Calculation Method for the MaRS 10-Year Cardiovascular Risk Index

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Abstract

The MaRS Index is a logistic regression model designed to estimate the 10-year risk of cardiovascular disease (CVD) without requiring laboratory tests. Implemented in an HTML web application, it uses variables such as age, sex, systolic blood pressure, antihypertensive treatment, smoking, diabetes, body mass index (BMI), and family history of premature CVD. This document outlines the calculation method, coefficients, and their interpretation, with an example and discussion of the model's strengths and limitations.

1 Introduction

The MaRS Index provides a practical tool for estimating 10-year cardiovascular risk in settings without access to laboratory tests. Inspired by established models like Framingham, QRISK, and SCORE2, it incorporates non-laboratory variables to enhance accessibility and usability (1; 2; 3; 4). The model includes age, sex, systolic blood pressure (SBP), antihypertensive treatment, smoking status, diabetes, BMI, and family history of premature CVD, making it suitable for office-based risk assessment.

2 Methods

The MaRS Index employs logistic regression to estimate the probability of a major cardiovascular event over 10 years. The general formula is:

$$\text{logit}(p) = \beta_0 + \sum \beta_i \cdot x_i \tag{1}$$

where:

- p is the probability of cardiovascular risk ($p \in [0, 1]$);
- $\text{logit}(p) = \ln\left(\frac{p}{1-p}\right)$;
- β_0 is the intercept;
- β_i are the coefficients for the variables x_i.

The final probability (%) is calculated as:

$$\text{Risk (\%)} = 100 \cdot \frac{1}{1 + e^{-\text{logit}(p)}} \tag{2}$$

2.1 Variables and Coefficients

The variables and coefficients used in the MaRS Index are:

$$\begin{aligned}\text{logit}(p) = -3.2 &+ 0.70 \cdot \frac{\text{Age} - 50}{10} + 0.45 \cdot I(\text{male}) + 0.18 \cdot \frac{\text{SBP} - 120}{10} \\ &+ 0.15 \cdot I(\text{treated}) + 0.70 \cdot I(\text{smoker}) + 0.70 \cdot I(\text{diabetes}) \\ &+ 0.22 \cdot \frac{\text{BMI} - 25}{5} + 0.40 \cdot I(\text{family history})\end{aligned} \tag{3}$$

where:

- Age: Age in years (30–79).
- SBP: Systolic blood pressure in mmHg (90–200).
- BMI: Body mass index in kg/m² (16–50).
- $I(\cdot)$: Binary indicator (1 if the condition is true, 0 otherwise).

The following table summarizes the coefficients and their effects:

Table 1: Coefficients and Effects in the MaRS Index

Variable	Coefficient (β)	Hazard Ratio (e^{β})
Intercept	-3.2	—
Age (per +10 years)	0.70	2.01
Male sex	0.45	1.57
SBP (per +10 mmHg)	0.18	1.20
Antihypertensive treatment	0.15	1.16
Smoking	0.70	2.01
Diabetes	0.70	2.01
BMI (per +5 kg/m²)	0.22	1.25
Family history of premature CVD	0.40	1.49

2.2 Interpretation of Coefficients

- **Intercept (-3.2)**: Represents the logit of the baseline risk for a reference profile (female, 50 years, SBP 120 mmHg, BMI 25, no risk factors). The baseline risk is $\approx 5\%$ (2).
- **Age (0.70)**: A 10-year increase doubles the risk (HR ≈ 2.0), reflecting the effect of aging (4).
- **Male sex (0.45)**: Men have a $\approx 57\%$ higher risk than women (1).
- **SBP (0.18)**: Each 10 mmHg above 120 increases the risk by $\approx 20\%$ (3).
- **Treatment (0.15)**: Antihypertensive treatment adds a slight additional risk (2).
- **Smoking/Diabetes (0.70)**: Both factors double the risk (HR ≈ 2.0), consistent with the literature (3; 4).
- **BMI (0.22)**: Each 5 kg/m² above 25 increases the risk by $\approx 25\%$, reflecting the impact of obesity (5).
- **Family history (0.40)**: Increases the risk by $\approx 49\%$, capturing genetic predisposition (6; 7).

3 Results

An example calculation is provided for a profile: male, 50 years, SBP 120 mmHg, no treatment, nonsmoker, no diabetes, BMI 30, positive family history:

1. Calculate the logit:

$$\begin{aligned}\text{logit}(p) &= -3.2 + 0.70 \cdot \frac{50-50}{10} + 0.45 \cdot 1 + 0.18 \cdot \frac{120-120}{10} \\ &\quad + 0.15 \cdot 0 + 0.70 \cdot 0 + 0.70 \cdot 0 + 0.22 \cdot \frac{30-25}{5} + \\ &= -3.2 + 0 + 0.45 + 0 + 0 + 0 + 0 + 0.22 + 0.40 = -2.13\end{aligned}$$

2. Calculate the probability:

$$p = \frac{1}{1+e^{2.13}} \approx 0.106 \quad \text{(Risk = } 10.6\%\text{)}$$

3. Classification: Intermediate risk (10–20%) (4).

Without BMI and family history, the logit would be $-3.2+0.45 = -2.75$, yielding a risk of $\approx 6.0\%$ (low). These variables refine the estimate, increasing the risk by $\approx 4.6\%$.

4 Discussion

Including BMI and family history improves the accuracy of the MaRS Index by capturing the effects of obesity and genetic predisposition. These variables are easy to obtain and enhance the model's applicability in settings without laboratory tests (3). However, the coefficients are approximated and do not account for interactions between variables, which may limit precision in complex cases (5).

5 References

References

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