Comparison of Nonblood-Based and Blood-Based Total CV Risk Scores in Global Populations

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ABSTRACT

Background: Cost-effective primary prevention of cardiovascular disease (CVD) in low- and middle-income countries requires accurate risk assessment. Laboratory-based risk tools currently used in high-income countries are relatively expensive and impractical in many settings due to lack of facilities.

Objectives: This study sought to assess the correlation between a non-laboratory-based risk tool and 4 commonly used, laboratory-based risk scores in 7 countries representing nearly one-half of the world's population.

Methods: We calculated 10-year CVD risk scores for 47,466 persons with cross-sectional data collected from 16 different cohorts in 9 countries. The performance of the non-laboratory-based risk score was compared with 4 laboratory-based risk scores: Pooled Cohort Risk Equations (ASCVD [Atherosclerotic Cardiovascular Disease]), Framingham, and SCORE (Systematic Coronary Risk Evaluation) for high- and low-risk countries. Rankings of each score were compared using Spearman rank correlations. Based on these correlations, we measured concordance between individual absolute CVD risk as measured by the Harvard NHANES (National Health and Nutrition Examination Survey) risk score, and the 4 laboratory-based risk scores, using both the conventional Framingham risk thresholds of >20% and the recent ASCVD guideline threshold of >7.5%.

Results: The aggregate Spearman rank correlations between the non-laboratory-based risk score and the laboratory-based scores ranged from 0.915 to 0.979 for women and from 0.923 to 0.970 for men. When applying the conventional Framingham risk threshold of >20% over 10 years, 92.7% to 96.0% of women and 88.3% to 92.8% of men were equivalently characterized as "high" or "low" risk. Applying the recent ASCVD guidelines risk threshold of >7.5% resulted in risk characterization agreement for women ranging from 88.1% to 94.4% and from 89.0% to 93.7% for men.

Conclusions: The correlation between non-laboratory-based and laboratory-based risk scores is very high for both men and women. Potentially large numbers of high-risk individuals could be detected with relatively simple tools.

Cardiovascular disease (CVD) remains a leading cause of death. However, many countries have seen reductions in age-adjusted death rates over the last 4 decades. Although public health measures such as smoking cessation campaigns and advances in acute care are likely responsible for a large portion of the decline, much of this improvement has been accomplished by identifying individuals at high probability of developing CVD through many identifiable risk factors and implementing targeted interventions to lower risk [1]. Initially, separate guidelines were developed for each individual risk factor and treatment was recommended when the risk factor reached a threshold above a specified level, such as blood pressure >140/90 mm Hg [2]. One limitation, however, is that for any given level of a risk factor, there is a broad range of overall risk for CVD depending on the level of other known risk factors.

In contrast, absolute risk scores using multiple risk factors have better precision and have been adapted into easily used score calculators that are more readily available [3]. Identifying those at highest risk with multiple risk factors will lead to the greatest benefit in terms of delaying onset of disease [4]. In addition, efforts to using a multiple risk factor approach are more cost-effective than basing interventions on single risk factors [5]. The calculation of the absolute CVD risk is usually based on age, sex, tobacco use status, blood pressure levels, and blood cholesterol

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TABLE 1. Study populations, inputs, and outcomes used to construct the risk scores

Score	Population*	Inputs	Outcome
Pooled Cohort Equations (ASCVD) [21]	U.S. population ages 40 to 79 drawn from ARIC [22], Cardiovascular Heart Study [23], CARDIA [24], Framingham (1968 to 1987) [25], Framingham Offspring Study Cohorts [26]	Age, sex, smoking, diabetes, systolic blood pressure, treatment for hypertension, race, total cholesterol, HDL cholesterol	Non-fatal MI or CHD death, or fatal or non-fatal stroke
Framingham CVD 2008 (D'Agostino et al., 2008) [20]	Framingham, MA, USA (1968 to 1987)	Age, sex, smoking, diabetes, systolic blood pressure, treatment for hypertension, total cholesterol, HDL cholesterol	MI, angina, coronary insufficiency, CHD death, stroke, TIA, CHF, PVD, CVD death
SCORE, high risk (Conroy et al., 2003) [7]	High-risk European countries†	Age, sex, smoking, systolic blood pressure, total cholesterol	Death from hypertensive disease, IHD, cerebrovascular disease
SCORE, low risk (Conroy et al., 2003) [7]	Low-risk European countries‡	Age, sex, smoking, systolic blood pressure, total cholesterol	Death from hypertensive disease, IHD, cerebrovascular disease
Non-laboratory-based (Gaziano et al., 2008) [11]	NHANES I (USA, 1971 to 1975)	Age, sex, smoking, diabetes, systolic blood pressure, treatment for hypertension, BMI	CVD death, MI, stroke, CHF, coronary bypass, PTCA

ARIC, Atherosclerosis Risk in Communities; ASCVD, Atherosclerotic Cardiovascular Disease; BMI, body mass index; CARDIA, Coronary Artery Risk Development in Young Adults; CHD, coronary heart disease; CHF, congestive heart failure; CVD, cardiovascular disease; HDL, high-density lipoprotein; IHD, ischemic heart disease; MI, myocardial infarction; NHANES, National Health and Nutrition Examination Survey; PTCA, percutaneous transluminal coronary angioplasty; PVD, peripheral vascular disease; SCORE, Systematic Coronary Risk Evaluation; TIA, transient ischemic attack.
*Years indicate when baseline values were collected.
†Applicable for all non-low-risk European countries.
‡Applicable for Belgium, France, Greece, Italy, Luxembourg, Portugal, Spain, and Switzerland.
Adapted from Gaziano et al. [12].

levels as was done with data from the Framingham study and other cohorts [6–10].

Whereas the absolute risk determination approach holds particular promise for resource scarce settings, blood lipid determinations for screening purposes are far too costly in most developing country settings with limited resources and consequently are unlikely to be adopted as policy in these settings. Therefore, an investigation into the possibility of using other known CVD risk factors that are easier and less costly to measure instead of CVD risk factors that require costly laboratory tests when calculating absolute CVD risk scores has been proposed. This previous work compared the ability to predict first-time fatal and nonfatal CVD events in the NHANES (National Health and Nutrition Examination Survey) I follow-up study cohort by 2 risk prediction models: the laboratory-based Framingham risk score and the Harvard NHANES non-laboratory-based model [11], which requires only history and physical examination measures and no measure of cholesterol. The exchangeability of the non-laboratory-based score with commonly used laboratory-based approaches has been validated in a U.S. population and assessed for agreement in South Africa [12,13], but not in other populations.

Many countries are unlikely in the short term to have their own validated risk score because of the time involved and/or expense of following a cohort with confirmed outcomes for a minimum of 5 to 10 years. As a result, countries have turned to other risk scores such as the laboratory-based risk scores or the non-laboratory-based risk scores such as the Harvard NHANES score [11] or the World Health Organization risk charts [14] based on individual risk factors. In the meantime, countries need to understand whether these risk scores rank individuals comparably even if the absolute risk scores may be overestimated or underestimated. We compare a non-laboratory-based risk score (Harvard NHANES) with 4 other commonly used laboratory-based risk scores to assess the level of correlations between them in 7 cohorts from 8 different countries representing nearly one-half the world's population.

METHODS

For the primary analysis, we needed to evaluate cohorts that had cross-sectional information to calculate both the non-laboratory-based risk score as well as the laboratory-based