

Original Research Article

Evaluation of cardiovascular risk using the Framingham risk score among adults attending a tertiary care centre: a cross-sectional study

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ABSTRACT

Background: Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality in India. The Framingham risk score (FRS) is a validated tool for estimating 10-year CVD risk; however, data on its applicability in tertiary care settings in Kerala are scarce.

Objective: To evaluate the 10-year cardiovascular risk profile of adults attending a tertiary care centre using the FRS and to identify factors associated with high cardiovascular risk.

Methods: A cross-sectional study was conducted among 450 adults aged 30–75 years attending outpatient departments of a tertiary care centre in Thiruvananthapuram, Kerala, from January to June 2026. The FRS was calculated using standard variables: age, sex, total cholesterol, HDL cholesterol, systolic blood pressure, antihypertensive treatment status, and smoking status. Participants were categorised as low (<10%), intermediate (10–19%), or high (≥20%) risk.

Results: The mean age of participants was 52.4±11.8 years (218 males, 232 females). The overall mean FRS was 17.4±9.2%. A total of 154 participants (34.2%) were categorised as high risk (FRS≥20%), 184 (40.9%) as intermediate risk, and 112 (24.9%) as low risk. Males had a significantly higher mean FRS than females (19.8% vs. 15.3%, $p=0.003$). Hypertension (OR 2.87; 95% CI 2.14–4.55), diabetes mellitus (OR=2.31), and current smoking (OR=1.94) were the strongest independent predictors of high cardiovascular risk.

Conclusions: A substantial proportion of adults attending this tertiary care centre are at high cardiovascular risk. The FRS is an effective and feasible screening tool in this setting. Targeted interventions addressing hypertension, diabetes, and tobacco use are urgently needed to reduce the CVD burden in this population.

Keywords: Framingham risk score, Cardiovascular risk, Tertiary care, India, Hypertension, Diabetes mellitus, Cross-sectional study

INTRODUCTION

Cardiovascular disease (CVD) constitutes the foremost cause of premature death and disability worldwide, accounting for approximately 17.9 million deaths annually, according to the World Health Organization. In India, the epidemiological transition over the past three decades has accelerated the rise of CVD, which now contributes to nearly 28% of all-cause mortality. The state

of Kerala, despite its high human development index, paradoxically bears one of the highest burdens of non-communicable diseases in the country, with CVD mortality rates exceeding the national average.^{1,2}

Preventing CVD events requires accurate identification of at-risk individuals before the onset of clinical disease. Risk stratification tools enable clinicians to estimate an individual's probability of developing a major

cardiovascular event, such as myocardial infarction or stroke over a defined time horizon. Among the numerous risk prediction models developed and validated over the past decades, the FRS remains the most widely used globally.³ Originally derived from the landmark Framingham heart study cohort in the United States, the FRS estimates 10-year cardiovascular risk using a combination of traditional risk factors: age, sex, total cholesterol, high-density lipoprotein (HDL) cholesterol, systolic blood pressure, antihypertensive medication use, and current smoking status.⁴

Despite Kerala's advanced healthcare infrastructure, robust data on the distribution of cardiovascular risk categories using the FRS among adults attending tertiary care facilities in the state are limited.⁵ Understanding the burden of high-risk individuals in this setting is essential for informing resource allocation, designing targeted prevention programmes, and prioritising intensive therapeutic strategies.^{6,7} Furthermore, identifying modifiable determinants of high FRS scores could guide evidence-based clinical and public health interventions. The present study was undertaken to evaluate the FRS among adults attending a tertiary care centre.

METHODS

A hospital-based cross-sectional study was conducted among adults aged 30-75 years attending the outpatient departments of a tertiary care centre in Thiruvananthapuram, Kerala, India, between January and June 2026. Consecutive sampling was employed to recruit eligible participants during the study period. Individuals attending the outpatient department for evaluation of non-acute conditions who provided written informed consent and had complete data available for FRS calculation were included in the study. Participants with a prior history of coronary artery disease, stroke, or peripheral arterial disease, pregnant or lactating women, those unwilling to participate, and individuals with severe illness precluding assessment were excluded. Based on an estimated prevalence of high cardiovascular risk of 30%, a confidence level of 95%, a margin of error of 5%, and a 10% non-response rate, a minimum sample size of 426 was calculated; however, 450 participants were enrolled.

Data were collected using a structured and pre-tested interviewer-administered questionnaire that captured sociodemographic characteristics, clinical history, and lifestyle-related factors. Anthropometric measurements including height, weight, and waist circumference were recorded using standardised procedures. Blood pressure was measured after five minutes of seated rest using a calibrated digital sphygmomanometer, and the average of two readings taken five minutes apart was considered for analysis. Fasting venous blood samples were obtained following an overnight fast of at least 10 hours and analysed for fasting blood glucose, HbA1c, lipid profile, serum creatinine, and complete blood count using standard laboratory methods. The sex-specific FRS was calculated

for each participant using age, total cholesterol, HDL cholesterol, systolic blood pressure, antihypertensive treatment status, and smoking status. Participants were categorised into low-risk (<10%), intermediate-risk (10-19%), and high-risk ($\geq 20\%$) groups based on their estimated 10-year cardiovascular risk.

Data were entered into Microsoft excel and analysed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Appropriate statistical tests, including Student's t-test, one-way ANOVA, and Chi-square test, were used to compare variables between groups. Logistic regression analyses were performed to identify independent predictors of high cardiovascular risk, and results were expressed as odds ratios with 95% confidence intervals. A $p < 0.05$ was considered statistically significant.

RESULTS

A total of 450 adults were enrolled, comprising 218 males (48.4%) and 232 females (51.6%). The overall mean age was 52.4 ± 11.8 years (range 30-75 years). The majority of participants (58.9%) were in the 40-59 year age group. Hypertension was the most prevalent comorbidity, affecting 267 participants (59.3%), followed by dyslipidemia (53.6%) and diabetes mellitus (44.0%). Current smoking was reported by 87 participants (19.3%), predominantly males (33.0% vs. 6.5% in females). Family history of premature CVD was present in 34.7% of participants (Table 1).

The overall mean FRS was $17.4 \pm 9.2\%$. When stratified by risk category, 112 participants (24.9%) were classified as low risk (FRS <10%), 184 (40.9%) as intermediate risk (FRS 10-19%), and 154 (34.2%) as high risk (FRS $\geq 20\%$). Males had a significantly higher mean FRS than females ($19.8 \pm 9.7\%$ vs. $15.3 \pm 8.4\%$; $p = 0.003$). Proportion of high-risk individuals was significantly greater among males than females (40.4% vs. 28.4%) (Table 2).

A significant gradient in cardiovascular risk was observed across age groups ($p < 0.001$). Participants in the 60-75 year age group had the highest mean FRS ($26.8 \pm 10.1\%$) and the greatest proportion of high-risk individuals (54.7%). In contrast, participants aged 30-39 years had a mean FRS of $8.3 \pm 3.1\%$, with only 5.9% classified as high risk. Among those aged 50-59 years, nearly two-fifths (39.2%) were in the high-risk category.

Bivariate logistic regression identified age, male sex, hypertension, diabetes mellitus, current smoking, dyslipidemia, family history of CVD, and obesity as significant predictors of high cardiovascular risk (FRS $\geq 20\%$). On multivariate logistic regression, adjusting for all covariates simultaneously, hypertension (adjusted OR 2.87; 95% CI 2.14-4.55; $p < 0.001$), age per 10-year increment (adjusted OR 2.19; 95% CI 1.87-3.10; $p < 0.001$), and diabetes mellitus (adjusted OR 2.31; 95% CI 1.82-

3.83; $p < 0.001$) emerged as the three strongest independent predictors of high cardiovascular risk. Current smoking (adjusted OR 1.94), male sex (adjusted OR 1.58),

dyslipidemia (adjusted OR 1.74), obesity (adjusted OR 1.44), and family history of CVD (adjusted OR 1.33) were also independently associated (Table 3).

Table 1: Baseline sociodemographic and clinical characteristics of study participants, (n=450).

Characteristics	Overall, (n=450)	Male, (n=218)	Female, (n=232)
Age (in years)			
Mean $\pm$ SD	52.4 $\pm$ 11.8	53.1 $\pm$ 12.2	51.8 $\pm$ 11.4
Range	30-75	30-75	30-74
Risk factors, N (%)			
Hypertension	267 (59.3%)	138 (63.3%)	129 (55.6%)
Diabetes mellitus	198 (44.0%)	101 (46.3%)	97 (41.8%)
Dyslipidemia	241 (53.6%)	118 (54.1%)	123 (53.0%)
Smoking (current)	87 (19.3%)	72 (33.0%)	15 (6.5%)
Family History of CVD	156 (34.7%)	79 (36.2%)	77 (33.2%)
Lab values (Mean$\pm$SD)			
Total cholesterol (mg/dl)	212.6 $\pm$ 38.4	209.1 $\pm$ 37.8	215.8 $\pm$ 39.0
HDL cholesterol (mg/dl)	44.3 $\pm$ 9.7	41.2 $\pm$ 8.4	47.1 $\pm$ 10.2
Systolic BP (mmHg)	138.7 $\pm$ 18.5	140.2 $\pm$ 19.1	137.3 $\pm$ 17.9
BMI (kg/m ²)	27.8 $\pm$ 4.6	27.2 $\pm$ 4.3	28.3 $\pm$ 4.9

Table 2: Distribution of FRS categories by sex, (n=450).

FRS risk category	Overall	Male	Female	P value
Low (<10%)	112 (24.9%)	41 (18.8%)	71 (30.6%)	<0.001
Intermediate (10-19%)	184 (40.9%)	89 (40.8%)	95 (40.9%)	
High ($\geq$20%)	154 (34.2%)	88 (40.4%)	66 (28.4%)	
Mean FRS ($\pm$SD)	17.4 $\pm$ 9.2%	19.8 $\pm$ 9.7%	15.3 $\pm$ 8.4%	0.003

Table 3: Bivariate and multivariate logistic regression analysis-predictors of high cardiovascular risk (FRS $\geq$ 20%).

Variables	OR (Crude)	95% CI	OR (Adjusted)	P value
Age (in years)	2.41	1.87-3.10	2.19	<0.001
Gender (Male)	1.73	1.21-2.47	1.58	0.003
Hypertension	3.12	2.14-4.55	2.87	<0.001
Diabetes mellitus	2.64	1.82-3.83	2.31	<0.001
Current smoking	2.18	1.38-3.44	1.94	0.001
Dyslipidemia	1.96	1.37-2.81	1.74	0.002
Family history of CVD	1.48	1.02-2.15	1.33	0.041
Obesity (BMI $\geq$30)	1.62	1.08-2.43	1.44	0.027

DISCUSSION

The present study evaluated cardiovascular risk among adults attending a tertiary care centre using the FRS. A substantial proportion of participants (34.2%) were categorized as having high cardiovascular risk (FRS $\geq$ 20%), while 40.9% and 24.9% belonged to the intermediate- and low-risk groups, respectively. These findings indicate a considerable burden of cardiovascular risk among adults seeking tertiary healthcare services. Similar observations have been reported by D'Agostino et al who demonstrated the usefulness of the Framingham model in identifying individuals at elevated risk of future cardiovascular events and emphasized the importance of risk-based preventive strategies.⁸

In the present study, males exhibited significantly higher mean FRS values than females (19.8% vs. 15.3%), and a greater proportion of men were classified as high risk. This sex difference has been consistently reported in previous studies and may be attributed to the higher prevalence of smoking, hypertension, and adverse lipid profiles among men. Wilson et al in the original Framingham risk prediction model, also observed that male sex was associated with a substantially greater risk of developing coronary heart disease over a 10-year period.⁹ The higher smoking prevalence among men in our study may have further contributed to the observed disparity in cardiovascular risk.

A significant age-related increase in cardiovascular risk was observed, with participants aged 60-75 years

demonstrating the highest mean FRS and greatest proportion of high-risk individuals. Age emerged as one of the strongest predictors of elevated cardiovascular risk on multivariate analysis. These findings are consistent with those of D'Agostino et al who identified advancing age as a major determinant of cardiovascular risk across populations.⁸ Increasing age is associated with cumulative exposure to cardiovascular risk factors, progressive vascular changes, and a higher prevalence of metabolic disorders, thereby increasing the likelihood of future cardiovascular events.

Hypertension, diabetes mellitus, and current smoking were identified as the strongest independent predictors of high cardiovascular risk in the present study. Hypertension showed the highest adjusted odds ratio, highlighting its critical role in CVD development. Similar findings have been reported by Kannel et al who demonstrated that elevated blood pressure significantly increases the risk of coronary heart disease, stroke, and cardiovascular mortality.¹⁰ Likewise, diabetes mellitus independently doubled the likelihood of high cardiovascular risk in our study. This observation is supported by the findings of Haffner et al., who reported that individuals with diabetes have a cardiovascular risk profile comparable to those with established coronary artery disease.¹¹ Smoking also remained an independent predictor, reinforcing the substantial contribution of tobacco use to cardiovascular morbidity and mortality.

CONCLUSION

The findings of the present study underscore the value of the FRS as a practical and feasible tool for cardiovascular risk assessment in tertiary care settings. Early identification of high-risk individuals allows implementation of targeted interventions focusing on blood pressure control, glycaemic management, smoking cessation, and lifestyle modification. Such measures have the potential to substantially reduce the future burden of cardiovascular disease in this population. Future prospective studies tracking incident cardiovascular events will be essential to validate the predictive accuracy of the FRS in the Kerala population and inform the development of locally calibrated risk prediction models.

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