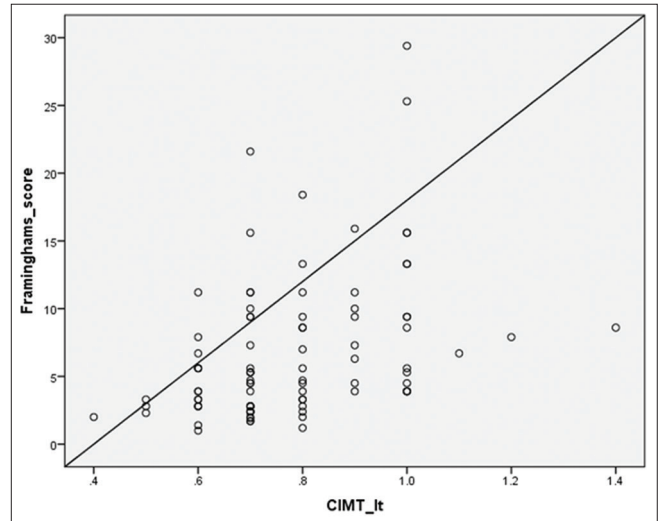
ACC/AHA: American College of Cardiology/American Heart Association

for all). Similarly, ACC/AHA scores and Q risk scores showed similar trends, with higher scores associated with more severe CAG findings.

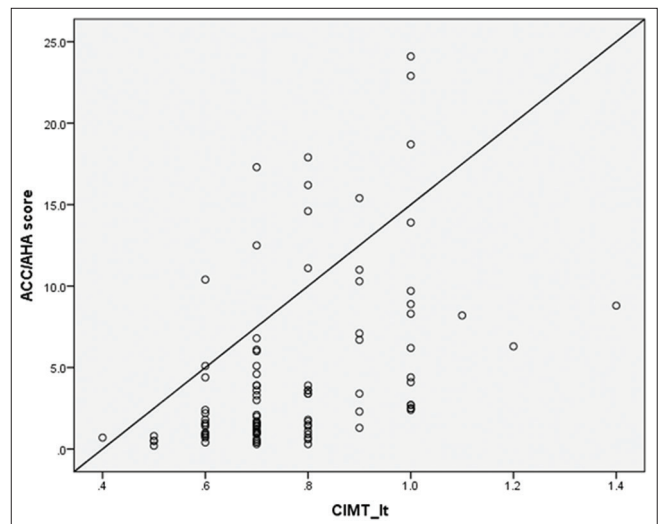
Figure 4 Displays the receiver operating characteristic curve comparing the predictive abilities of the Framingham score, ACC/AHA score, and Q risk score with CAG reports. The AUC values indicate the discriminatory power of each score in predicting the presence of CAD. Framingham score exhibited an AUC of 0.683, ACC/AHA score showed an AUC of 0.699, and the Q risk score demonstrated an AUC of 0.695.

## DISCUSSION

The results of this study provide valuable insights into the performance of three widely used CV risk assessment algorithms – the Framingham score, ACC/AHA score, and Q risk score – in predicting the presence of CVDs as determined by CAG. Our findings reveal that all three scoring systems exhibit moderate discriminatory ability in predicting the presence of CVD, with the ACC/AHA score demonstrating slightly higher discriminative power compared to the Framingham score and Q risk score. These results corroborate previous studies that have emphasized the utility of these risk assessment tools in identifying individuals at heightened risk of CV events.<sup>3,4</sup>



**Figure 1:** A positive correlation between carotid intima-media thickness and Framingham score

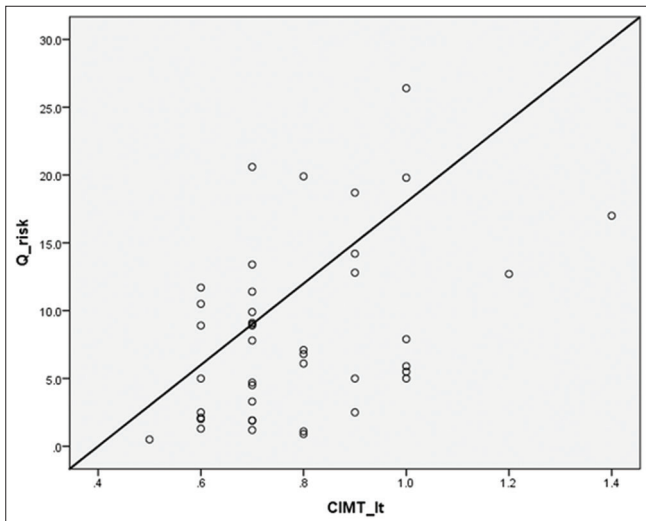


**Figure 2:** A positive correlation between carotid intima-media thickness and American College of Cardiology/American Heart Association score

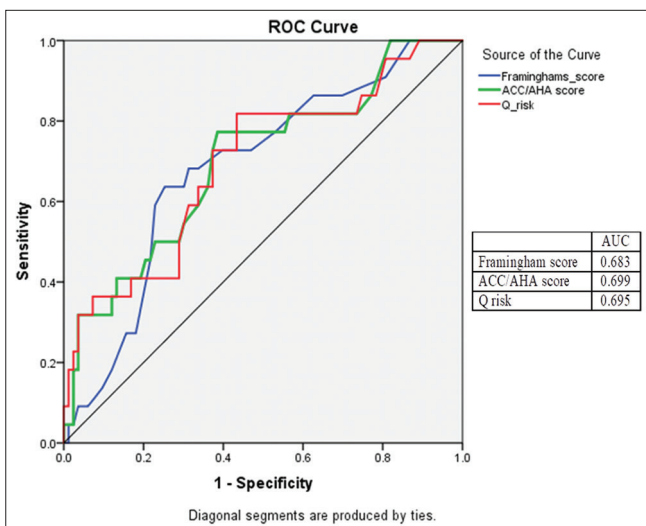
Accurate estimation of CV risk is imperative in clinical practice as it furnishes an objective measure of the severity of the illness and facilitates informed treatment decisions.<sup>7</sup> Our study underscores the importance of integrating CV risk assessment into routine clinical practice, particularly in populations characterized by a high burden of CV risk factors, such as smoking, alcohol consumption, and dyslipidemia. Consistent with existing evidence, we observed that individuals with elevated levels of total cholesterol and LDL were at increased risk of CV events, thereby underscoring the critical role of lipid management in CV risk reduction.<sup>2,8</sup>

This study revealed significant positive correlations between CIMT, a marker of subclinical atherosclerosis, and all three CV risk scores. This suggests that individuals





**Figure 3:** A positive correlation between carotid intima-media thickness and Q risk score



**Figure 4:** Receiver operating characteristic curve comparing the predictive ability of Framingham score, American College of Cardiology/American Heart Association score, and Q risk score with coronary angiography reports

with greater CIMT measurements are more likely to have elevated CV risk scores, highlighting the potential utility of CIMT assessment as a complementary tool in CV risk stratification.<sup>9,10</sup> In addition, the observed associations between the severity of CAG findings and higher Framingham, ACC/AHA, and Q risk scores further validate the utility of these risk assessment algorithms in predicting CAD severity.

Of particular note, the ACC/AHA and Q risk scores exhibited stronger correlations with CV events compared to the Framingham score, indicating that these algorithms may offer improved predictive accuracy in Indian populations. Especially, the Q risk score demonstrated the

least likelihood of underestimating CV events, suggesting its potential utility as a robust risk assessment tool.<sup>11,12</sup> These findings have significant clinical implications, suggesting that the ACC/AHA and Q risk scores may be the most appropriate CV risk assessment algorithms for use in Indian populations at present.<sup>13-15</sup> By identifying the ACC/AHA and Q risk scores as potentially superior tools for CV risk assessment in the Indian population, our study contributes to the optimization of preventive strategies and healthcare resource allocation. These results align with the evolving landscape of CV risk assessment, emphasizing the importance of incorporating validated risk prediction models that reflect the unique characteristics of diverse populations.<sup>16</sup>

However, it is important to acknowledge certain limitations of our study, including its cross-sectional design and relatively small sample size. In addition, the study was conducted at a single center, which may limit the generalizability of our findings to broader populations. Therefore, large-scale prospective studies are warranted to validate our results and further elucidate the performance of CV risk assessment tools in Indian populations. Moreover, future research should explore the potential impact of integrating CIMT assessment into routine CV risk stratification protocols and evaluate the long-term predictive value of these risk scores in guiding clinical management decisions.

#### Limitations of the study

It is a single centered, cross sectional study with a relatively small sample size. Hence large scale prospective study is needed to further validate our study results.

## CONCLUSION

This study contributes to the growing body of evidence on the performance of commonly used CV risk assessment algorithms in predicting the presence of CAD in Indian populations. The findings underscore the importance of comprehensive CV risk assessment in clinical practice and suggest that the ACC/AHA and Q risk scores may offer improved predictive accuracy compared to the Framingham score. These findings have implications for guiding risk stratification and management strategies aimed at reducing the burden of CVD in India and beyond.

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## AVAILABILITY OF DATA AND MATERIAL

The datasets analyzed during this study are available from the corresponding author on reasonable request.

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### Authors Contribution:

**ES-** Definition of intellectual content, literature survey, prepared the first draft of the manuscript, implementation of the study protocol, data collection, data analysis, manuscript preparation and submission of article; **KK-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **NM-** Design of study, statistical analysis, and Interpretation; **VN-** Review manuscript.

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