

# Race, Gender, and Mortality in Adults $\geq 65$ Years of Age With Incident Heart Failure (from the Cardiovascular Health Study)

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In patients with heart failure (HF), mortality is lower in women versus men. However, it is unknown whether the survival advantage in women compared with men is present in both whites and African Americans with HF. The inception cohort consisted of adults  $\geq 65$  years with incident HF after enrollment in the CHS, a prospective population-based study of cardiovascular disease. Of 5,888 CHS subjects, 1,264 developed new HF and were followed up for 3 years. Subjects were categorized into 4 race-gender groups, and Cox proportional hazard regression models were used to examine whether 3-year total and cardiovascular mortality differed among the 4 groups after adjusting for sociodemographic factors, co-morbidities, and treatment. A gender-race interaction was also tested for each outcome. In subjects with incident HF, African Americans had more hypertension and diabetes than whites, and white men had more coronary heart disease than other gender-race groups. Receipt of cardiovascular treatments among the 4 groups was similar. Mortality rates after HF were lower in women compared with men (for white women, African-American women, African-American men, and white men, total mortality was 35.5, 33.6, 44.4, and 40.5/100 person-years, and cardiovascular mortality was 18.4, 19.5, 20.2, and 22.7/100 person-years, respectively). After adjusting for covariates, women had a 15% to 20% lower risk of total and cardiovascular mortality compared with men, but there was no significant difference in outcome by race. The gender-race interaction for either outcome was not significant. In conclusion, in older adults with HF, women had significantly better survival than men irrespective of race, suggesting that gender-based survival differences may be more important than race-based differences. © 2009 Elsevier Inc. (Am J Cardiol 2009;103:1120–1127)

Women constitute  $>1/2$  of all prevalent heart failure (HF) cases and differ from men in risk factors, response to therapy, and quality of care.<sup>1</sup> Some,<sup>2–6</sup> but not all,<sup>7–9</sup> studies have shown that women with HF had lower mortality compared with men. Most studies assessed gender differences in short- or intermediate-term (30 days to 1 year) all-cause mortality in selected HF populations with limited racial

diversity. There is limited information for long-term mortality in patients with HF. Additionally, similar to published reports of gender disparities, some,<sup>10–13</sup> but not all,<sup>2,14–16</sup> studies reported that white patients with HF have lower mortality and rehospitalization rates compared with African Americans. None of these studies stratified effects of race on outcomes in patients with HF by gender, perhaps because of the small number of women included in several of these studies. In other heart-disease populations, such as myocardial infarction (MI), African Americans have higher mortality rates than whites, and the group that showed the highest mortality compared with white men is African-American women.<sup>17,18</sup> Thus, it is possible that African-American women with HF may have a similar disadvantage in survival as seen after MI. Recently, the Institute of Medicine<sup>19</sup> and the US Public Health Service's Healthy People 2010 initiative<sup>20</sup> made prominent efforts to remedy race and gender difference in health outcomes. Consistent with these efforts, we evaluated gender and racial differences in mortality in an inception cohort with incident HF that was part of a prospective community-based study of older adults, the Cardiovascular Health Study (CHS).

## Methods

The CHS is a community-based longitudinal study initiated in 1988 by the National Heart, Lung, and Blood Insti-

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Table 1  
 Characteristics of subjects with an incident heart failure (HF) diagnosis

Characteristics	Women		Men		p Value*
	White (n = 537)	African American (n = 106)	White (n = 555)	African American (n = 66)	
Age (yrs)	82 ± 6	81 ± 7	81 ± 6	79 ± 6	0.015
Education <sup>†</sup>					<0.001
None–grade 9	103 (19%)	43 (41%)	115 (21%)	23 (35%)	
High school	226 (42%)	33 (31%)	181 (33%)	16 (24%)	
Professional/vocational	206 (39%)	30 (28%)	258 (47%)	27 (41%)	
Income <sup>‡</sup> (\$)					<0.001
<8,000	91 (18%)	53 (54%)	38 (7%)	14 (22%)	
8,000–34,999	350 (69%)	41 (42%)	343 (65%)	43 (66%)	
≥35,000	65 (13%)	4 (4%)	146 (28%)	8 (12%)	
Occupation <sup>†</sup>					<0.001
White collar	218 (43%)	19 (20%)	315 (59%)	22 (37%)	
Blue collar	42 (8%)	18 (19%)	158 (30%)	30 (50%)	
Housewife/other	250 (49%)	59 (62%)	58 (11%)	8 (13%)	
Marital status <sup>†</sup>					<0.001
Married	282 (53%)	28 (26%)	464 (84%)	42 (64%)	
Widowed	206 (38%)	56 (53%)	57 (10%)	11 (17%)	
Divorced, separated, or never married	48 (9%)	22 (21%)	34 (6%)	13 (20%)	
Smoking status					<0.001
Never	312 (58%)	64 (60%)	175 (32%)	19 (29%)	
Former	208 (39%)	40 (38%)	362 (65%)	43 (65%)	
Current	17 (3%)	2 (2%)	18 (3%)	4 (6%)	
Alcohol drinks/wk)	1.0 ± 3.3	0.3 ± 1.6	2.8 ± 6.7	1.3 ± 4.4	<0.001
Diabetes	83 (17%)	39 (38%)	122 (23%)	18 (29%)	<0.001
Systolic blood (mm Hg)	143 ± 23	146 ± 22	137 ± 22	140 ± 19	<0.001
Diastolic blood pressure (mm Hg)	68 ± 12	73 ± 14	70 ± 12	72 ± 14	<0.001
Total cholesterol (mg/dl)	212 ± 41	209 ± 44	191 ± 34	194 ± 39	<0.001
Body mass index (kg/m <sup>2</sup> )	26.8 ± 5.5	31.4 ± 7.1	26.9 ± 3.8	27.1 ± 4.0	<0.001
General health					<0.001
Excellent, very good, good	293 (60%)	41 (40%)	320 (64%)	35 (56%)	
Fair or poor	199 (40%)	61 (60%)	182 (36%)	28 (44%)	
Hypertension	366 (68%)	81 (76%)	320 (58%)	49 (74%)	<0.001
History of cerebrovascular disease before HF					
Angina pectoris	155 (29%)	33 (31%)	228 (41%)	14 (21%)	<0.001
MI	78 (15%)	10 (9%)	148 (27%)	14 (21%)	<0.001
CHD <sup>‡</sup>	169 (32%)	33 (31%)	252 (45%)	20 (30%)	<0.001
Stroke	64 (12%)	13 (12%)	72 (13%)	8 (12%)	0.962
Transient ischemic attack	30 (6%)	7 (7%)	42 (8%)	6 (9%)	0.507
Coronary bypass	24 (5%)	4 (4%)	79 (16%)	4 (6%)	<0.001
Coronary angioplasty	9 (2%)	3 (3%)	33 (6%)	4 (6%)	0.002
Atrial fibrillation	42 (8%)	5 (5%)	51 (9%)	4 (6%)	0.395
Clinical precipitants of HF <sup>§</sup>					
Arrhythmia	155 (30%)	16 (16%)	159 (30%)	17 (27%)	0.027
Coronary disease <sup>§</sup>	251 (49%)	53 (53%)	327 (62%)	39 (62%)	<0.001
Procedure-related HF	101 (20%)	8 (8%)	85 (16%)	7 (11%)	0.014
Pulmonary disease	139 (35%)	23 (34%)	121 (29%)	24 (47%)	0.027
Valvular disease	126 (25%)	13 (13%)	92 (17%)	11 (18%)	0.006
Volume problems	73 (14%)	12 (12%)	53 (10%)	11 (18%)	0.115
Other	76 (15%)	16 (16%)	71 (13%)	7 (11%)	0.734
Medications					
Aspirin	28 (5%)	6 (6%)	32 (6%)	8 (12%)	0.165
Angiotensin-converting enzyme inhibitors/ angiotensinogen receptor blockers	95 (18%)	21 (20%)	86 (16%)	16 (24%)	0.259
β Blockers	89 (17%)	15 (14%)	98 (18%)	9 (14%)	0.727
Calcium channel blockers	144 (27%)	41 (39%)	145 (26%)	21 (32%)	0.061
Diuretics	224 (42%)	49 (46%)	182 (33%)	23 (35%)	0.005
Digitalis	105 (20%)	9 (10%)	92 (17%)	15 (23%)	0.027
Any antihypertensive medication	343 (70%)	79 (76%)	329 (65%)	45 (71%)	0.139
Lipid-lowering medication	39 (7%)	8 (8%)	51 (9%)	2 (3%)	0.292

Table 1  
(continued)

Characteristics	Women		Men		p Value*
	White (n = 537)	African American (n = 106)	White (n = 555)	African American (n = 66)	
Rate of assessment of EF	251 (47%)	53 (50%)	257 (46%)	27 (41%)	0.712
EF <45% at point of care (total n = 588)	82 (33%)	16 (30%)	131 (51%)	12 (44%)	<0.001

Values expressed as mean  $\pm$  SD or number (percent). All variables without  $\dagger$  were assessed at the visit immediately after the HF diagnosis.

\* Tests whether there was a significant difference in characteristics among the 4 race-gender subgroups.

$\dagger$  At baseline visit.

$\ddagger$  Angina, MI, bypass surgery, or angioplasty.

$\S$  Events concurrent with the hospitalization for HF.

Table 2  
Incidence rates for mortality and cardiovascular mortality

	n	Total Mortality			Cardiovascular Mortality		
		Person-yr at Risk	No. of Deaths	Rate (/100 Person-yr) (95% Confidence Interval)	Person-yr at Risk	No. of Deaths	Rate (/100 Person-yr) (95% Confidence Interval)
Women	1,264	2,690	1,020	37.9 (35.8–40.0)	2,690	550	20.4 (19.3–21.6)
Men	643	1,399	492	35.2 (32.5–37.9)	1,399	260	18.6 (17.2–20.0)
White	621	1,291	528	40.9 (37.7–44.1)	1,291	290	22.5 (20.7–24.2)
African American	1,092	2,340	889	38.0 (35.7–40.2)	2,340	481	20.6 (19.3–21.8)
White women	172	350	131	37.5 (31.9–43.1)	350	69	19.7 (16.8–22.7)
African-American women	537	1,173	416	35.5 (32.5–38.5)	1,173	216	18.4 (16.9–20.0)
African-American men	106	226	76	33.6 (27.2–40.0)	226	44	19.5 (15.8–23.2)
White men	66	124	55	44.4 (33.7–55.1)	124	25	20.2 (15.3–25.1)
African-American men	555	1,168	473	40.5 (37.1–43.9)	1,168	265	22.7 (20.8–24.6)

Incidence rates in percentage per year.

tute, National Institutes of Health, Bethesda, Maryland, to evaluate clinical and subclinical risk factors for the incidence and progression of cardiovascular disease in adults aged  $\geq 65$  years at baseline.<sup>21</sup> The CHS cohort was identified and recruited from Medicare eligibility lists from the 4 geographically dispersed centers Forsyth County, North Carolina; Sacramento County, California; Allegheny County, Pittsburgh, Pennsylvania; and Washington County, Maryland.<sup>22</sup> The overall design, rationale, and recruitment strategy of the CHS have been described previously.<sup>21</sup> Briefly, interview, examinations, and questionnaires were used at the time of enrollment to obtain data about demographic characteristics (gender, age, education, income, occupation, and marital status), smoking and alcohol history, body measurements (height and weight), medical history, seated blood pressure, and total cholesterol. Annual clinic visits similar to the baseline visit alternated with semiannual telephone contacts through June 1999, and semiannual telephone contacts continued through the present time to ascertain medication use and hospitalizations. Cardiovascular medication use (e.g., aspirin, angiotensin-converting enzyme inhibitors,  $\beta$ -adrenergic blockers, calcium channel blockers, diuretics, digitalis, other antihypertensive medications, and lipid-lowering medication) was assessed using a medication inventory.<sup>23</sup> Self-report of medical history and cardiovascular diseases at baseline were validated according to standardized criteria using assessment of medications, medical records, and relevant information obtained during the initial examination. Subjects were asked to indicate their race by selecting from the categories of white (Caucasian), African-American, American Indian/Alaskan native, Asian/Pacific

Islander, and other. Only the first 2 groups were included in this analysis because the other groups constituted <1% of the population. Self-report of general health was defined as excellent, very good, good, fair, and poor using the 36-Item Short Form Health Survey.<sup>24,25</sup>

Eligible persons were expected to remain in the defined geographic area for  $\geq 3$  years. People were excluded if they were wheelchair bound or institutionalized, unable to participate in the examination, or receiving active treatment for cancer. Prevalent stroke, coronary heart disease (CHD), and HF were not exclusion criteria for enrollment in the CHS. The CHS included 5,888 subjects, 5,201 who were recruited in 1989 to 1990 and 687 predominantly self-reported African-American subjects who were added in 1992 to 1993.

At semiannual contacts, subjects were asked about physician-diagnosed HF in the past 6 months. Medical records were reviewed by the CHS events adjudication committee for final adjudication of HF. HF was defined as a constellation of symptoms (such as edema, rales, and nocturnal dyspnea) and physical signs (such as tachycardia, gallop rhythm, and displaced left ventricular apical impulse).<sup>26–28</sup> For definite HF, it was required that subjects have a diagnosis of HF from a physician and be under medical treatment for HF (a current prescription of a diuretic and digitalis or a vasodilator [nitroglycerin, hydralazine, or angiotensin-converting enzyme inhibitor]). In addition, any of the criteria of the presence of cardiomegaly and pulmonary edema on chest radiograph, decreased left ventricular ejection fraction (LVEF) or evidence of left ventricular dilation and segmental wall left ventricular dysfunction using either contrast ventriculography or echocar-

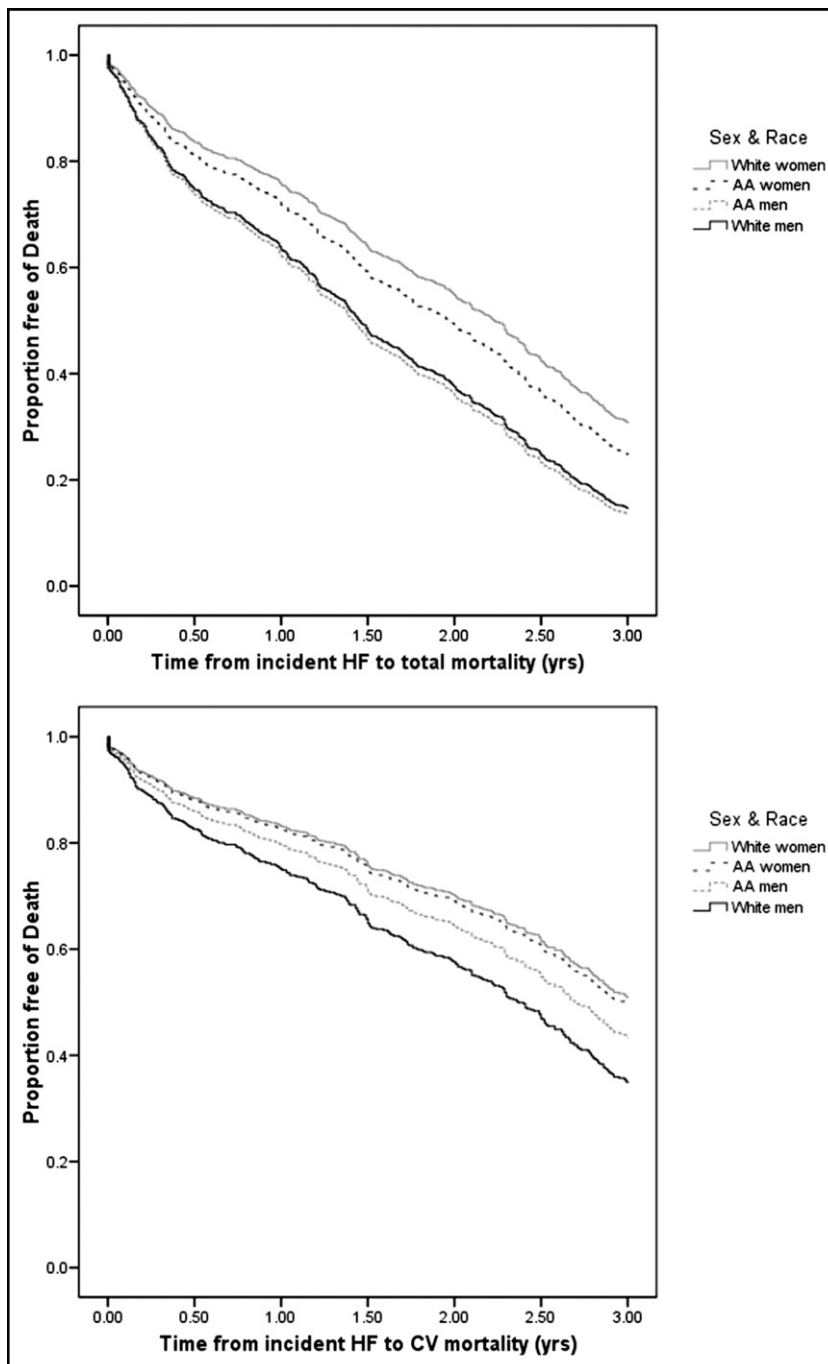


Figure 1. Survival curves for total and cardiovascular (CV) mortality by gender and race. AA = African American.

diography were considered sufficient, but not necessary, to validate a diagnosis of HF.<sup>26</sup> Clinical precipitants of HF were determined by the CHS events adjudication committee.

Reports for echocardiographic examinations at the time of HF diagnosis were obtained to evaluate LVEF. Consistent with previous studies, LVEF was classified as normal if  $\geq 55\%$ , borderline if  $\geq 45\%$  and  $< 55\%$ , and abnormal if  $< 45\%$ .<sup>26</sup>

The population for analysis was subjects without prevalent HF at enrollment who developed HF during follow-up before June 30, 2002. This date was chosen to allow assessment of 3-year mortality rates (through June 2005) after the

HF diagnosis. The HF inception cohort consisted of 1,141 subjects from the original cohort (1989 to 1990) and 123 subjects from the African-American cohort (1992 to 1993).

The 2 outcome measures within 3 years of the HF diagnosis were all-cause and cardiovascular mortality. Deaths were identified during regular 6-month surveillance contacts and obituaries and followed by data collection from death certificates, proxy interviews, and medical records. Underlying cause of death was assigned by a committee of physicians,<sup>27</sup> with cardiovascular deaths defined as those caused by atherosclerotic coronary disease, cerebrovascular disease (stroke), other atherosclerotic disease (such as aortic aneurysm), and

Table 3

Cox proportional hazard regression models to examine the association of the four gender-race subgroups with time to all-cause mortality

	Age Adjusted	Added Socioeconomic Status and Co-morbidities*	Added Treatment (Fully Adjusted) <sup>†</sup>	Fully Adjusted in Patients With LVEF Assessment <sup>‡</sup>
Men <sup>§</sup>	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Women	0.83 (0.72–0.94)	0.85 (0.73–0.99)	0.85 (0.73–0.99)	0.78 (0.62–0.98)
Whites <sup>¶</sup>	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
African Americans	1.02 (0.84–1.24)	0.98 (0.80–1.20)	0.98 (0.80–1.20)	1.07 (0.79–1.45)
White women	0.84 (0.73–0.97)	0.86 (0.73–1.01)	0.86 (0.73–1.01)	0.80 (0.63–1.01)
African-American women	0.83 (0.64–1.07)	0.82 (0.62–1.09)	0.82 (0.62–1.08)	0.80 (0.53–1.21)
African-American men	1.15 (0.86–1.55)	1.02 (0.76–1.38)	1.02 (0.76–1.38)	1.24 (0.78–1.95)
White men	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)

Values expressed as HR (95% confidence interval).

\* Adjusted for age, income, systolic blood pressure, diastolic blood pressure, smoking, diabetes, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), and body mass index.

<sup>†</sup> Adjusted for age, income, systolic blood pressure, diastolic blood pressure, smoking, diabetes, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), body mass index, and hypertension medications.

<sup>‡</sup> Adjusted for age, income, systolic blood pressure, diastolic blood pressure, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), body mass index, hypertension medications, and LVEF <45%.

<sup>§</sup> Adjusted for race.

<sup>¶</sup> Adjusted for gender.

other vascular disease (such as valvular heart disease or pulmonary embolism). We obtained outcome measures in 100% of subjects using these methods.

We categorized subjects into the 4 groups according to race and gender of white women, African-American women, white men, and African-American men. Covariates were chosen from the visit closest in time and before the HF event, except for medication use, which was selected from the visit after the HF event. Differences across groups in sociodemographic factors and clinical variables were assessed using chi-square and Student's *t* tests, as appropriate. In addition, bivariate analysis was conducted to examine differences in precipitants of HF between men and women.

Death rates per 100 person-years at risk after the first HF diagnosis were calculated for each outcome, stratified by race and gender. Cox proportional hazard regression models were used to examine the association of the 4 gender-race subgroups (white women, African-American women, and African-American men compared with white men) with time to death and time to cardiovascular death after adjusting for covariates. Covariates were selected based on whether they were previously associated with poor outcomes and whether they changed the coefficient of gender/race by 5% for either total or cardiovascular mortality. Three consecutive models were constructed for each end point. Model 1 included age; model 2 expanded the data in model 1 by including marital status, income, cardiovascular risk factors, and co-morbidities (smoking status, diabetes, total cholesterol, systolic blood pressure, diastolic blood pressure, body-mass index, and self-reported health and history of CHD before HF, including angina, MI, coronary artery bypass grafting, and percutaneous coronary intervention); and model 3 expanded the data in model 2 to include cardiovascular medications as described previously. In addition, a multiplicative interaction term was used to evaluate effect modification between gender and race.

Secondary analyses were conducted to examine the association of the 4 gender-race groups with time to death and

cardiovascular death using only subjects who had LVEF assessed. Covariates were added to the model as described, and we also adjusted for systolic dysfunction (LVEF <45%). Furthermore, in secondary analysis, we added clinical precipitants of HF in the models described to evaluate whether clinical precipitants of HF confounded the association between gender-race groups and outcomes. All tests for statistical significance were 2 tailed with  $\alpha = 0.05$ . All analyses were conducted using SPSS software, release 13.0.1 (SPSS Inc., Chicago, Illinois), and S-Plus 6.1 (Insightful Corp., Seattle, Washington).

## Results

A total of 1,264 CHS subjects (537 white women [43%], 106 African-American women [8%], 555 white men [44%], and 66 African-American men [5%]) met eligibility criteria for incident HF and a follow-up of 3 years. African-American men with incident HF were more likely to be younger and smokers, whereas African-American women with incident HF had lower income and education and more often had diabetes and higher body mass index compared with other gender-race groups (Table 1). Compared with other gender-race groups, white men with HF were more likely to have angina, previous MI, or coronary artery bypass grafting and therefore total CHD, whereas white women were less likely to have diabetes.

Reports of LVEF at the time of HF diagnosis (mean days from HF diagnosis to echocardiographic assessment  $11 \pm 166$  [SD]) were available for 588 of 1,264 patients with HF (47%). Rates of LVEF assessment using echocardiography were similar in all gender-race groups (Table 1). In the 588 subjects with incident HF who had echocardiography data, women were less likely to have low LVEF (<45%) compared with men (Table 1). Use of cardiovascular medications at the visit immediately after the HF diagnosis was similar across race-gender groups (Table 1). Except for diuretics and digitalis, there were no statistically significant

Table 4  
Cox proportional hazard regression models to examine the association of the four gender-race subgroups with time to cardiovascular death

	Age Adjusted	Added Socioeconomic Status and Co-morbidities*	Added Treatment (fully adjusted) <sup>†</sup>	Fully Adjusted in Patients With LVEF Assessment <sup>‡</sup>
Men <sup>§</sup>	1.00 (reference)	1.00 (reference)	1.00	1.00 (reference)
Women	0.81 (0.67–0.97)	0.81 (0.66–0.99)	0.80 (0.65–0.99)	0.81 (0.60–1.09)
Whites <sup>¶</sup>	1.00 (reference)	1.00 (reference)	1.00	1.00 (reference)
African Americans	1.02 (0.78–1.33)	1.00 (0.75–1.32)	1.00 (0.75–1.32)	1.01 (0.66–1.54)
White women	0.79 (0.65–0.96)	0.79 (0.63–0.98)	0.78 (0.63–0.98)	0.82 (0.60–1.13)
African-American women	0.88 (0.63–1.23)	0.87 (0.59–1.26)	0.86 (0.59–1.25)	0.79 (0.45–1.38)
African-American men	0.96 (0.63–1.48)	0.89 (0.58–1.38)	0.89 (0.58–1.38)	1.15 (0.61–2.18)
White men	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)

Values expressed as HR (95% confidence interval).

\* Adjusted for age, income, systolic blood pressure, diastolic blood pressure, smoking, diabetes, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), and body mass index.

<sup>†</sup> Adjusted for age, income, systolic blood pressure, diastolic blood pressure, smoking, diabetes, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), body mass index, and hypertension medications.

<sup>‡</sup> Adjusted for age, income, systolic blood pressure, diastolic blood pressure, self-reported health, CHD prevalence (includes angina, MI, bypass surgery, or angioplasty), body mass index, hypertension medications, and LVEF <45%.

<sup>§</sup> Adjusted for race.

<sup>¶</sup> Adjusted for gender.

differences in the treatment received by subjects (aspirin, angiotensin-converting enzyme inhibitors,  $\beta$  blockers, calcium channel blockers, and lipid-lowering agents) according to gender and race. Women were more often treated with diuretics and African-American women were less frequently treated with digitalis compared with the other groups. CHD was the primary precipitant of HF in both men and women, but was more common in men (62% of patients) than women (49% to 53% of patients). Statistically significant differences across race-gender groups were found for nearly all clinical precipitants (Table 1). HF in African-American women was less likely to be preceded by arrhythmia or valvular disease, whereas white women had the highest rate of valvular disease. Pulmonary disease was more common in African-American men, and procedure-related CHF was more common in whites than African Americans.

Within 3 years of an adjudicated HF diagnosis, 1,020 subjects (81%) died, of which 550 (44%) were cardiovascular deaths. Mortality rates, particularly total mortality rates, were lower in women than men (Table 2; Figure 1).

Age-adjusted results showed that significant differences by gender, but not race, were observed, and there was no significant interaction of gender by race ( $p = 0.77$ ; Table 3). Gender- and race-stratified results supported the lack of a gender-by-race interaction and the 15% reduced risk of mortality in women compared with men. Risk of total mortality for African-American men was similar to that for white men. Results were similar for total mortality after adjusting for patient and treatment characteristics (Table 3). The hazards in our data were proportional over time.

Similar to all-cause mortality results, results listed in Table 4 indicated an approximately 20% decrease in risk of cardiovascular mortality for women compared with men at all levels of adjustment, with no significant interaction of gender by race ( $p = 0.54$ ). Stratified analyses further illustrated this reduced risk, and although hazard ratios (HRs) appeared higher for African-American women compared with white women, we were unable to detect a significant difference by race in women ( $p > 0.5$ ).

Results were similar after additionally adjusting for low LVEF in subjects with available reports of LVEF during hospitalization (Tables 3 and 4). Furthermore, in secondary analysis, on adjustment for clinical precipitants for HF, our results did not differ from previous results.

## Discussion

This population-based longitudinal study of older adults with incident HF is the first to our knowledge to examine the effect of gender and race on long-term survival of elderly patients with HF. We found no racial differences in HF all-cause and cardiovascular mortality. Even after adjusting for demographic and socioeconomic characteristics, comorbidities, and cardiovascular treatments, women continued to have better survival compared with men irrespective of race. Our results suggested that in patients with HF, survival differences according to gender may be more important than differences according to race.

Results of our study expands previous published reports in several ways. Our study shows that in older adults with HF, being a woman was a good prognostic factor for survival, but race per se did not offer a survival benefit. Our study responds to the controversy related to gender and racial differences in HF outcomes. Most,<sup>2–6</sup> but not all,<sup>7–9</sup> studies reported better survival in women. Similarly, several<sup>10–13</sup> but not all,<sup>2,14,15</sup> studies showed better survival in whites compared with African Americans. Most studies of outcome of HF have focused on either racial or gender disparities, but rarely both within the same study. Therefore, gender differences in long-term HF outcome may be applicable to only a white population. In addition, the inconsistency of previous study results has been attributed in part to method limitations, including nonrepresentative populations, limited follow-up, exclusion of nonsystolic HF, and inadequate clinical data for risk adjustment. Also, most studies included both prevalent and incident cases of HF, which may limit the data available regarding time to outcome event. It is also important to recognize that most studies included a small number of women ( $\geq 20\%$ ), implying that the

number of women was too small to detect a significant difference in mortality. Our study sample was not limited to specific hospitals, specialized clinics, or referral practices and was free of selection biases of clinical trials, in which strict selection criteria were used. Our data were prospectively and systematically collected and validated. The diagnosis of HF was adjudicated by the CHS events committee using clinically accepted diagnostic criteria of HF and included subjects with HF with preserved systolic function, a common cause of HF in the elderly,<sup>26</sup> in addition to those with systolic dysfunction. Thus, our study reflects typical community-dwelling elderly patients with HF more closely than previous investigations. In addition, the large sample size of women (>50%) enabled us to examine differences in mortality by gender with sufficient precision. Finally, by examining long-term mortality, especially cardiovascular mortality in patients with HF, our study adds to previous published reports that mostly examined short or intermediate-term (30 days to 1 year) mortality.

It is reassuring that there were no racial differences in survival in subjects with HF, and the disadvantage in survival that African-American women experienced in other CHD populations, such as after MI,<sup>17,18</sup> was not observed in our HF population. There could be several reasons for this observation. First, although African-American women in our study had worse socioeconomic status and a higher burden of co-morbidities compared with other gender-race groups, after adjusting for these covariates, African-American women had better survival compared with white men. Second, previous studies indicated that left ventricular function explained most of the survival advantage of women compared with men.<sup>3,29</sup> Consistent with these studies,<sup>3,29</sup> in our study, women were less likely to have systolic dysfunction compared with men, and white and African-American women had similar rates of systolic dysfunction. In addition, after adjusting for LVEF in subjects for whom LVEF data were available, women, both African-American and white, continued to have better survival compared with men. Third, there were no meaningful gender-racial differences in pharmacologic treatments and rates of assessment of LVEF using echocardiography. In addition, in secondary analyses, after adjusting for clinical precipitants of HF, results were unchanged. Thus, there remained either unmeasured differences in subject characteristics, access to care, lifestyle, or a cultural or genetic basis that must account for better survival in women compared with men. Persistence of these outcome differences in different cardiovascular populations including patients with HF emphasize a need for continued research to understand the reasons for these differences so that inequities can be eliminated in medical outcomes.

Our study has a number of limitations. Because the CHS is a large population-based evaluation of people aged  $\geq 65$  years, our findings are generalizable to only these subjects. However, because >80% of patients with HF in the United States are  $\geq 65$  years, our study results are pertinent to the HF population. Left ventricular assessments were available for approximately 50% of subjects in our study. The lack of data for LVEF may have caused bias or unmeasured confounding between gender-race groups in those not assessed. However, our results were unchanged when analysis was limited to subjects who had LVEF data. It was previously

reported that a large proportion of elderly patients with HF did not receive assessment of LVEF.<sup>30</sup> Although it was reassuring that LVEF assessment did not differ by gender or race, the lack of documentation of LVEF in elderly patients with HF suggests a deficiency in the current clinical care of these patients. Additionally, we were unable to assess gender-race differences in quality-of-life or health status measures other than mortality. Another limitation was the relatively low number of HF cases in African-Americans. When the 4 gender-age groups were compared in the fully adjusted model, HRs for white and African-American women were nearly identical. That the HR for African-American women did not reach statistical significance at the  $p = 0.05$  level was because of the smaller sample size in that group. However, the consistency of effects in white and African-American women is further supported by a lack of a statistically significant interaction of gender by race. Finally, although we measured and controlled for several subject and clinical characteristics, such unmeasured variables as EF in the gender-race groups could confound results.

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