

Association of Race and Sex With Risk of Incident Acute Coronary Heart Disease Events

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ALTHOUGH MORTALITY RATES for acute myocardial infarction (MI) and coronary heart disease (CHD) have declined in the United States since the 1970s,¹⁻⁴ both death certificate data and evidence from 4 US communities suggest a steeper decline in acute CHD mortality between 2000 and 2008 for whites than for blacks, widening a long-standing disparity.^{5,6} Furthermore, data from Kaiser Permanente suggested that hospitalizations for MI decreased between 2002 and 2007,⁷ but more so for whites than for blacks. Neither death certificate data nor health plan data permit examination of incident events.^{5,8-10}

Two other major secular trends may influence contemporary estimates of incident CHD. First, statins have come into wide use over the past 10 years,¹¹ low-

Context It is unknown whether long-standing disparities in incidence of coronary heart disease (CHD) among US blacks and whites persist.

Objective To examine incident CHD by black and white race and by sex.

Design, Setting, and Participants Prospective cohort study of 24 443 participants without CHD at baseline from the Reasons for Geographic and Racial Differences in Stroke (REGARDS) cohort, who resided in the continental United States and were enrolled between 2003 and 2007 with follow-up through December 31, 2009.

Main Outcome Measure Expert-adjudicated total (fatal and nonfatal) CHD, fatal CHD, and nonfatal CHD (definite or probable myocardial infarction [MI]; very small non-ST-elevation MI [NSTEMI] had peak troponin level <0.5 µg/L).

Results Over a mean (SD) of 4.2 (1.5) years of follow-up, 659 incident CHD events occurred (153 in black men, 138 in black women, 254 in white men, and 114 in white women). Among men, the age-standardized incidence rate per 1000 person-years for total CHD was 9.0 (95% CI, 7.5-10.8) for blacks vs 8.1 (95% CI, 6.9-9.4) for whites; fatal CHD: 4.0 (95% CI, 2.9-5.3) vs 1.9 (95% CI, 1.4-2.6), respectively; and nonfatal CHD: 4.9 (95% CI, 3.8-6.2) vs 6.2 (95% CI, 5.2-7.4). Among women, the age-standardized incidence rate per 1000 person-years for total CHD was 5.0 (95% CI, 4.2-6.1) for blacks vs 3.4 (95% CI, 2.8-4.2) for whites; fatal CHD: 2.0 (95% CI, 1.5-2.7) vs 1.0 (95% CI, 0.7-1.5), respectively; and nonfatal CHD: 2.8 (95% CI, 2.2-3.7) vs 2.2 (95% CI, 1.7-2.9). Age- and region-adjusted hazard ratios for fatal CHD among blacks vs whites was near 2.0 for both men and women and became statistically nonsignificant after multivariable adjustment. The multivariable-adjusted hazard ratio for incident nonfatal CHD for blacks vs whites was 0.68 (95% CI, 0.51-0.91) for men and 0.81 (95% CI, 0.58-1.15) for women. Of the 444 nonfatal CHD events, 139 participants (31.3%) had very small NSTEMIs.

Conclusions The higher risk of fatal CHD among blacks compared with whites was associated with cardiovascular disease risk factor burden. These relationships may differ by sex.

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ering incidence rates. Second, cardiac troponin assays have become increasingly sensitive and very small amounts of myocardial necrosis are now routinely detected. Even very small non-ST-elevation MIs (NSTEMIs), with peak troponin level of less than 0.5 µg/L, may confer similar long-term risks as larger MIs.¹²⁻¹⁴ However, very small NSTEMIs have only recently been included in studies of MI event rates, resulting in higher reported MI incidence rates. The overall effect of these secular trends on estimates of CHD incidence and racial disparities is unclear.

We analyzed data from the national Reasons for Geographic and Racial Differences in Stroke (REGARDS) cohort with 3 objectives: (1) to examine racial and sex differences in incident total

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CHD, fatal CHD, and nonfatal CHD across race-sex groups, (2) to examine whether risk factors were associated with observed race-sex risk differences, and (3) to examine race-sex differences in participants with very small NSTEMIs.

METHODS

REGARDS Cohort Study

Procedures

REGARDS is a prospective cohort study of 30 239 individuals examining regional and racial influences on stroke mortality. Details are described elsewhere^{15,16}; briefly, participants were enrolled between 2003 and 2007 using commercially available lists and a combination of mail and telephone contacts to recruit English-speaking, community-dwelling adults aged 45 years or older, who were living in the continental United States. Race and sex were balanced by design, with oversampling from the Southeastern United States; the final cohort included 58% of participants who were women and 42% of participants who had black race. Race was self-reported. Baseline data collection included computer-assisted telephone surveys assessing medical history and health status. In-home examinations by trained health care professionals followed standardized, quality-controlled protocols to collect fasting blood and urine samples; electrocardiograms; blood pressure, height, and weight measurements; and medication use by pill bottle review. Blood and urine samples were centrally analyzed at the University of Vermont. Electrocardiograms were centrally analyzed at Wake Forest University.

Living participants or their proxies were followed up every 6 months by telephone with retrieval of medical records for reported hospitalizations. Deaths were detected by report of next of kin or through online sources (eg, Social Security Death Index) and the National Death Index. Proxies or next of kin were interviewed about the circumstances surrounding death, including the presence of chest pain. Death certificates and autopsy reports also were obtained to adjudicate cause of death.

For this study, individuals with prevalent CHD (self-report of MI or coronary revascularization procedure at baseline or evidence of prior MI on the baseline electrocardiogram) were excluded. Events through December 31, 2009, were included in this analysis. At that time, 9.5% were lost to follow-up. The study protocol was reviewed and approved by the institutional review boards at the participating institutions and all participants provided informed consent.

Acute CHD Events

The CHD events were adjudicated by a team of experts who used published guidelines.^{17,18} For MI, medical records were examined for the presence of signs or symptoms suggestive of ischemia; a rising and/or falling pattern in cardiac troponin level or creatine phosphokinase-MB level over 6 or more hours with a peak level greater than twice the upper limit of normal (diagnostic cardiac enzymes); and electrocardiogram changes consistent with ischemia or MI, guided by the Minnesota code and classified as evolving diagnostic, positive, nonspecific, or not consistent with ischemia.^{19,20} Definite MIs were those with diagnostic enzymes or electrocardiogram. Probable MIs were those with elevated but not diagnostic (ie, equivocal) enzymes with a positive but not diagnostic electrocardiogram; or, if enzymes were missing, with a positive electrocardiogram in the presence of ischemic signs or symptoms. Only definite or probable MIs were included as events in this study. The highest and lowest levels of troponin and upper limits of normal for the hospital's assay also were recorded. Myocardial infarction that was adjudicated to have been caused by an invasive procedure was classified as procedure-related.

Because there is no widely accepted approach to defining very small NSTEMI, we examined publicly available upper limits of normal for commercially available troponin assays²¹ and conservatively used 0.5 µg/L as the threshold of peak troponin to define very small NSTEMI, which is a level above twice the upper limit of all but 1 assay. Other MIs, including the 9 without troponin level available, were considered

typical MIs. Elective and urgent coronary revascularization procedures were not included in the main analysis because their use differs by race.²²⁻³⁰

For fatal events, the medical history, hospital records, interviews with next of kin or proxies, and death certificate or National Death Index data were reviewed to adjudicate the cause of death, with definite or probable CHD death used in the analysis (an expanded definition appears in the eAppendix at <http://www.jama.com>).¹⁷

Cases were assigned to 2 adjudicators and disagreements were adjudicated by committee. The test for agreement between adjudicators yielded a κ level greater than 0.80 for the presence of definite or probable MI or definite or probable acute CHD death.

The 3 main end points examined were a composite of fatal (definite or probable CHD death) or nonfatal CHD (definite or probable MI), and fatal and nonfatal CHD events, separately. Within nonfatal CHD events, we also examined very small NSTEMI and typical MI separately.

Covariates

Age, race, sex, income, education, and smoking status were self-reported. Annual income was dichotomized at less than \$20 000 and education was dichotomized at less than a high school diploma. Smokers were defined as having smoked at least 100 cigarettes in their lifetime and smoking now, even if just occasionally. Use of antihypertensive and statin medications was based on self-report and pill bottle review.

The biometrics used in this analysis included body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) and blood pressure. Participants had their height and weight measured using a standardized protocol during the in-home visit. Body mass index was modeled as a continuous measure. Blood pressure was obtained using an aneroid sphygmomanometer after a seated rest of 5 minutes with both feet on the floor.¹⁶ Two measures were obtained following a standardized protocol and averaged. Systolic blood pressure was modeled as a continuous variable.

Blood and urine markers included levels of total cholesterol, high-density lipoprotein (HDL) cholesterol, fasting glucose, high-sensitivity C-reactive protein (CRP), serum creatinine, and urinary albumin and creatinine from a spot urine specimen. Total and HDL cholesterol levels were modeled as continuous variables. Diabetes was classified as present if fasting glucose level was ≥ 126 mg/dL or greater (nonfasting glucose level: ≥ 200 mg/dL; $n=229$) or if patient reported taking diabetes medications. High-sensitivity CRP was log-transformed and modeled as a continuous variable. Estimated glomerular filtration rate (GFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation.³¹ Urinary albumin and creatinine levels were used to define the ratio of albumin to creatinine.

Analysis

Age-standardized incidence rates per 1000 person-years were calculated for each race and sex group for each end point. Sex-stratified Cox proportional hazards models were constructed to estimate the hazard ratios (HRs) for blacks compared with whites for incident events for the 3 end points (total CHD, fatal CHD, and nonfatal CHD). The assumptions of proportionality were met and there were no time-dependent variables. Individuals were censored at the time of their event, death, or the end of follow-up. Models were constructed incrementally to examine changes in HR as covariates were added. Model 1 adjusted for age and region (stroke belt, stroke buckle, or other parts of the continental United States because the REGARDS study oversampled residents of the stroke belt and stroke buckle).

Model 2 added income and education to model 1 covariates. Model 3 added Framingham risk factors (levels of total and HDL cholesterol, smoking status, systolic blood pressure, and diabetes status) and use of statin or antihypertensive medication to model 2 covariates. Model 4 added BMI, estimated GFR, and log-transformed ratio of albumin to creatinine, and high-sensitivity CRP to model 3 covariates. Missing covariates were imputed using chained equations with 5 data sets.^{32,33}

We calculated the age-standardized incidence of very small NSTEMI and typical MI per 1000 person-years for each race and sex group. The HRs for blacks compared with whites for typical and very small NSTEMI were estimated from sex-stratified Cox proportional hazards models with identical incremental adjustment as those described above for the main analysis.

Sensitivity analyses examined the effect of including elective and urgent percutaneous coronary revascularization procedures and coronary artery bypass graft surgery in the analysis as incident events. After including these procedures, the age-standardized rates for total incident CHD, fatal CHD, and nonfatal CHD and Cox proportional hazard models (as described above) were calculated for each race and sex group. Because blacks have a shorter life expectancy than whites, we also examined whether all-cause mortality among blacks was a competing risk for nonfatal CHD by entering all-cause mortality as a competing risk to the fully adjusted models. Also, we examined the role of MIs complicating coronary interventions and other surgical procedures for the end points. Statistical significance for all analyses was a P value of less than .05. Analyses were conducted using SAS version 9.2 (SAS Institute Inc) and Stata version 11 (StataCorp).

Table 1. Baseline Characteristics of REGARDS Cohort Members Without Coronary Heart Disease at Baseline

	No. (%) of Cohort ^a			
	Men		Women	
	Black (n = 3739)	White (n = 6420)	Black (n = 6609)	White (n = 7675)
Region				
Stroke belt ^b	1245 (33.3)	2221 (34.6)	2252 (34.1)	2762 (36.0)
Stroke buckle ^c	604 (16.2)	1261 (19.6)	1272 (19.2)	1975 (25.7)
Non-stroke belt or buckle	1890 (50.5)	2938 (45.8)	3085 (46.7)	2938 (38.3)
Education \leq high school	685 (18.3)	380 (5.9)	1249 (18.9)	509 (6.6)
Annual income $<$ \$20 000 ^d	704 (21.0)	428 (7.3)	1951 (34.3)	1109 (17.1)
Antihypertensive medication use	2080 (57.7)	2420 (39.4)	4216 (66.3)	3074 (41.7)
Diabetes	1176 (31.5)	1110 (17.3)	2046 (31.0)	1119 (14.6)
Statin use	940 (25.2)	1823 (28.5)	1668 (25.3)	1892 (24.7)
Current smoker ^e	730 (19.6)	738 (11.5)	1012 (15.4)	973 (12.7)
Estimated glomerular filtration rate $<$ 60 mL/min	355 (10.0)	499 (8.0)	666 (10.7)	686 (9.3)
	Mean (SD)			
Age, y	63.9 (9.2)	64.9 (9.2)	63.5 (9.3)	64.1 (9.5)
Body mass index ^f	28.9 (5.4)	28.2 (4.8)	31.9 (7.1)	28.2 (6.2)
Cholesterol, mg/dL				
Total	187.0 (39.5)	187.2 (36.4)	198.8 (40.5)	202.7 (38.5)
High-density lipoprotein	48.4 (14.6)	44.9 (13.3)	57.2 (15.9)	57.9 (16.4)
Systolic blood pressure, mm Hg	131.7 (16.9)	126.8 (15.0)	129.5 (17.2)	123.0 (15.7)
	Median (25th-75th)			
High-sensitivity C-reactive protein, mg/L	2.0 (0.92-4.4)	1.5 (0.7-3.3)	3.5 (1.4-7.5)	2.2 (1.0-4.9)
Ratio of albumin to creatinine, mg/g	7.2 (4.1-20.9)	5.9 (4.0-12.0)	7.7 (4.9-17.0)	7.5 (5.0-13.1)

Abbreviation: REGARDS, Reasons for Geographic and Racial Differences in Stroke.

SI conversion factors: To convert C-reactive protein to nmol/L, multiply by 9.524; high-density lipoprotein and total cholesterol to mmol/L, multiply by 0.0259.

^aUnless otherwise indicated.

^bDefined as the states of Alabama, Arkansas, Louisiana, Mississippi, Tennessee and the noncoastal regions within the states of North Carolina, South Carolina, and Georgia.

^cDefined as the coastal regions within the states of North Carolina, South Carolina, and Georgia.

^dThe 3033 (12.4%) who declined to report income were not included in the denominator.

^eDefined as having smoked at least 100 cigarettes in one's lifetime and currently smoking, even if only occasionally.

^fCalculated as weight in kilograms divided by height in meters squared.

education and a lower income level. Smoking, diabetes, and reduced estimated GFR were more prevalent and systolic blood pressure, BMI, and level of high-sensitivity CRP were higher among blacks than whites.

Incidence Rates

The mean (SD) follow-up time was 4.2 (1.5) years. The 659 total incident CHD events through December 31, 2009, included 153 events in black men, 254 in white men, 138 in black women, and 114 in white women (TABLE 2). Although the incidence rate per 1000 person-years of total CHD was similar among black men (9.0; 95% CI, 7.5-10.8) and white men (8.1; 95% CI, 6.9-9.4), black men had higher incidence of fatal CHD (4.0 [95% CI, 2.9-5.3] vs 1.9 [95% CI, 1.4-2.6] for white men) and lower incidence of nonfatal CHD (4.9 [95% CI, 3.8-6.2] vs 6.2 [95% CI, 5.2-7.4] for white men; FIGURE). Women had lower incidence rates per 1000 person-years than men within each racial group. However, black women had higher incidence rates per 1000 person-years for total CHD (5.0 [95% CI, 4.2-6.1] vs 3.4 [95% CI, 2.8-4.2] for white women), for fatal CHD (2.0 [95% CI, 1.5-2.7] vs 1.0 [95% CI, 0.7-1.5] for white women), and for nonfatal CHD (2.8 [95% CI, 2.2-3.7] vs 2.2 [95% CI, 1.7-2.9] for white women; Figure).

Risks for CHD

For total CHD, the age- and region-adjusted HR for black men compared with white men was 1.15 (95% CI, 0.94-1.41) (model 1) and in the fully adjusted model it was 0.87 (95% CI, 0.69-1.08; model 4) (TABLE 3). Among women, the age- and region-adjusted HR for total CHD for blacks vs whites was 1.48 (95% CI, 1.15-1.90) and in the fully adjusted model it was 0.90 (95% CI, 0.68-1.20).

For fatal CHD, the age- and region-adjusted HR for black men compared with white men was 2.18 (95% CI, 1.55-3.06) and in the fully adjusted model it was 1.34 (95% CI, 0.91-1.96). Among women, the age- and region-adjusted HR for fatal CHD for blacks vs whites

was 1.93 (95% CI, 1.23-3.03) and in the fully adjusted model it was 1.14 (95% CI, 0.69-1.99) (Table 3).

For nonfatal CHD, the age- and region-adjusted HR for black men compared with white men was 0.81 (95% CI, 0.63-1.06) and in the fully adjusted model it was 0.68 (95% CI, 0.51-0.91). Among women, the age- and region-adjusted HR for nonfatal CHD for blacks vs whites was 1.31 (95% CI, 0.97-1.77) and in the fully adjusted model it was 0.81 (95% CI, 0.58-1.15) (Table 3).

Role of Very Small NSTEMI

Very small NSTEMI comprised 31.3% of nonfatal CHD events; there were 33 (40.2%) among black men, 47 (24.6%) among white men, 35 (39.8%) among black women, and 24 (28.9%) among

white women (Table 2). Incidence rates for typical MI were lower for black men than for white men, but rates for very small NSTEMI were similar (eFigure 1 at <http://www.jama.com>). In contrast, incidence rates for typical MI were similar for black women and white women, but incidence rates for very small NSTEMI were higher for black women than for white women.

The HRs for typical MI for blacks vs whites were similar to the overall nonfatal CHD results for both men and women (TABLE 4). The HR for very small NSTEMI was not statistically different for black men vs white men, but black women had a higher age-adjusted HR for very small NSTEMI vs white women, which became nonsignificant with full adjustment.

Table 2. Incident Coronary Heart Disease (CHD) Events Through December 31, 2009^a

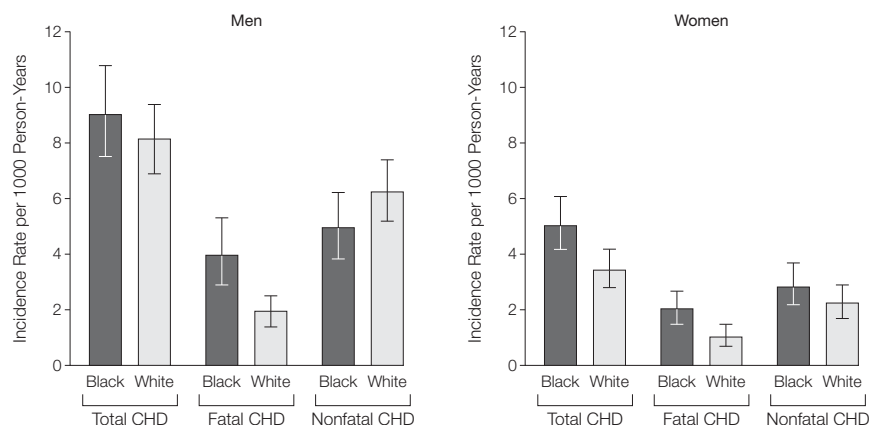
	Overall (N = 24 443)	Men		Women	
		Black (n = 3739)	White (n = 6420)	Black (n = 6609)	White (n = 7675)
Person-years of follow-up	102 907	15 977	28 733	26 760	31 438
Total CHD events	659 (3)	153 (4)	254 (4)	138 (2)	114 (2)
Fatal	215 (1)	71 (2)	63 (1)	50 (1)	31 (<1)
Nonfatal	444 (2)	82 (2)	191 (3)	88 (1)	83 (1)
Very small NSTEMI ^b	139 (31.3)	33 (40.2)	47 (24.6)	35 (39.8)	24 (28.9)

Abbreviation: NSTEMI, non-ST-elevation myocardial infarction.

^aIncident CHD defined as adjudicated definite or probable myocardial infarction or definite or probable CHD death. Values are expressed as number (percentage) unless otherwise indicated.

^bDefined as an adjudicated definite or probable MI with peak troponin level of less than 0.5 µg/L. The percentages reflect the number of incident very small NSTEMIs divided by the number of nonfatal incident CHD events.

Figure. Coronary Heart Disease (CHD) Outcomes by Race and Sex in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) Cohort



Data are through December 31, 2009. Error bars indicate 95% confidence intervals. The *P* values for the differences between black and white men are total CHD, *P* = .30; fatal CHD, *P* < .001; and nonfatal CHD, *P* = .07. The *P* values for the differences between black and white women are total CHD, *P* = .002; fatal CHD, *P* = .003; and nonfatal CHD, *P* = .10.

Sensitivity Analyses

Including coronary revascularization procedures substantially and disproportionately increased the age-standardized incidence rates for whites vs blacks. For white men, total CHD increased by 69.3% and nonfatal CHD increased by 93.7%; for white women, total CHD increased by 63.2% and nonfatal CHD increased by 86.7%. For black men, total CHD increased by 21.6% and nonfatal CHD increased by 42.7%; for black

women, total CHD increased by 34.1% and nonfatal CHD increased by 54.5%. Effects on fatal CHD were trivial (eTable 1 and eFigure 2). For men, the HRs for blacks compared with whites for incident total and nonfatal CHD were lower than in the model without revascularizations, but there were minimal changes in the HRs for incident fatal CHD comparing black men with white men (eTable 2). For black women compared with white women, higher HRs for

total CHD became significantly lower in the fully adjusted models; multivariable-adjusted HRs for nonfatal CHD also were significantly lower. Higher HRs for fatal CHD became nonsignificant with multivariable adjustment (eTable 2).

Accounting for the competing risk of all-cause mortality among blacks had little effect on the risks for nonfatal CHD (adjusted HRs comparing blacks with whites: 0.59 [95% CI, 0.46-0.78] for men and 0.87 [95% CI, 0.64-1.18] for women without revascularizations; adjusted HRs comparing blacks with whites: 0.44 [95% CI, 0.36-0.55] for men and 0.72 [95% CI, 0.56-0.91] for women with revascularizations). There were 10 procedure-related MIs among black men and 23 among white men; the results including procedure-related MIs were almost identical to those that did not include these events.

Table 3. Total, Fatal, and Nonfatal Acute Coronary Heart Disease (CHD) Events

	Black vs White, Hazard Ratio (95% CI)	
	Men	Women
Total CHD		
Model 1 ^a	1.15 (0.94-1.41)	1.48 (1.15-1.90)
Model 2 ^b	1.04 (0.84-1.29)	1.25 (0.96-1.62)
Model 3 ^c	0.93 (0.74-1.16)	0.95 (0.72-1.25)
Model 4 ^d	0.87 (0.69-1.08)	0.90 (0.68-1.20)
Fatal CHD		
Model 1 ^a	2.18 (1.55-3.06)	1.93 (1.23-3.03)
Model 2 ^b	1.78 (1.24-2.56)	1.63 (1.02-2.62)
Model 3 ^c	1.50 (1.02-2.19)	1.20 (0.73-1.97)
Model 4 ^d	1.34 (0.91-1.96)	1.14 (0.69-1.99)
Nonfatal CHD		
Model 1 ^a	0.81 (0.63-1.06)	1.31 (0.97-1.77)
Model 2 ^b	0.78 (0.60-1.03)	1.10 (0.80-1.52)
Model 3 ^c	0.72 (0.54-0.95)	0.85 (0.61-1.19)
Model 4 ^d	0.68 (0.51-0.91)	0.81 (0.58-1.15)

^aAdjusted for age and region of residence.

^bAdjusted for model 1 covariates plus education level and income.

^cAdjusted for model 2 covariates plus total cholesterol, high-density lipoprotein cholesterol, smoking status, systolic blood pressure, diabetes, and use of antihypertensive and statin medications.

^dAdjusted for model 3 covariates plus body mass index, estimated glomerular filtration rate of less than 60 mL/min, log-transformed high-sensitivity C-reactive protein, and log-transformed albumin-to-creatinine ratio.

Table 4. Nonfatal Myocardial Infarctions (MIs) by Typical and Very Small Non-ST-Elevation MI (NSTEMI) Classification^a

	Black vs White, Hazard Ratio (95% CI)	
	Men	Women
Nonfatal typical MI		
Model 1 ^b	0.65 (0.47-0.89)	1.11 (0.76-1.61)
Model 2 ^c	0.64 (0.45-0.90)	0.97 (0.65-1.44)
Model 3 ^d	0.64 (0.45-0.91)	0.75 (0.50-1.14)
Model 4 ^e	0.62 (0.44-0.88)	0.74 (0.49-1.14)
Nonfatal very small NSTEMI		
Model 1 ^b	1.33 (0.85-2.09)	1.79 (1.06-3.03)
Model 2 ^c	1.22 (0.76-1.95)	1.44 (0.83-2.51)
Model 3 ^d	0.93 (0.57-1.52)	1.08 (0.60-1.92)
Model 4 ^e	0.83 (0.50-1.37)	0.97 (0.54-1.74)

^aVery small NSTEMI defined as a nonfatal incident CHD event with highest troponin level of less than 0.50 µg/L.

^bAdjusted for age and region of residence.

^cAdjusted for model 1 covariates, education level, and income.

^dAdjusted for model 2 covariates, total cholesterol, high-density lipoprotein cholesterol, smoking status, systolic blood pressure, diabetes, and use of antihypertensive and statin medications.

^eAdjusted for model 3 covariates, body mass index, estimated glomerular filtration rate of less than 60 mL/min, log-transformed high-sensitivity C-reactive protein, and log-transformed albumin-to-creatinine ratio.

COMMENT

In the REGARDs study, black men and black women had twice the age-standardized rate of fatal incident CHD compared with white men and white women. This increased risk was associated with racial differences in CHD risk factors, which were more prevalent among black men and women compared with white men and women. A marked sex difference was present for nonfatal acute CHD: black men had a lower risk of presenting with incident nonfatal acute MI than white men, but black women had a higher risk than white women. The low risk in black men remained present in the fully adjusted models, but the excess risk observed among black women was entirely attenuated after accounting for their higher cardiovascular disease risk factor burden. The high risk of presenting with death as the first manifestation of CHD among black men and women, which is associated with excess burden of cardiovascular disease risk factors, is similar to past reports⁴⁻⁷ and demonstrates little evidence of progress toward eliminating this disparity.

The incidence rates we observed were consistent with other reports of continued downward trends in MI and acute

CHD mortality. There are relatively few biracial cohorts that provide incidence data in the United States. Incidence rates for CHD from the Atherosclerosis Risk in Communities (ARIC) study were substantially higher per 1000 person-years in the 1990s than in our study (10.6 for black men, 12.5 for white men, 5.1 for black women, and 4.0 for white women).³⁴ Of note, coronary revascularizations were included as CHD events in that report. The use of these procedures has increased dramatically since that time, albeit with some recent decreases,²² and we observed lower revascularization use among black vs white REGARDS participants. More recently, the ARIC surveillance study reported declines in CHD death without history of MI as well as first MI from 1987 through 2008, revealing larger declines for whites than for blacks, with the lowest decline found in black men and an increase in first MI among black men.⁵ These results support the continued disparities in CHD we observed.

The racial and sex differences in fatal vs nonfatal acute CHD incidence rates that we observed are, to our knowledge, new. In the ARIC study, the incidence of overall CHD was similar for black and white men and for black and white women, but nonfatal and fatal events were not reported separately.³⁴ A recent analysis of pooled ARIC and Cardiovascular Health Study data compared risks of sudden cardiac death (SCD) and non-SCD CHD (nonfatal CHD, including revascularization procedures, and fatal CHD judged not to be SCD) over 14 years ending in 2002.³⁵ This study reported a HR of 1.81 (95% CI, 1.31-2.49) for SCD for blacks compared with whites and a HR of 0.76 (95% CI, 0.67-0.86) for non-SCD. While these categories are not directly comparable with ours, the results are generally concordant. Our more recent results, taken together with prior studies, suggest there has been disappointingly little progress in lowering the excess risk of death at first clinical presentation of acute CHD among blacks.

To our knowledge, previous reports have not found the lower risk of incident nonfatal CHD among black

men that we described. The additional analyses we conducted did not support that all-cause mortality was a competing risk, or that procedure-related MI, which potentially could have inflated nonfatal CHD in white men, contributed substantially. The low risk was seen only for typical MIs but not very small NSTEMIs. Additional studies are needed to confirm these findings.

The role of very small NSTEMI in the incidence of acute CHD is an emerging phenomenon. Numerous reports confirm the long-term risks associated with very small NSTEMIs, and experts including the European Society of Cardiology, the American College of Cardiology Federation, the American Heart Association, and the World Heart Federation recommend classifying such events as MIs.^{14,18,36-40} The large proportion of very small NSTEMIs suggests that comparisons of contemporary with past incidence rates will be complicated, especially for studies of racial disparities if our findings across race and sex groups are confirmed in other studies. In addition, the optimal threshold for defining very small NSTEMI is not clear; past reports that included estimates of the incidence of very small NSTEMI relative to typical MIs used varying definitions of this entity.^{14,38,39,41} We selected a conservative threshold but other thresholds may be reasonable, and consensus on how to define very small NSTEMI across epidemiological studies may be warranted, along with consensus on how to handle very small NSTEMI for comparisons with past studies.

Limitations of this study include its observational design and attendant cautions about drawing causal inferences. The REGARDS cohort was not designed as a surveillance study; thus, we likely underestimated incidence for nonfatal CHD events but not for fatal CHD events, which have more complete ascertainment. Although the REGARDS cohort has wide reach, participants in any research study may differ from the general population, affecting generalizability. Some of our covariates were self-reported, which carries limitations. Future analyses will

permit more in-depth exploration of very small NSTEMIs.

Strengths of this study include its national scope and unique in-home data collection, facilitating participation from residents of geographic areas beyond driving distance of large research institutions. The large number of geographically dispersed black and white participants is another notable strength, as is the contemporaneous nature of the cohort, with ongoing follow-up and rigorous adjudication of events using published guidelines, including conducting interviews with next of kin.

CONCLUSIONS

Similar incidence rates of total CHD among men obscured marked racial differences in fatal and nonfatal CHD. Fatal CHD risk was higher among black men and associated with known risk factors, but nonfatal CHD risk was lower with and without risk factor adjustment. In contrast, black women had higher rates of total, fatal, and nonfatal CHD, with higher risks attenuated by known risk factors. Excess risk factor burden among black men and women continues to be a major public health challenge, along with their high risk for death as the presentation of CHD. Increased emphasis on optimizing well-established CHD risk factors among blacks could potentially reduce these disparities.

Author Contributions: Dr Safford 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.

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Online-Only Material: The eAppendix, 2 eFigures, and 2 eTables are available at <http://www.jama.com>.

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