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BRIEF REPORT

Predictive Validity of the American College of Cardiology/American Heart Association Pooled Cohort Equations in Predicting All-Cause and Cardiovascular Disease–Specific Mortality in a National Prospective Cohort Study of Adults in the United States

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Abstract

The predictive validity of the Pooled Cohort risk (PCR) equations for cardiovascular disease (CVD)–specific and all-cause mortality among a national sample of US adults has yet to be evaluated, which was this study's purpose. Data from the 1999-2010 National Health and Nutrition Examination Survey were used, with participants followed up through December 31, 2011, to ascertain mortality status via the National Death Index probabilistic algorithm. The analyzed sample included 11,171 CVD-free adults (40-79 years of age). The 10-year risk of a first atherosclerotic cardiovascular disease (ASCVD) event was determined from the PCR equations. For the entire sample encompassing 849,202 person-months, we found an incidence rate of 1.00 (95% CI, 0.93-1.07) all-cause deaths per 1000 person-months and an incidence rate of 0.15 (95% CI, 0.12-0.17) CVD-specific deaths per 1000 person-months. The unweighted median follow-up duration was 72 months. For nearly all analyses (unadjusted and adjusted models with ASCVD expressed as a continuous variable as well as dichotomized at 7.5% and 20%), the ASCVD risk score was significantly associated with all-cause and CVD-specific mortality ($P<.05$). In the adjusted model, the increased all-cause mortality risk ranged from 47% to 77% based on an ASCVD risk of 20% or higher and 7.5% or higher, respectively. Those with an ASCVD score of 7.5% or higher had a 3-fold increased risk of CVD-specific mortality. The 10-year predicted risk of a first ASCVD event via the PCR equations was associated with all-cause and CVD-specific mortality among those free of CVD at baseline. In this American adult sample, the PCR equations provide evidence of predictive validity.

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Similar to the Framingham coronary heart disease risk score (among others), a new set of equations has been developed to estimate cardiovascular disease (CVD) risk. Developed (in 2013) by the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, the Pooled Cohort risk (PCR) equations are intended for predicting 10-year risk for a first atherosclerotic CVD (ASCVD) event.[1] These 2013 American College of Cardiology/American Heart Association guidelines on the assessment of CVD risk were developed from 5 large National Institutes of Health–funded cohorts, including the Framingham Heart Study, the Framingham Offspring Study, the Atherosclerosis Risk in Communities study, the Cardiovascular Health Study, and the Coronary Artery Risk Development in Young Adults Study.

In a cross-sectional study among neurologically asymptomatic Korean adults, Park et al[2] reported that the PCR equations were independently related to the presence of silent brain infarction; however, other studies have not found strong evidence for the PCR equations in the Korean,[3] Chinese[4] or Indian[5] populations. Kandula et al[6] reported that among South Asians in the prospective Mediators of

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Atherosclerosis in South Asians Living in American study, the PCR equations were predictive of coronary artery calcium burden and carotid intima-media thickness. Health-enhancing behaviors have also been found to be associated with CVD risk scores from the PCR equations. For example, Ford[7] reported an association between habitual sleep patterns and PCR, and our work has revealed that physical activity is associated PCR-derived CVD risk.[8-13]

In the Reasons for Geographic and Racial Differences in Stroke study, Muntner et al[14] found that predicted (via the PCR equations) and observed CVD incidence yielded very similar estimates (within 1%-5% of each other). For example, for those with a PCR-predicted ASCVD score of less than 7.5%, the 5-year observed and predicted incidence rate per 1000 person-years was 5.3 and 4.1, respectively. For those with a PCR-predicted ASCVD score of 7.5% to less than 10%, the 5-year observed and predicted incidence rate per 1000 person-years was 7.7 and 6.5, respectively. Further, for those with a PCR-predicted ASCVD score of 10% or higher, the 5-year observed and predicted incidence rate per 1000 person-years was 18.2 and 19.3, respectively. These findings suggest that the PCR equations may be suitable for the population from which they were derived. This point is important because research has documented incongruent CVD risk scores when comparing multiple CVD risk equations developed from various populations.[15-18]

To our knowledge, no study to date has evaluated the predictive validity of the PCR equations for all-cause and CVD-specific mortality among a national sample of US adults, which was this study's purpose. In this brief report, we also evaluate the predictive validity of the PCR equation for mortality risk while considering individual physical activity and body mass index (calculated as weight in kilograms divided by height in meters squared) levels. These parameters are not considered within the PCR equations, nor were they evaluated in the study by Muntner et al.[14] Consideration of these parameters is important because they both play an important role in influencing mortality risk.[19-21]

PARTICIPANTS AND METHODS

Study Design and Participants

Data from the 1999-2010 National Health and Nutrition Examination Survey were used, with participants followed up through December 31, 2011, to ascertain mortality status via the National Death Index probabilistic algorithm. As discussed subsequently, the PCR equations were derived among CVD-free adults aged 40 years or older and 79 years or younger; thus, our analyses were restricted to these age ranges (ie, 40-79 years). In the 1999-2010 NHANES, 18,447 adults aged 40 to 79 years were enrolled. Among these participants, 27 had missing mortality status data. Among the 18,420 remaining participants, 17 were excluded from analysis because of positive results on a urine pregnancy test. Another 2703 were excluded because of a physician diagnosis of CVD, congestive heart failure, angina, heart attack, or stroke, and 2692 were excluded because of current self-reported cholesterol medication use. Among the remaining 13,008 participants, 1698 were further excluded because of missing data for the parameters (described subsequently) used to calculate the PCR score. Obesity and physical activity were used as covariates, and another 139 participants were excluded because of missing (measured) body mass index or self-reported physical activity data. The remaining 11,171 CVD-free adults aged 40 to 79 years constituted the analytic sample.

All-Cause and CVD-Specific Mortality

The number of individuals who died during the follow-up period was calculated by comparing the participants' personal identification information with the National Center for Health Statistics National Death Index. This linkage was performed on the basis of a probabilistic matching algorithm.[22] Cardiovascular disease—specific deaths were identified on the basis of the *International Classification of Diseases, Tenth Revision* guidelines.

PCR Equations to Identify 10-Year ASCVD Risk

Details on the derivation of the PCR equations to predict 10-year risk for a first ASCVD event are described thoroughly in the American College of Cardiology/American Heart Association

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