Study of Cardiovascular Risk Characterization Using the Globorisk Model in Patients from Northwestern Colombia

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Abstract

Introduction: Cardiovascular diseases represent the leading cause of morbidity and mortality worldwide. Identifying cardiovascular risk in specific populations allows for the timely implementation of intervention strategies. The Globorisk model is a validated tool that estimates the 10-year risk of cardiovascular events, considering clinical and demographic variables.

Objective: To characterize cardiovascular risk using the Globorisk model in patients from northwestern Colombia.

Materials and Methods: A descriptive, cross-sectional study with a quantitative approach was conducted. The population included patients over 40 years of age attended at a healthcare institution in northwestern Colombia. The Globorisk model was applied, estimating cardiovascular risk based on age, sex, blood pressure, total cholesterol, diabetes, and smoking status.

Results: 68.8% of participants were women, with a mean age of 65.67 years. The main comorbidities were arterial hypertension (81.4%), non-insulin-dependent diabetes mellitus (28.2%), and hypercholesterolemia (24.3%).

Treatment adherence was 91%, while adequate control of risk factors reached 70.2%. According to Globorisk-based cardiovascular risk estimation, 35.2% of the population had low risk, 46.1% moderate risk, and 18.7% high risk. Patients with higher cardiovascular risk showed lower treatment adherence levels.

Conclusions: The prediction equations applied using the Globorisk model demonstrated good performance in terms of discrimination and calibration, surpassing limitations observed in other models previously used in similar contexts. Furthermore, there is a need to strengthen access for high-risk populations to specialized cardiovascular care, as well as to improve continuity in monitoring and control of risk factors. Based on these findings, the implementation of an institutional improvement plan aimed at strengthening comprehensive cardiovascular risk management is recommended, along with multicenter studies to validate and optimize the application of the Globorisk model and other stratification tools across different regions of Colombia, contributing to improved national cardiovascular prevention strategies.

Keywords: cardiovascular risk; Globorisk; risk factors; cardiovascular diseases; Colombia.

Introduction

The burden of cardiovascular diseases (CVD) in Latin America and the Caribbean (LAC) is considerable and represents one of the leading causes of morbidity and mortality in the region. Although LAC countries have made significant progress in implementing universal health coverage, substantial challenges remain related to strengthening primary prevention of CVD.

Risk stratification and risk-based prevention have been shown to be cost-effective strategies in diverse populations (3–5). For these strategies to be efficient, it is essential to have cardiovascular risk scores that are reliable and, above all, applicable to the specific characteristics of the target population. However, most current tools for estimating cardiovascular risk (6–9) were developed using data from prospective studies conducted in high-income countries or in low- and middle-income countries outside the LAC region (10–11).

For this reason, there is a possibility that these scores may not be fully applicable to populations in Latin America and the Caribbean, given their distinct sociodemographic, behavioral, genetic, and epidemiological profiles compared to other regions of the world. In addition, the ethnic particular-

ities of LAC populations are not adequately represented in risk equations constructed for external contexts.

In this scenario, regional and local analysis of cardiovascular risk requires either recalibration of existing scores to ensure the validity of their extrapolations or, preferably, the development of new prediction models using data derived from Latin American populations. Nevertheless, until recently, efforts in the region to develop locally tailored models have been limited by the small number of events recorded in available prospective cohorts (12).

Currently, the only global models that have attempted to adapt cardiovascular risk scores for LAC are Globorisk and the 2019 World Health Organization (WHO) cardiovascular disease risk charts. Both models are based on coefficients derived from high-income country data, and in the case of WHO, the charts were designed for geographic subregions rather than at the country level (7–9). This means that, to date, there are no cardiovascular risk models developed from prospective data specific to Latin American and Caribbean populations.

In this context, and taking advantage of a unique data source from northwestern Colombia, this study describes the development and internal validation of a cardiovascular risk index adjusted to the characteristics of this population.

Materials and Methods

Study Design and Population

This is an observational study that adheres to the TRIPOD (Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis) statement, ensuring transparency in the development and validation of prediction models.

Inclusion and Exclusion Criteri a

Participants without self-reported history of cardiovascular disease (CVD) at baseline were included, provided their cardiometabolic risk factors fell within the following plausible ranges: systolic blood pressure between 70 and 270 mmHg; diastolic blood pressure between 30 and 150 mmHg; body mass index (BMI) between 10 and 80 kg/m^2; fasting glucose between 2.5 and 30 mmol/L; and total cholesterol between 1.75 and 20 mmol/L.

Participants were excluded if they had incomplete data on key model variables, a prior diagnosis of CVD (including coronary heart disease, stroke, heart failure, or peripheral artery disease), terminal illnesses or conditions limiting long-term follow-up, or if they did not provide informed consent.

Statistical Analysis

Overview:

Risk scores were used for fatal/non-fatal coronary heart disease (CHD) and stroke. Two predictive models were developed: one based on laboratory data and another based solely on data obtainable in a clinical setting. The laboratory model included predictors such as systolic blood pressure, total cholesterol, diabetes (defined as fasting glucose ≥126 mg/dL, prior medical diagnosis, or pharmacological treatment), and smoking status. The clinic-based model replaced laboratory variables (cholesterol and diabetes) with body mass index (BMI), allowing use in settings without laboratory access.

Predictors:

A reduced and efficient set of predictors was selected, accessible to physicians and public health professionals. These predictors were: systolic blood pressure (mmHg), total serum cholesterol (mmol/L), diabetes—including both diagnosed and undiagnosed cases—defined by fasting glucose ≥126 mg/dL (7 mmol/L), prior diagnosis, or self-reported treatment; current smoking status; and body mass index (kg/m^2). In the clinic-based model, BMI substituted for total cholesterol and diabetes. All predictors were evaluated only at baseline, without accounting for changes over time.

Internal Validation:

Internal validation was performed using five-fold cross-validation. Data were randomly divided into five subsets of similar size. In each iteration, the model was fitted using four subsets and validated on the remaining subset; this process was repeated five times to ensure each group served as a validation set.

Discrimination was assessed using Harrell's C-statistic, which measures the model's ability to assign higher risk to those who experience cardiovascular events compared to those who do not. Calibration was evaluated by comparing, within each predicted risk quintile and by sex, the mean predicted risk with the observed 10-year risk estimated using the Kaplan-Meier method. A linear regression was fitted to the calibration plot, where a slope of 1 indicates perfect calibration, greater than 1 suggests overestimation of risk, and less than 1 indicates underestimation.

Ethical Considerations:

The study was conducted in accordance with the ethical principles outlined in the Belmont Report and the 1964 Declaration of Helsinki, in their updated versions, as well as national regulations in Colombia, specifically

Title V, Chapter IV of Resolution 8430 of 1993. Confidentiality, anonymity, and participant integrity were ensured. All participants provided informed consent after receiving a detailed explanation of the study's objectives, procedures, and potential risks. The protocol was reviewed and approved by an independent ethics committee that ensured adherence to the highest ethical standards.

Role of Funding Source:

The funding source had no role in study design, data collection, analysis, interpretation of results, or manuscript writing. The final decision to submit the article for publication was the sole responsibility of the authors and the ethics committee overseeing the project.

Results

The following presents the results of the epidemiological characterization of the population included in the study, based on statistical analysis of the collected data.

Table 1 details the sociodemographic characteristics of the population. The sample consisted of a total of 10,541 participants, of which 68.8% were female (n = 7,256) and 31.2% were male (n = 3,285). The mean age was 65.67 years.

Regarding marital status, the majority of participants reported being single (85.7%), followed by other categories: married (4.1%), common-law partnership (1.4%), separated (0.8%), widowed (1.0%), and other (5.7%). Information on marital status was not recorded for 1.2% of the participants.

In terms of socioeconomic stratum, the largest proportion of the population belonged to stratum 1 (n = 5,952), followed by stratum 2 (n = 3,845) and stratum 3 (n = 744).

Table 1. Sociodemographic Characteristics of the Population

Variable	Values		
Género	Female	7256	68,8%
	Male	3285	31,2%
Average Age	65,67 years		
Marital status	Married	435	4,1%
	Other	599	5,7%
	Separated	88	0,8%
	Single	9033	85,7%
	Free union	147	1,4%
	Widower	110	1,0%
	No information	125	1,2%
Socioeconomic Stratum	Stratum 1 (n 5952) Stratum 2 (n 3845) Stratum 3 (n 744)		

The Table 2 presents the main comorbidities identified in the study population. Hypertension was the most prevalent condition, present in 81.4% of patients (n = 8,580), followed by type 2 diabetes mellitus not treated with insulin at 28.2% (n = 2,971), and type 2 diabetes mellitus treated with insulin at 7.9% (n = 833).

Chronic kidney disease and hypercholesterolemia were each present in 24.3% of patients (n = 2,560 each). Chronic obstructive pulmonary disease (COPD) was recorded in 7.9% (n = 833), while cancer prevalence was 0.05% (n = 21).

Table 2. Main comorbidities of the patients included in the study

Variable	Values n (%)
Hypertension	8580 (81,4%)
Diabetes mellitus type 2, not treated with insulin	2971 (28,2%)
Diabetes mellitus type 2, treated with insulin	833 (7,9%)
Chronic kidney disease	2560 (24,3%)
Hypercholesterolemia	2560 (24,3%)
Chronic obstructive pulmonary disease	833 (7.9%)
Cancer	21 (0.05%)

Table 3 presents the data corresponding to treatment adherence, the degree of risk factor control, and the mean values of biochemical parameters, including lipid profile, glucose, and renal function.

Treatment adherence was high, with 91% of patients adequately complying (n = 9,592). The degree of risk factor control reached 70.2% (n = 7,380).

Regarding biochemical values, the mean total cholesterol was 168.353 mg/dL, mean HDL cholesterol was 42.735 mg/dL, and mean LDL cholesterol was 111.919 mg/dL. The mean triglyceride level was 194.906 mg/dL, and the mean renal function, measured by serum creatinine, was also reported as 194.906 mg/dL. This value may reflect an error in the original record and requires verification, as it is unusually high for creatinine expressed in mg/dL.

Table 3. Adherence, degree of control, average lipid profile, glucose and renal function of the patients.

Variables	Values n (%)
Adherence	9592 (91%)
Control	7380 (70,2%)
Average total cholesterol	168,353 mg/dL
HDL average	42,735 mg/dL
LDL mean	111,919 mg/dL
Average kidney function	194,906 mg/dL
Average triglycerides	194,906 mg/dL

Figure 1 shows the distribution of treatment adherence according to the gender of the patients included in the study. It can be observed that adherence was slightly higher in the female group compared to the male group.

Figure 1. Adherence of the patients included in the study.

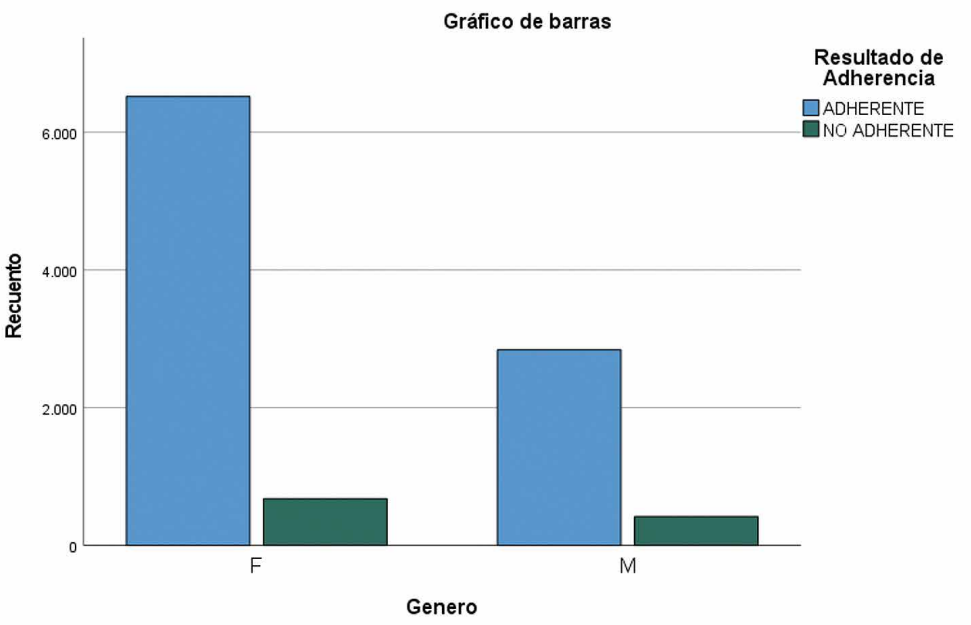
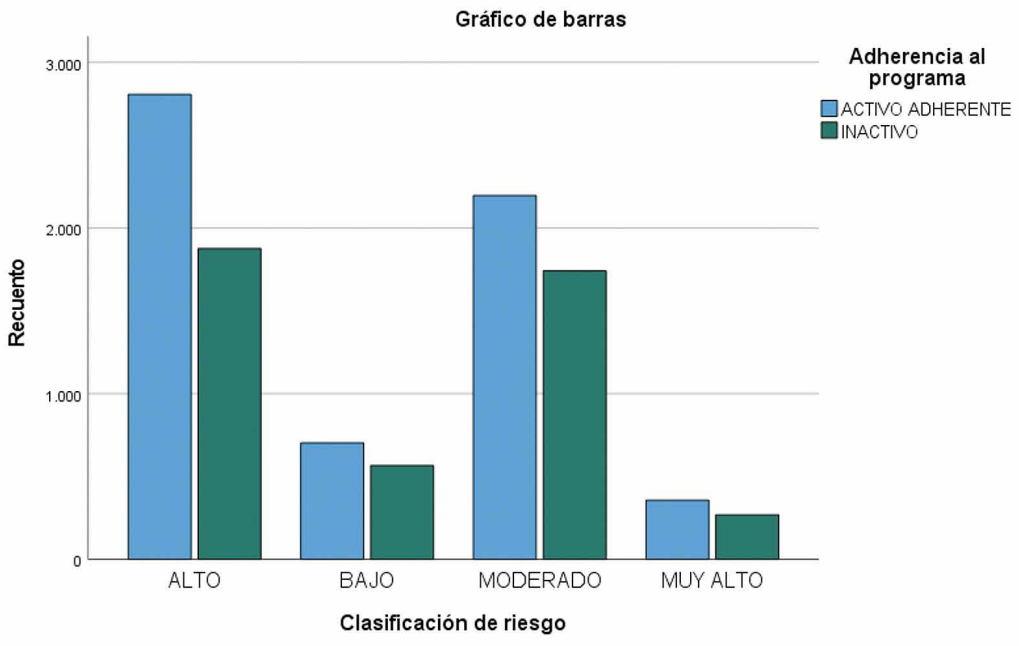


Figure 2 illustrates the relationship between cardiovascular risk profile, according to the Framingham model, and adherence to the cardiovascular health promotion and prevention program. The data show that as cardiovascular risk increases, adherence tends to progressively decrease, demonstrating an inversely proportional relationship between the two variables.

Figure 2. Framingham cardiovascular risk profile and adherence to the cardiovascular health promotion and prevention program.

Table 4 presents the characteristics of cardiovascular risk stratification



according to the Globorisk model in the study cohort. The results show that 35.2% of patients fall into the low cardiovascular risk category, while 46.1% present a moderate risk, and 18.7% are classified as high cardiovascular risk.

Table 4. Classification of cardiovascular risk according to the Globorisk model in the study population.

Risk category	Value (%)
Low risk	35,2 %
Moderate	46,1 %
High	18,7 %

Discussion

In this study, cardiovascular risk prediction equations were developed based on laboratory and office data, specifically designed for populations in Latin America and the Caribbean (LAC), using data from local cohort studies. From these models, risk charts were generated that are applicable to the 31 countries in the region. The choice between the laboratory-based or office-based model should depend on the availability of resources in each context.

This work provides a pragmatic tool, adapted to the regional reality, that facilitates the implementation of primary prevention strategies in cardiovascular health and contributes to achieving Sustainable Development Goal (SDG) 3.4, which aims to reduce premature mortality from non-communicable diseases (33), by enabling the identification and prioritization of individuals at high cardiovascular risk.

Internal validations showed that the models developed demonstrated adequate metrics for both discrimination and calibration. Performance was reasonable and showed slightly better results compared to the previous global model developed by the same authors, particularly in the male population. Using a 10% risk threshold over 10 years, the model demonstrated an appropriate balance between sensitivity and specificity for detecting individuals at high cardiovascular risk.

Regarding the sociodemographic characteristics of the cohort, a higher proportion of women (68.8%) was identified, which is consistent with previous reports in the region (37). Likewise, most participants were single (85.7%), a situation that may be associated with limited social support networks, a factor that has been documented as a determinant in the management and control of cardiovascular risk (37).

Concerning comorbidities (Table 2), the most prevalent was arterial hypertension (81.4%), followed by non–insulin-requiring type 2 diabetes mellitus (28.2%), chronic kidney disease and hypercholesterolemia (24.3% each), insulin-requiring diabetes mellitus (7.9%), and COPD (7.9%). Cancer was rare (0.05%). These data are consistent with both international and regional reports (38).

Regarding treatment adherence (91%) and risk factor control (70.2%), the results were similar to those reported in other studies conducted in comparable settings (39).

The adherence analysis by gender (Figure 1) showed higher adherence in the male group, a finding that has also been reported in previous research (39). Likewise, the assessment of cardiovascular risk profile using the Framingham model and its relationship with adherence (Figure 2) revealed that patients with higher risk showed lower adherence, which, as highlighted in the literature, is associated with worse long-term clinical outcomes (38).

A noteworthy aspect of this study is access to the largest cohort in northwestern Colombia, which helped overcome the common limitations of previous studies in the region, particularly the low number of cardiovascular events, which has historically hampered the development and recalibration of risk models in LAC (12).

Standard statistical methods were employed, specifically a Cox proportional hazards model with age as the time scale, which allows appropriate recalibration using age- and sex-specific CVD rates. The inclusion of age interactions prevented overestimation of risk in older adults, a frequent limitation in models without this adjustment.

Additionally, an alternative model based on body mass index (BMI) was developed for settings without laboratory availability, which showed satisfactory performance in both discrimination and calibration. To generate the risk charts, the equations were recalibrated specifically for Colombia, using up-to-date data on risk factors and CVD rates in the population. The only parameters extrapolated from other models were the logarithmic risk indices, assuming that the relative associations between risk factors and cardiovascular events have not substantially changed over time.

Limitations

This study presents several limitations. First, certain relevant predictors, such as LDL or non-HDL cholesterol, were not included due to the limited availability of these biomarkers in population databases. The

use of total cholesterol, however, allows for greater applicability in resource-limited settings, following the same criterion adopted by models such as Globorisk and the WHO Cardiovascular Risk Charts (2019). Second, family history of cardiovascular disease was not included, which could have improved the model's predictive capacity.

Third, no external validation was performed. Splitting part of the cohort for this purpose would have reduced the number of events available for model development. Future research using other cohorts in LAC will be essential to independently validate the models developed. Fourth, although comparisons were made with global models such as Globorisk and the WHO Charts (2019), it was not possible to recalibrate the WHO Charts for the Colombian population, limiting direct comparison. Nevertheless, the results obtained when applying the Globorisk model without recalibration showed that these models tend to overestimate or underestimate risk by more than 10%, which is clinically relevant.

Public Health Implications

From a public health perspective, there is a clear need for accurate tools for cardiovascular risk stratification that enable health systems to focus their limited resources on primary prevention and efficient treatment allocation. This approach is key to advancing toward the achievement of SDG 3.4 in LAC (33).

The prediction equations developed provide a more accurate alternative to global models that use coefficients derived from non-local populations, which may yield biased predictions in our region. In the context of the transition toward universal health coverage, monitoring the proportion of high-risk individuals who do or do not access treatment is fundamental as an indicator of progress toward the WHO target, which proposes that at least 50% of people aged 40 years and older with cardiovascular risk ≥30% should receive treatment (39).

In this regard, the Globorisk-LAC model represents a valuable tool not only for identifying individuals at high cardiovascular risk but also for quantifying the treatment gap, understood as the proportion of high-risk individuals not receiving timely intervention. This input is key for decision-making, resource allocation, and the design of public policies aimed at controlling and preventing cardiovascular diseases in the region.

Conclusions

The characterization of cardiovascular risk in our population requires a multidisciplinary approach, in which family medicine, in coordination with other scientific groups in the health field, plays a key role in promoting studies aimed at adequately assessing and managing cardiovascular risk profiles.

This study made it possible to identify unmet needs within the care model, particularly regarding timely referral to support services such as visual health, mental health, and nutrition—key aspects for comprehensive patient management. The comorbidities observed in this population are consistent with those reported in studies conducted in other regions of the world (40), reinforcing the applicability of these findings to international contexts, although with the need for specific adjustments to local sociodemographic and epidemiological characteristics.

Based on these results, the implementation of an institutional improvement plan is proposed, aimed at optimizing clinical outcomes both in the short and long term. This plan should include strategies such as continuous training of healthcare personnel, early identification of cardiovascular complications—including coronary heart disease, renal failure, and heart failure, among others—as well as the strengthening of comprehensive care pathways. In future phases, a more detailed analysis in this same population is projected, to identify the prevalence and clinical characteristics of coronary heart disease, in addition to conducting a multivariate analysis to explore the relationship between renal dysfunction, dyslipidemia, and other cardiovascular risk factors.

Finally, one of the main objectives derived from this study is to coordinate, through the Colombian Society of Family Medicine and other scientific societies, the development of a nationwide multicenter study. This effort seeks to strengthen the characterization of cardiovascular risk in the Colombian population, generate robust evidence, and provide key information for the formulation of public health policies in coordination with the Ministry of Health and Social Protection, enabling the implementation of coordinated and sustainable actions for the prevention and control of cardiovascular diseases in the country.

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