HHS Public Access
Author manuscript
JAMA Intern Med. Author manuscript; available in PMC 2016 February 01.

Published in final edited form as:
JAMA Intern Med. 2015 February ; 175(2): 299–302. doi:10.1001/jamainternmed.2014.6403.

Trends in Predicted Risk for Atherosclerotic Cardiovascular Disease Using the Pooled Cohort Risk Equations Among US Adults From 1999 to 2012

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Risk assessment has become an important tool to assess an individual's future risk for cardiovascular disease. Recently, the American College of Cardiology/American Heart Association (ACC/AHA) released a report that presented updated risk equations, the Pooled Cohort Risk Equations, for cardiovascular disease.[1] Race and ethnicity-specific estimates were novel to the new risk equations. Because changes over time in predicted cardiovascular risk using these new risk equations have not been examined, our objectives were to (1) examine the trend in predicted 10-year cardiovascular risk using the new ACC/AHA Pooled Cohort Risk Equations and (2) estimate the potential for risk reduction by optimizing levels of cardiovascular risk factors.

Methods

We used data from seven 2-year cycles of the National Health and Nutrition Examination Survey (1999-2000 to 2011-2012) that includes nationally representative samples of the US population selected with a complex multistage sampling design.[2] Response rates for the interview and examination stages all exceeded 70%. The surveys were approved by the National Center for Health Statistics Research Ethics Review Board.

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Author Contributions: Dr Ford had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Ford, Will.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Ford.
Critical revision of the manuscript for important intellectual content: Will, Mercado, Loustalot.
Statistical analysis: Ford, Will.
Administrative, technical, or material support: Loustalot.
Study supervision: Ford.

Conflict of Interest Disclosures: None reported.

We used the Pooled Cohort Risk Equations to calculate predicted 10-year cardiovascular risk[1] and limited the analyses to men and nonpregnant women who were aged 40 to 79 years and free of self-reported congestive heart failure, coronary heart disease, angina, myocardial infarction, or stroke. Tests for trend were calculated by using orthogonal linear contrasts. Racial- or ethnic-specific estimates were limited to the 3 major racial or ethnic groups (ie, Mexican American, non-Hispanic white, and non-Hispanic black). To account for the complex sampling design of the surveys, we conducted the analyses with SUDAAN statistical software (RTI International).

Results

Of the 5 modifiable cardiovascular risk factors, significant improvements occurred for total cholesterol, high-density lipoprotein cholesterol, systolic blood pressure, and smoking status (Table 1). The prevalence of diabetes increased progressively.

Overall, risk of 20% or greater declined from 13.0% to 9.4% (*P* value for trend, .008). Risk of 20% or greater decreased significantly among women (*P* value for trend, <.001), non-Hispanic whites (*P* value for trend, .02), non-Hispanic white women (*P* value for trend, .001), and non-Hispanic black women (*P* value for trend, .03). During each 2-year cycle, predicted 10-year cardiovascular risk of 20% or greater was higher among men compared with women and among non-Hispanic black women compared with non-Hispanic white women.

Using data from 2011-2012, we examined the potential impact of aligning modifiable risk factors levels with optimal values on predicted 10-year cardiovascular risk. The reduction of systolic blood pressure to lower than 120 mm Hg yielded the largest drop in mean predicted risk, followed by the elimination of diabetes, and elimination of smoking (Table 2). When all 5 cardiovascular risk factors were simultaneously optimized, mean predicted risk declined by 3.3% overall, 6.4% among non-Hispanic black men, and 4.5% among non-Hispanic black women.

Discussion

Our results show that predicted 10-year cardiovascular risk among women has improved substantially compared with men; predicted risk was higher among non-Hispanic black women than among non-Hispanic white and Mexican American women; and predicted risk lower than 7.5% declined significantly among non-Hispanic black men. Also, improvements in risk factors levels, led by systolic blood pressure, can produce substantial reductions in future cardiovascular disease. Interventions aimed at improving the modifiable risk factors other than total cholesterol level could help to narrow the gender gap in predicted risk, and improving systolic blood pressure and concentrations of hemoglobin A_{1c} could help to narrow the racial disparity.

The limited evidence about the validity of the Pooled Cohort Risk Equations poses one limitation.[3] Furthermore, we were unable to exclude participants who underwent cardiovascular procedures such as percutaneous coronary interventions.

Sex and racial disparities in cardiovascular risk continue to exist, and the risk factors fueling these disparities will require redress. The enormous progress in reducing cardiovascular disease mortality realized since the 1960s represent public health and health care improvement successes, yet more progress in reducing the remaining colossal burden of cardiovascular disease in the United States awaits.

Acknowledgments

Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Table 1

Cardiovascular Risk Factors and Unadjusted Distribution of Predicted 10-Year Risk for Cardiovascular Disease (CVD) Among US Adults Aged 40 to 79 Years Without Self-reported CVD[a]

Variable	1999-2000 (n = 1965)	2001-2002 (n = 2176)	2003-2004 (n = 1984)	2005-2006 (n = 2011)	2007-2008 (n = 2703)	2009-2010 (n = 2864)	2011-2012 (n = 2404)	*P* Value for Trend
Age, mean (SE), y								
Total	54.3 (0.4)	53.5 (0.2)	53.8 (0.3)	54.1 (0.6)	54.4 (0.3)	54.8 (0.2)	55.1 (0.3)	.002
NHW	54.8 (0.5)	54.0 (0.3)	54.2 (0.4)	54.7 (0.7)	54.9 (0.4)	55.5 (0.3)	55.8 (0.3)	.002
NHB	52.5 (0.4)	52.0 (0.7)	52.9 (0.6)	53.0 (0.5)	53.5 (0.4)	53.9 (0.5)	54.1 (0.5)	.001
MA	51.2 (0.5)	50.6 (0.9)	51.2 (0.8)	51.3 (0.5)	51.8 (0.8)	51.8 (0.5)	50.6 (0.7)	.75
Current smoker, % (SE)								
Total	20.6 (1.6)	20.5 (1.1)	22.1 (1.2)	22.2 (1.6)	19.8 (1.7)	17.1 (1.1)	19.1 (0.9)	.045
NHW	19.5 (1.8)	18.8 (1.5)	20.9 (1.2)	21.4 (2.2)	19.5 (2.4)	15.7 (1.4)	19.3 (1.1)	.31
NHB	31.3 (3.3)	29.7 (2.7)	29.3 (2.9)	27.0 (2.5)	25.8 (2.2)	28.7 (4.0)	22.0 (2.6)	.04
MA	20.8 (2.6)	21.5 (1.5)	20.6 (2.4)	19.0 (1.8)	16.9 (2.5)	17.8 (1.9)	18.5 (3.1)	.19
TC, mean (SE), mg/dL								
Total	214.3 (1.9)	211.7 (1.5)	209.8 (1.5)	207.1 (1.1)	205.2 (1.3)	205.9 (1.7)	205.0 (1.3)	<.001
NHW	216.6 (2.4)	210.8 (1.4)	211.0 (1.6)	207.6 (1.4)	205.0 (1.6)	207.2 (2.0)	206.6 (1.6)	<.001
NHB	204.2 (2.6)	208.6 (3.1)	203.9 (2.1)	197.8 (2.1)	200.1 (1.8)	199.7 (1.6)	198.3 (1.6)	.001
MA	211.9 (1.2)	209.2 (3.5)	208.5 (2.8)	208.1 (1.7)	208.2 (1.6)	204.2 (1.6)	200.3 (2.9)	.001
HDL-C, mean (SE), mg/dL								
Total	52.2 (0.9)	52.9 (0.5)	54.6 (0.5)	55.5 (0.4)	52.9 (0.6)	54.9 (0.5)	54.1 (0.7)	.04
NHW	52.8 (1.1)	53.1 (0.7)	54.7 (0.5)	55.6 (0.5)	52.8 (0.7)	55.3 (0.7)	54.8 (0.9)	.08
NHB	53.7 (0.8)	56.5 (1.0)	57.6 (1.0)	59.2 (0.8)	58.3 (0.9)	57.4 (0.9)	56.2 (0.6)	.02
MA	48.2 (0.8)	48.9 (0.5)	50.2 (0.6)	50.0 (1.0)	49.9 (0.8)	50.1 (1.0)	49.2 (1.1)	.30
SBP, mean (SE), mm Hg								
Total	127.3 (0.9)	126.2 (0.5)	126.1 (0.7)	125.0 (0.6)	123.6 (0.5)	122.6 (0.6)	123.8 (0.7)	<.001
NHW	126.3 (1.1)	125.7 (0.6)	125.4 (0.8)	124.6 (0.6)	123.3 (0.6)	121.8 (0.7)	123.2 (0.8)	<.001
NHB	132.9 (1.0)	132.2 (1.0)	130.7 (1.5)	130.6 (0.7)	126.9 (1.7)	128.5 (1.2)	128.1 (1.0)	<.001
MA	127.7 (1.0)	125.5 (0.6)	125.8 (1.4)	123.9 (0.9)	123.9 (1.3)	125.1 (0.8)	122.7 (1.1)	.001
Diabetes, % (SE)[b]								
Total	9.9 (1.2)	10.1 (0.8)	10.9 (0.8)	10.5 (1.0)	12.6 (0.9)	12.6 (1.0)	13.5 (0.7)	.001
NHW	7.5 (1.3)	7.8 (0.8)	9.5 (1.1)	8.4 (1.1)	10.0 (1.4)	9.8 (0.8)	10.6 (0.9)	.02
NHB	17.7 (1.8)	15.7 (1.8)	14.6 (1.4)	17.8 (2.5)	23.7 (1.1)	20.2 (1.8)	24.1 (2.3)	.001
MA	16.5 (2.2)	17.7 (1.1)	18.7 (1.9)	18.9 (1.1)	20.5 (2.2)	21.4 (2.3)	22.6 (3.2)	.04
Predicted 10-y ASCVD risk, % (SE)								
<7.5%								
Total								
Total	63.1 (1.9)	66.1 (1.4)	65.7 (0.9)	66.5 (2.1)	67.1 (1.3)	66.5 (0.9)	63.9 (1.1)	.54

Variable	1999-2000 (n = 1965)	2001-2002 (n = 2176)	2003-2004 (n = 1984)	2005-2006 (n = 2011)	2007-2008 (n = 2703)	2009-2010 (n = 2864)	2011-2012 (n = 2404)	*P* Value for Trend
NHW	63.1 (2.6)	66.9 (1.7)	66.1 (1.2)	67.1 (2.5)	68.0 (1.8)	66.9 (0.9)	64.6 (1.5)	.53
NHB	54.1 (2.6)	57.2 (2.2)	57.4 (2.2)	55.7 (2.8)	57.4 (2.8)	54.0 (2.5)	51.3 (2.2)	.25
MA	69.2 (2.3)	73.4 (3.7)	73.4 (3.1)	72.4 (2.1)	69.9 (3.0)	70.6 (3.3)	72.1 (4.5)	.99
Men								
Total	52.1 (2.5)	58.1 (1.9)	54.0 (1.9)	57.3 (2.9)	56.3 (1.8)	54.9 (1.2)	48.7 (2.4)	.23
NHW	52.2 (3.4)	59.5 (2.2)	55.1 (2.4)	59.1 (3.6)	57.6 (2.4)	54.4 (1.3)	49.1 (3.2)	.28
NHB	47.8 (3.5)	46.7 (4.5)	46.7 (3.1)	42.4 (3.5)	48.6 (4.8)	44.0 (2.4)	32.0 (3.0)	.006
MA	58.2 (3.5)	66.5 (4.5)	65.3 (3.9)	65.2 (3.0)	59.9 (4.0)	61.1 (4.5)	57.4 (7.5)	.51
Women								
Total	72.6 (1.8)	74.0 (1.4)	76.5 (1.4)	74.7 (2.2)	76.7 (1.5)	76.9 (0.9)	77.6 (1.1)	.005
NHW	72.9 (2.3)	74.3 (1.8)	76.5 (1.3)	74.5 (2.5)	77.4 (2.0)	78.3 (1.0)	78.6 (1.4)	.008
NHB	59.2 (4.0)	67.2 (2.8)	66.2 (3.7)	66.9 (2.4)	64.2 (2.2)	62.0 (2.7)	66.6 (2.0)	.55
MA	79.4 (2.4)	80.2 (3.9)	82.5 (2.9)	79.8 (2.0)	79.5 (3.8)	81.1 (2.2)	88.8 (2.7)	.07
7.5% to <20%								
Total								
Total	23.9 (1.7)	22.8 (0.7)	23.6 (0.8)	23.4 (1.4)	22.3 (1.0)	23.4 (0.5)	26.8 (1.2)	.20
NHW	23.7 (2.2)	22.4 (1.0)	23.7 (1.0)	22.8 (1.7)	21.3 (1.4)	23.6 (0.7)	26.3 (1.5)	.37
NHB	29.6 (2.1)	27.6 (1.8)	28.3 (2.1)	29.8 (2.1)	28.8 (2.2)	31.6 (1.6)	36.1 (1.4)	.004
MA	21.6 (1.7)	18.3 (2.7)	15.8 (1.4)	18.8 (1.9)	20.7 (1.7)	18.6 (1.9)	19.7 (4.2)	>.99
Men								
Total	30.7 (2.1)	28.0 (1.3)	31.6 (1.6)	30.3 (2.5)	29.4 (1.4)	32.8 (0.8)	36.8 (2.7)	.02
NHW	30.3 (2.8)	27.3 (1.7)	31.0 (1.9)	28.7 (3.1)	27.2 (2.1)	33.8 (1.1)	36.0 (3.4)	.07
NHB	35.8 (2.1)	37.2 (2.6)	38.1 (2.0)	41.0 (3.6)	38.2 (4.5)	40.9 (2.2)	50.7 (2.4)	<.001
MA	29.8 (2.2)	22.1 (3.4)	21.0 (2.1)	24.9 (2.6)	27.5 (2.7)	23.5 (2.1)	30.2 (6.2)	.63
Women								
Total	18.0 (1.7)	17.7 (1.3)	16.2 (1.2)	17.1 (1.5)	16.0 (1.3)	15.0 (0.8)	17.7 (0.9)	.33
NHW	17.8 (2.0)	17.5 (1.8)	16.9 (1.2)	17.5 (1.8)	15.9 (1.9)	14.3 (1.0)	17.6 (1.2)	.34
NHB	24.6 (3.4)	18.6 (3.1)	20.1 (3.2)	20.3 (1.7)	21.6 (1.4)	24.3 (1.9)	24.5 (1.6)	.36
MA	14.0 (2.4)	14.5 (2.9)	10.0 (1.7)	12.5 (1.6)	14.2 (2.6)	13.1 (2.2)	7.9 (2.4)	.19
≥20%								
Total								
Total	13.0 (1.1)	11.1 (0.9)	10.7 (0.5)	10.2 (0.9)	10.6 (0.6)	10.1 (0.6)	9.4 (0.9)	.008
NHW	13.2 (1.3)	10.7 (1.0)	10.2 (0.6)	10.0 (1.0)	10.7 (0.7)	9.5 (0.6)	9.1 (1.2)	.02
NHB	16.3 (2.0)	15.1 (2.0)	14.4 (1.8)	14.5 (2.3)	13.8 (1.2)	14.3 (1.6)	12.6 (1.5)	.17
MA	9.2 (1.3)	8.3 (1.5)	10.8 (2.2)	8.8 (1.3)	9.4 (1.9)	10.8 (1.8)	8.1 (1.4)	.96
Men								
Total	17.1 (1.5)	13.9 (1.5)	14.4 (0.9)	12.4 (1.0)	14.3 (1.0)	12.3 (0.9)	14.5 (1.5)	.13
NHW	17.5 (1.7)	13.3 (1.5)	13.9 (1.1)	12.2 (1.2)	15.2 (1.1)	11.7 (1.0)	14.9 (1.9)	.26
NHB	16.4 (3.5)	16.1 (3.0)	15.1 (2.5)	16.6 (3.3)	13.3 (1.6)	15.1 (2.6)	17.3 (2.6)	.95

Variable	1999-2000 (n = 1965)	2001-2002 (n = 2176)	2003-2004 (n = 1984)	2005-2006 (n = 2011)	2007-2008 (n = 2703)	2009-2010 (n = 2864)	2011-2012 (n = 2404)	*P* Value for Trend
MA	12.1 (1.9)	11.4 (2.3)	13.7 (3.1)	9.9 (2.2)	12.6 (3.1)	15.4 (3.0)	12.4 (3.1)	.57
Women								
Total	9.4 (0.9)	8.3 (0.8)	7.4 (1.0)	8.2 (0.9)	7.3 (0.7)	8.1 (0.4)	4.7 (0.5)	<.001
NHW	9.3 (1.3)	8.2 (1.1)	6.7 (1.0)	8.0 (1.0)	6.7 (0.9)	7.5 (0.5)	3.8 (0.7)	.001
NHB	16.2 (2.0)	14.2 (2.4)	13.7 (2.8)	12.8 (2.0)	14.2 (1.8)	13.7 (1.7)	8.9 (1.3)	.03
MA	6.6 (0.9)	5.3 (1.7)	7.5 (1.5)	7.6 (1.0)	6.4 (1.4)	5.8 (1.4)	3.3 (1.3)	.15

Abbreviations: ASCVD, atherosclerotic cardiovascular disease; HDL-C, high-density lipoprotein cholesterol; MA, Mexican American; NHB, non-Hispanic black; NHW, non-Hispanic white; SBP, systolic blood pressure; TC, total cholesterol.

SI conversion factor: To convert cholesterol to millimoles per liter, multiply by 0.0259.

[a]National Health and Nutrition Examination Survey 1999-2000 to 2011-2012.

[b]Participants who responded affirmatively to the question “Have you ever been told by a doctor or health professional you have diabetes or sugar diabetes?” or had a concentration of hemoglobin A_{1c} level of 6.5% or greater were defined as having diabetes.

Table 2

Absolute Change in Mean Predicted 10-Year Cardiovascular Disease (CVD) Risk Using the Pooled Cohort Risk Equations Based on Applying Optimal Levels for 5 CVD Risk Factors Among US Adults Aged 40 to 79 Years Without Self-reported CVD[a]

	Absolute Change in Mean Predicted 10-y CVD Risk, % (95% CI)					
Variable	**Eliminate Smoking**	**SBP <120 mm Hg**	**TC <200 mg/dL**	**HDL-C <40/50 mg/dL**	**Eliminate Diabetes**	**Improve All 5 Risk Factors**
Total	−0.90 (−1.03 to −0.77)	−1.32 (−1.54 to −1.10)	−0.49 (−0.59 to −0.38)	−0.26 (−0.31 to −0.21)	−1.04 (−1.17 to −0.92)	−3.31 (−3.67 to −2.94)
NHW	−0.82 (−0.99 to −0.65)	−1.20 (−1.49 to −0.91)	−0.50 (−0.63 to −0.36)	−0.22 (−0.29 to −0.16)	−0.83 (−1.03 to −0.63)	−3.00 (−3.52 to −2.48)
NHB	−1.40 (−1.72 to −1.08)	−2.36 (−2.66 to −2.06)	−0.39 (−0.49 to −0.29)	−0.19 (−0.27 to −0.11)	−2.24 (−2.56 to −1.91)	−5.31 (−5.97 to −4.66)
MA	−1.09 (−1.51 to −0.66)	−1.03 (−1.29 to −0.77)	−0.59 (−0.82 to −0.36)	−0.48 (−0.69 to −0.26)	−1.36 (−1.73 to −1.00)	−3.44 (−4.29 to −2.58)
Men						
Total	−1.31 (−1.62 to −1.00)	−1.63 (−1.91 to −1.35)	−0.68 (−0.86 to −0.50)	−0.35 (−0.39 to −0.31)	−1.45 (−1.68 to −1.23)	−4.46 (−5.03 to −3.89)
NHW	−1.19 (−1.54 to −0.84)	−1.55 (−1.93 to −1.18)	−0.73 (−0.97 to −0.49)	−0.31 (−0.40 to −0.21)	−1.27 (−1.61 to −0.94)	−4.21 (−4.99 to −3.42)
NHB	−2.10 (−2.66 to −1.55)	−2.54 (−3.05 to −2.03)	−0.16 (−0.21 to −0.12)	−0.16 (−0.24 to −0.07)	−2.68 (−3.32 to −2.03)	−6.40 (−7.63 to −5.16)
MA	−1.70 (−2.47 to −0.92)	−1.47 (−1.90 to −1.05)	−0.94 (−1.35 to −0.53)	−0.73 (−1.12 to −0.34)	−1.85 (−2.60 to −1.10)	−4.99 (−6.61 to −3.37)
Women						
Total	−0.53 (−0.65 to −0.41)	−1.03 (−1.22 to −0.85)	−0.31 (−0.36 to −0.27)	−0.18 (−0.25 to −0.11)	−0.67 (−0.81 to −0.54)	−2.26 (−2.57 to −1.96)
NHW	−0.48 (−0.65 to −0.31)	−0.88 (−1.11 to −0.65)	−0.28 (−0.32 to −0.24)	−0.15 (−0.21 to −0.08)	−0.43 (−0.62 to −0.24)	−1.90 (−2.29 to −1.52)
NHB	−0.84 (−1.07 to −0.61)	−2.22 (−2.53 to −1.90)	−0.57 (−0.74 to −0.39)	−0.22 (−0.32 to −0.11)	−1.88 (−2.22 to −1.55)	−4.45 (−5.08 to −3.82)
MA	−0.40 (−0.68 to −0.11)	−0.53 (−0.81 to −0.24)	−0.20 (−0.24 to −0.15)	−0.19 (−0.26 to −0.13)	−0.80 (−1.18 to −0.43)	−1.68 (−2.32 to −1.04)

Abbreviations: HDL-C, high-density lipoprotein cholesterol; MA, Mexican American; NHB, non-Hispanic black; NHW, non-Hispanic white; SBP, systolic blood pressure; TC, total cholesterol.

SI conversion factor: To convert cholesterol to millimoles per liter, multiply by 0.0259.

[a] National Health and Nutrition Examination Survey 2011-2012.