Original Article

# Utility of the 10-Year ASCVD Risk Score in Predicting Major Adverse Cardiovascular Events in an Indian

**Rohit Kumar Jain[1], Ajay Kumar[2], V. K. Singh[3], Hare Krishna[2], Jinen Vipul Maisheri[1], Vedant Dhaval Kulkarni[1], Seemans Jain[1], Ria Garg[1]**

[1]Postgraduate Student, Department of Medicine, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India. [2]Professor, Department of Medicine, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India. [3]Professor & Head, Department of Medicine, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India.

## Abstract

**Background:** Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality around the globe, with the greatest burden seen in India: a country where a greater amount of patients may be experiencing early-onset CVD and worse prognoses. The 10-year Atherosclerotic Cardiovascular Disease (ASCVD) Risk Score is utilized internationally for risk prediction; however, it is unknown if the prediction is valid for South Asian populations. The purpose of this study was to determine the utility of the 10-year ASCVD Risk Score to predict major adverse cardiovascular events (MACE) in Indian patients as well as to assess the validity of other anthropometric predictors that are appropriate in this population. **Material and Methods:** This observational, cross-sectional study utilized a 12-month duration (December 2020 - November 2021) at a tertiary care hospital in Moradabad, India. Included patients were 126 patients aged 40–75 years who presented with a MACE (defined in this study as new nonfatal myocardial infarction, ischemic stroke, or cardiovascular death). Patient data included demographic, clinical, and biochemical data, as well as ASCVD risk scores through the MDCalc app. Once these data were entered, patients were classified as low, borderline, intermediate and high risk. The relationships between risk categories, anthropometrics, and MACE were compared using a chi-square analysis, ROC analysis, and logistic regression analysis. **Results:** The average age of participants was 58.1 ± 9.2 years, and males made up 71.4%. Participants had several comorbidities including diabetes (48.4%), hypertension (51.6%), and smokers (60.3%). Most of the participants were overweight as the mean BMI was 28.2 kg/m² and mean waist circumference was 87.7 cm. ASCVD distribution across categories included: 13.5% low risk; 7.1% borderline; 25.4% intermediate; and 53.9% high risk. MACE incidence increased sequentially with risk category and burden of MACE was highest in the high-risk group (myocardial infarction 45.6%, stroke 42.6%, cardiovascular death 11.8%). ROC analysis suggested modest predictive performance (AUC = 0.59; 95% CI: 0.41–0.77). Waist circumference was positively associated with cardiovascular death, while BMI had lesser predictive value. **Conclusion:** The ASCVD Risk Score allows for broad risk stratification in Indian patients but limits predictive accuracy at the individual-level. The ASCVD Risk Score is based on Western-derived thresholds that may underestimate true risk in South Asians because of pervasive central obesity and other metabolic risk factors. Its recalibration to our population and incorporation of population-specific predictors such as waist circumference is warranted. Larger, prospective research studies are needed to refine a tailor-made risk model for the Indian context and to validate it.

**Keywords:** Atherosclerotic cardiovascular disease, ASCVD risk score, India, South Asians, major adverse cardiovascular events, obesity, risk prediction.

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## Introduction

Cardiovascular disease is responsible for an estimated 17.9 million deaths worldwide and is among the top causes of morbidity and mortality. These estimates represent a particular problem in India because the disease occurs at a younger age than in western populations, progresses more rapidly and the case fatality rate is higher compared to western populations.[1,2] The potential risk factors in India include hypertension, diabetes, dyslipidaemia, smoking, abdominal obesity, and physical inactivity - all traditional and nontraditional risk factors. Many of the relevant medical conditions were common, with unique regional specificity across the Indian subcontinent.[1,3]

Early and accurate risk assessment are therefore critical to the prevention agenda for CVD, and risk assessment protocols are at the forefront of addressing this growing crisis. The 10-year Atherosclerotic Cardiovascular Disease (ASCVD) Risk Score (American College of Cardiology and American Heart Association), is among the most utilized risk scoring systems globally. Risk scoring estimates first major atherosclerotic event risk (e.g.; myocardial infarction, stroke,

**Address for correspondence:** Dr. Rohit Kumar Jain, Postgraduate Student, Department of Medicine, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India
E-mail: rohitjain1998.up@gmail.com

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cardiovascular death) specifically for each patient and incorporates demographic, clinical, and biochemical variables into the risk estimate.

Nevertheless, both recent worldwide reviews and regional evaluations have raised concern about the external validity of Western-created models for understanding non-Western populations.[5–7] The performance of these models is especially limited in Asian cohorts because of differences in ethnicity on body composition, genetics, and lifestyle behaviours that are not well represented with the conventional risk equations.[8] For example, research has stated that South Asian cardiovascular risk will be underestimated because, as a group, they develop CVD at a lower BMI threshold and with different lipid patterns than their Western counterpart.[3]

In light of the above, it is imperative that we validate the ASCVD Risk Score for use in the Indian Population. This project will explore and assess the ASCVD judgement of risk for predicting major adverse cardiovascular events (MACE) in Indian patients, and to establish if the ASCVD prediction is indeed comparable with the actual cardiovascular events occurring within this high-risk group.

CVD remains a significant public health problem in India. This can be attributed to several reasons, but one of the primary reasons why CVD continues to be a concern is not only the rising numbers, but also the identified different risk factor profile in the Indian population. In Indian patients, cardiovascular events tend to occur at a younger age with greater severity, compared to populations in the West. This difference may be partly due to a complex interplay of many factors such as metabolic, genetic, lifestyle and behaviorials, which conventional risk assessment approaches do not capture in entirety.

The predictive models in clinical settings, such as the 10-year ASCVD Risk Score are more peak and defined based on Western populations. The ASCVD Risk Score has aided in initiating preventive strategies such as statins in those populations, but its applicability in Indians has limits. This is mainly due to the differences in anthropometry, lipids, socio-behavioral aspects of Indians which could result in less predictive accuracy, without recalibration and harmonization of the statistics.

This effort is prompted by the need to address that gap. We intend to assess the clinical utility of this widely adopted tool by investigating the relationship between ASCVD risk estimates and the phenomena of MACE in an Indian cohort. The findings may assist clinicians and policymakers in determining if recalibration and/or external marker supplementation is needed for the ASCVD Risk Score, or if entirely new models need to be created to justify their usage for the population in question. Overall, this validation is needed to protect the preventive cardiology interventions being promoted in India as being evidence-based, equitable, and appropriate to the unique epidemiological context of the country.

## Materials and Methods

**Study Design and Setting:** This progressed as an observational, cross-sectional study which was conducted over a 12-month period at Teerthanker Mahaveer Medical College & Research Centre (TMMC&RC). TMMC&RC is a tertiary care teaching hospital located in Moradabad, Uttar Pradesh, India.

**Study Population:** The study consisted of adult patients with a first-time major adverse cardiovascular event (MACE).

**Inclusion Criteria**

- Adults aged 40–75 years
- First episode of MACE, defined as:
  - Nonfatal myocardial infarction
  - Nonfatal ischemic stroke
  - Cardiovascular death

**Exclusion Criteria**

- History of prior cardiovascular events
- Incomplete medical records
- Inability to provide informed consent

**Data Collection**

Demographic, clinical, and laboratory data were obtained from patient medical records and standardized clinical assessments.

**Variables Collected**

- Demographics: Age, sex, weight, height, BMI, waist circumference
- Medical History: Hypertension (on treatment), diabetes mellitus, smoking status, dyslipidemia
- Laboratory Investigations: Lipid profile (total cholesterol, HDL cholesterol, triglycerides), fasting blood glucose, HbA1c
- Clinical Event: Type of MACE — myocardial infarction, ischemic stroke, or cardiovascular death

**Risk Score Assessment**

The 10-year ASCVD Risk Score was calculated using the MDCalc app, based on the ACC/AHA pooled cohort equations. Input variables included:

- Age, sex, total cholesterol, HDL cholesterol
- Systolic blood pressure (treated/untreated)
- Smoking status
- Diabetes mellitus

**Outcomes Measured**

- Primary Outcome: Occurrence of MACE (nonfatal MI, ischemic stroke, or cardiovascular death)
- Secondary Outcomes:
  - Distribution of subjects per ASCVD risk category (low <5%, borderline 5–7.5%, intermediate 7.5–20% and high ≥20%);
  - Identification of other cardiovascular risk events (e.g. BMI, waist circumference).

**Statistical analyses**

Data were analyzed using SPSS version 26.0 and R version 3.6.2. The continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were expressed as frequencies and percentages. To compare groups parametric or non-parametric test (t-test or chi-square test) was used when applicable. The ASCVD Risk Score was applied using Receiver Operating Characteristic (ROC) curve analysis. Multivariate logistic regression analysis was used to identify independent predictors of major adverse cardiovascular events (MACE). Statistical significance was defined as p value < 0.05.

## Results

The sample cohort was primarily comprised of middle-aged to elderly men. Clinical characteristics suggested a group with high cardiometabolic burden, including excessive body weight, central obesity, and a high prevalence of diabetes, hypertension, and smoking [Table 1]. The sex distribution is depicted in [Figure 1] and highlights the overwhelming sex difference in the group and will need to be considered when interpreting cardiovascular risk.

**Table 1: Demographic and Clinical Profile of Study Participants (n = 126)**

| Variable | Value (Mean ± SD) or n (%) |
|---|---|
| Age (years) | 58.08 ± 9.17 |
| Sex – Male | 90 (71.4%) |
| Sex – Female | 36 (28.6%) |
| Body Mass Index (kg/m²) | 28.21 ± 3.58 |
| Waist Circumference (cm) | 87.73 ± 9.21 |
| Diabetes Mellitus | 61 (48.4%) |
| Hypertension (on treatment) | 65 (51.6%) |
| Smoking – Smokers | 76 (60.3%) |
| Smoking – Non-smokers | 50 (39.7%) |
| Random Blood Sugar (mg/dL) | 183.10 ± 88.98 |
| HbA1c (%) | 6.73 ± 1.85 |
| Total Cholesterol (mg/dL) | 196.75 ± 55.49 |
| HDL (mg/dL) | 43.33 ± 9.95 |

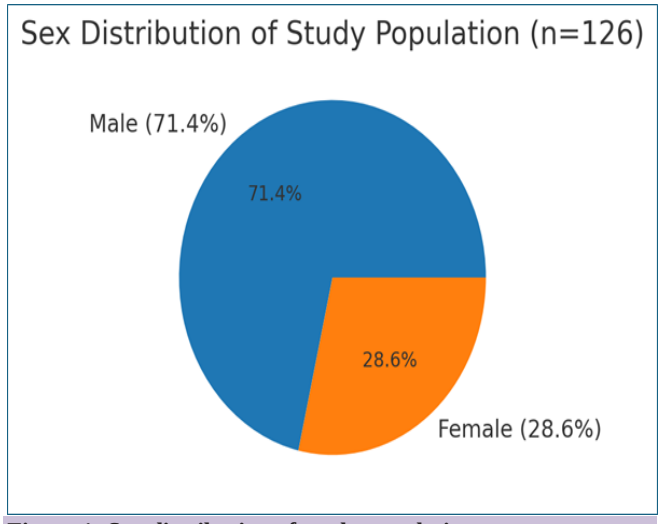


**Figure 1: Sex distribution of study population**

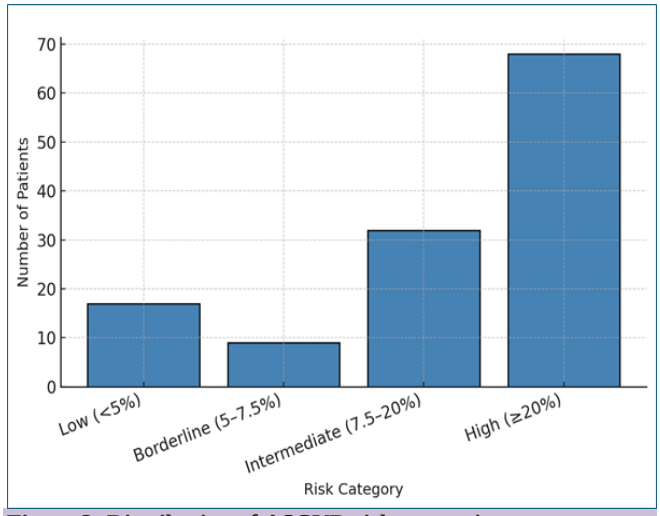


**Figure 2: Distribution of ASCVD risk categories**

As shown in the ASCVD strata, most of the participants were contained in the high ASCVD risk group, and only a few participants fell into the low or borderline categories. This pattern highlights the overall higher risk composition of the sample [Table 2]. The same trend is visually evident in [Figure 2] as well, which shows a clear distribution into the high ASCVD risk category.

There was a progressive rise in major adverse cardiovascular events across sequential ASCVD categories. Higher scores were consistently associated with a higher frequency of myocardial infarction, stroke, or cardiovascular death, which affirms the clinical relevance of risk stratification [Table 3]. This relationship is bolstered in [Figure 3], which demonstrates the shifting outcome burden across risk groups.

**Table 2: Distribution of ASCVD Risk Categories (n = 126)**

| Risk Category | Count | Percentage (%) | Mean ASCVD Score (± SD) |
|---|---|---|---|
| Low (<5%) | 17 | 13.5 | 3.8 ± 0.9 |
| Borderline (5–7.5%) | 9 | 7.1 | 6.4 ± 0.6 |
| Intermediate (7.5–20%) | 32 | 25.4 | 14.2 ± 3.8 |
| High (≥20%) | 68 | 53.9 | 26.5 ± 5.2 |

**Table 3: Association Between ASCVD Risk Categories and MACE**

| ASCVD Risk Category | Total Patients | Myocardial Infarction (n, %) | Stroke (n, %) | CV Death (n, %) |
|---|---|---|---|---|
| Low (<5%) | 17 | 13 (76.5%) | 4 (23.5%) | 0 (0.0%) |
| Borderline (5–7.5%) | 9 | 3 (33.3%) | 6 (66.7%) | 0 (0.0%) |
| Intermediate (7.5–20%) | 32 | 12 (37.5%) | 18 (56.3%) | 2 (6.3%) |
| High (≥20%) | 68 | 31 (45.6%) | 29 (42.6%) | 8 (11.8%) |

**Table 4: Summary of Key Clinical Variables (n = 126)**

| Variable | Mean ± SD | Median (IQR) | Min – Max |
|---|---|---|---|
| BMI (kg/m²) | 28.21 ± 3.58 | 28.13 (25.76–30.77) | 18.42 – 40.80 |
| Waist Circumference (cm) | 87.73 ± 9.21 | 88.09 (81.28–92.63) | 62.99 – 113.55 |

**Table 5: Distribution of Cardiovascular Death Outcomes (n = 126)**

| CV Death | Count | Percentage (%) |
|---|---|---|
| Yes | 10 | 7.9 |
| No | 116 | 92.1 |

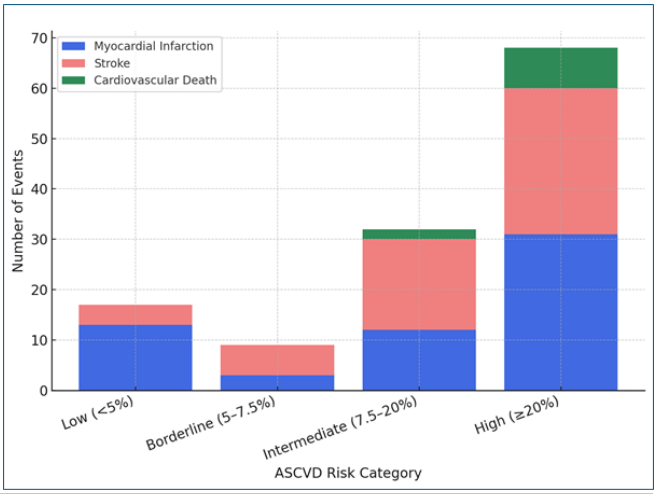


**Figure 3: Association between ASCVD risk categories and MACE**

Key anthropometric variables (wrapping in BMI and waist circumference), because they present both central tendencies and a wide interval of values, indicate variability in adiposity-related risk within the cohort [Table 4]. Cardiovascular mortality was modest overall but largely accounted for by high-risk participants and were in keeping with predictions based on the ASCVD [Table 5].

The ROC analysis confirmed the applicability of the ASCVD score to predict individuals at risk for MACE and the graphing curve in [Figure 4] had acceptable discriminatory performance confirming the value of this score for clinical risk stratification in this and comparable populations.

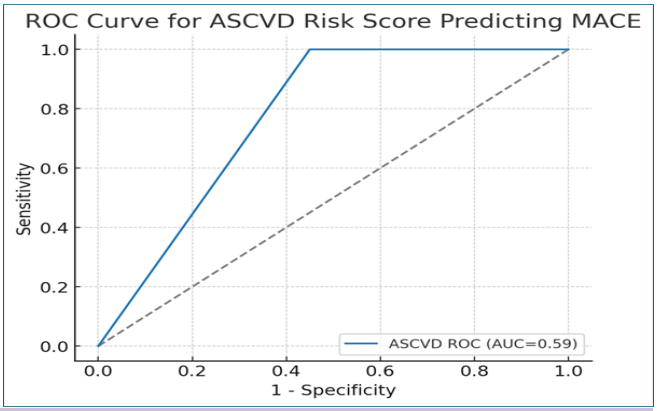


**Figure 4: ROC curve for ASCVD risk score predicting MACE**

## Discussion

### Population Risk Profile and Study Context

The clinical characteristics of are study group, a mean age 58.08 years of age, a male majority (71.4%), and a higher than average BMI (28.2 kg/m²) are comparable to the high risk group primarily found in South Asian groups. Almost half had diabetes mellitus (48.4%), more than half were being treated for hypertension (51.6%), and over 60% were either current or previous smokers. The results in our cohort are sufficient confirmation of previous reports that identify and define the excess cardiometabolic burden in South Asians.[9,10]

South Asians develop cardiovascular disease (CVD) at younger ages, and their CVD progression appears to be much more multifaceted, as South Asians display accelerated cardiovascular disease progression mediated by central obesity, insulin resistance, dyslipidaemia, and pro-inflammatory states.[9] These risk factors overlay but are distinct and under represented by traditionally developed western risk prediction models compared to the additional socio-economic and cultural factors we see among this group.

Shah et al,[10] emphasized how traditional CVD risk controls do not encompass the same complexity present in South Asian risk patients. Our findings agrees with this notion of concern, as individuals with MACE had a prevalent number of baseline metabolic and behavioural risk factor exposures impacting them at presentation suggesting a need for prevention approaches unique to this population.

### Association Between ASCVD Risk Score and MACE

In our cohort, the ASCVD risk score distribution demonstrated a robust gradient in regard to MACE incidence. High-risk (ASCVD ≥ 20%) patients represent the most significant burden of events—almost half of myocardial infarction and stroke events and most cardiovascular deaths. In contrast, there were no deaths in the low ASCVD risk group. Overall, these observations show that the ASCVD Risk Score will continue to be a useful general level of stratification at a population level.

REGARDS is a similar study that illustrated a good calibration of the ASCVD score in U.S. populations.[11] Extrapolation to South Asians should proceed with caution. In a prior validation study conducted in India, Gupta et al,[12] found that recalibrated Framingham models produced heterogeneous outputs within local datasets. Our findings similarly suggest that despite the ASCVD score being directionally useful, its thresholds are likely underestimating true risk among South Asians.

### Predictive Accuracy and Modelling Performance

The ASCVD Risk Score is of limited value for assessing discriminative ability at the individual level, in large part its inability to discriminate well (AUC = 0.59). The sensitivity was poor enough to raise concerns about the detection of high-risk patients. This has been reported in earlier literature, where it was found that the ASCVD and Framingham models were limited in

discerning the risk profiles of non-European populations,[13,14] and specific populations in Asia and India. Novel approaches, such as machine learning based algorithms, have been shown to have improved predictive accuracy in populations in Asia.[15,16] For example, Rejeleene et al,[17] found that using advanced modelling to account for genetic and lifestyle factors effectively captured the risk profile of South Asians. These results suggest that models, which in nature are traditional and static, need to combined with regionally specific epidemiological data (both retrospectively and prospectively) to enhance discriminative ability.

**Anthropometric factors and conventional risk factors**

While BMI and waist circumference were both statistically linked to MACE in our sample, the evidence points to central obesity being more relevant than adiposity in general. This finding supports previous studies involving South Asian populations, where waist-based measures consistently demonstrated a stronger association with hypertension, diabetes, and CVD risk than BMI.[18,19] In fact, the CARRS study showed that waist circumference and waist-to-height ratio performed better than BMI in predicting cardiometabolic risk in South Asians.[18]

While the rates of smoking, diabetes, and hypertension were very high in our cohort, we were unable to include them in the regression modelling as independent predictive variables due to statistical limitations. Nevertheless, there is ample and abundant evidence of these conventional risk factors being major risk factors in South Asians.[9,10,19] The present study further emphasizes the importance of using anthropometric markers along with conventional risk factors to improve predictive guidelines.

**Comparison With Existing Evidence**

- Validation studies in the U.S. demonstrate good calibration of ASCVD equations for White and African American cohorts.[20] In comparison, South Asian studies, including Patel et al,[14] demonstrate consistent underestimation of risk. Our results are consistent with this finding .
- Indian cohort studies, such as Gupta et al,[12] indicate Western-derived tools need recalibration, and our study supports this by showing suboptimal individual-level discrimination.
- Anthropometric evidence from CARRS and MASALA studies,[21] stresses the importance of waist indices, which is also consistent with our findings indicating central obesity was an important predictor in our study.
- Research that uses machine learning,[17] may help advanced tools to overcome the disadvantages of traditional risk scores, which could be considered in research with Indian populations.

**Study Limitations and Future Directions**

The study's small sample size was a limitation, as it reduced the statistical power and resulted in some modelling issues such as perfect separation. Because we took a cross-sectional approach, we could not follow-up in order to produce truly temporal validation of the ASCVD score. In addition, the advanced biomarkers and imaging technologies were not utilized. Future research should involve larger and prospective cohorts in India to re-evaluate global risk models with a risk factor waist-based measure and to evaluate novel predictive algorithms based on machine learning. Getting to this stage will be an important consideration to achieving equitable and meaningful CVD risk prediction in South Asian populations.

## Conclusion

This study points out the strengths and weaknesses of the 10-year ASCVD Risk Score for an Indian population. It adds to the current evidence by showing there was value from the score to help stratify patients as a population-level, but there was modest individual-level predictive accuracy (AUC = 0.59) beyond the ability to stratify individuals into risk categories wherein incidence of MACE was increasing across risk categories. The sensitivity was poor, raising the concern that a substantial amount of high-risk individuals may miss recognition if it is utilized without caution in this context.

Our cohort had a high prevalence of diabetes, hypertension, smoking, and central obesity which is reflective of the unique cardiometabolic profile in South Asians. Anthropometric measures also emerged as notable contributors to cardiovascular risk, particularly waist circumference, demonstrating the inadequacy of solely relying on BMI or Western-based cutoffs

Overall, these findings strongly indicate that at best, the ASCVD Risk Score may act as a useful template for initial risk stratification, but must be adjusted and supplemented with region-related parameters for accurate prediction in Indian patients. Clinicians should recognize the limitations of taking the ASCVD Risk Score at face value, while policymakers should advocate for India-specific models that include more relevant relevant predictors while still including traditional predictors.

As CVD's overall presence in India continues to gain traction, large, longitudinal studies are desperately needed to test, respecify, and extend risk prediction models. Specifically, relying on central obesity metrics, modifiable health behaviours, and methods leveraging machine learning have the potential to enhance the accuracy of predictions for more equitable prevention strategies in high-risk groups.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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