





ORIGINAL RESEARCH

Epidemiology of Heart Failure Stages in Middle-Aged Black People in the Community: Prevalence and Prognosis in the Atherosclerosis Risk in Communities Study

Ramachandran S. Vasan , MD; Solomon K. Musani, PhD; Kunihiro Matsushita , MD, PhD; Walter Beard, MD; Olushola B. Obafemi, MD; Kenneth R. Butler , PhD; Patricia P. Chang, MD, MHS; Thomas H. Mosley , PhD; Ervin Fox, MD

BACKGROUND: Black individuals have a higher burden of risk factors for heart failure (HF) and subclinical left ventricular remodeling.

METHODS AND RESULTS: We evaluated 1871 Black participants in the Atherosclerosis Risk in Communities Study cohort who attended a routine examination (1993–1996, median age 58 years) when they underwent echocardiography. We estimated the prevalences of 4 HF stages: (1) *Stage 0*: no risk factors; (2) *Stage A*: presence of HF risk factors (hypertension, diabetes mellitus, obesity, smoking, dyslipidemia, coronary artery disease without clinical myocardial infarction), no cardiac structural/functional abnormality; (3) *Stage B*: presence of prior myocardial infarction, systolic dysfunction, left ventricular hypertrophy, regional wall motion abnormality, or left ventricular enlargement; and (4) *Stage C/D*: prevalent HF. We assessed the incidence of clinical HF, atherosclerotic cardiovascular disease events, and all-cause mortality on follow-up according to HF stage. The prevalence of HF Stages 0, A, B, and C/D were 3.8%, 20.6%, 67.0%, and 8.6%, respectively, at baseline. On follow-up (median 19.0 years), 309 participants developed overt HF, 390 incurred new-onset cardiovascular disease events, and 651 individuals died. Incidence rates per 1000 person-years for overt HF, cardiovascular disease events, and death, respectively, were Stage 0, 2.4, 0.8, and 7.6; Stage A, 7.4, 9.7, and 13.5; Stage B 13.6, 15.9, and 22.0. Stage B HF was associated with a 1.5- to 2-fold increased adjusted risk of HF, cardiovascular disease events and death compared with Stages 0/A.

CONCLUSIONS: In our large community-based sample of Black individuals, we observed a strikingly high prevalence of Stage B HF in middle age that was a marker of high cardiovascular morbidity and mortality.

Key Words: Black participants ■ cardiovascular disease ■ epidemiology ■ heart failure

See Editorial by Okoh and Morris

Multiple investigations have documented a substantial burden of clinical heart failure (HF) in Black people in the United States.^{1–10} HF often presents in younger Black people^{11,12} and is characterized by high morbidity and mortality.^{13,14}

Several reports also have noted race-related differences in cardiac remodeling features based on imaging studies.^{15–19} Black people have a greater burden of HF risk factors,^{13,20,21} heightened afterload sensitivity,²² and a higher prevalence of subclinical left ventricular

Correspondence to: Ramachandran S. Vasan, MD, Sections of Preventive Medicine and Epidemiology and Cardiology, Department of Medicine, and Department of Epidemiology, Boston University Schools of Medicine and Public Health, Boston, MA. E-mail: vasan@bu.edu

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CLINICAL PERSPECTIVE

What Is New?

- Approximately two thirds of Black people in the community-based ARIC (Atherosclerosis Risk in Communities) Study have evidence of structural heart disease (termed Stage B heart failure) in midlife as determined by echocardiographic evaluation.
- Black people with Stage B heart failure in the ARIC Study were at high risk for developing fatal and nonfatal coronary heart disease or stroke, and death from all causes.

What Are the Clinical Implications?

- Our findings emphasize the critical need to screen for and detect both risk factors for heart disease and structural heart disease earlier in their life course in Black people, and to treat the modifiable risk factors optimally to prevent cardiovascular disease and heart failure in midlife and beyond.

Nonstandard Abbreviations and Acronyms

ACC	American College of Cardiology
AHA	American Heart Association
ARIC Study	Atherosclerosis Risk in Communities Study
CARDIA	Coronary Artery Disease Risk in Young Adults

(LV) abnormalities.²³ Black people also experience a more adverse clinical course in the context of progression of asymptomatic LV dysfunction,^{24,25} even though this finding has been debated.^{26,27} Notwithstanding the greater burden of preclinical HF noted above, additional recent investigations have reported that the lifetime risk of overt HF is actually lower in Black people compared with White people. This apparent paradox has been attributed to a greater risk of competing causes of mortality in Black people with risk factors for HF.²⁸ Additionally, other reports have corroborated that among people with multiple risk factors, the hazard of dying before developing HF is higher in Black women compared with their White counterparts.¹⁴ These aforementioned observations are consistent with parallel observations underscoring that Black people with abnormal LV geometry have a substantially elevated mortality risk.^{29,30}

Given the burden of HF in Black people, investigators³¹ have evaluated the profile of HF stages in Black

people by using the American College of Cardiology/American Heart Association (ACC/AHA) classification system for HF.^{31–33} Briefly, the ACC/AHA classification schema includes 5 stages that reflect sequential phases of disease progression, with 1 stage indicating a state of health (Stage 0), 2 subsequent stages (Stage A and B) indicating varying propensity for developing clinical HF, and the last 2 stages (Stages C and D) reflecting presence of overt disease with its associated substantial mortality risk.^{31–33} A prior investigation³¹ of HF stages in Black people (as part of evaluation of a biracial ARIC [Atherosclerosis Risk in Communities] cohort study) studied older participants at an average age of 75 years, an age that approximates the average life expectancy for Black people in the United States.³⁴ The prevalence of HF stages in Black people in their midlife and the long-term outcomes associated with these stages have not been well characterized. Accordingly, we evaluated the prevalence of HF stages in middle-aged Black people in the ARIC study. We hypothesized that a greater prevalence of structural heart abnormalities without HF signs and symptoms (Stage B) in midlife would be associated with higher risk of HF but would also be an indicator of greater non-HF-related cardiovascular morbidity and mortality.^{14,29,30} We tested this hypothesis in the community-based ARIC study sample in an examination where the cohort was middle-aged.

METHODS

Data from the ARIC study (including that used for the current article) are available at the NHLBI data repository BioLINCC at <https://biolincc.nhlbi.nih.gov/studies/aric/>

Study Sample

The design and selection criteria for the ARIC study have been described previously.³⁵ Briefly, 15 792 people aged 45 to 64 years were recruited at a baseline examination (1987–1989), randomly chosen from 4 US communities (ie, Forsyth County, NC; Jackson, MS; Minneapolis suburbs, MN; and Washington County, MD). ARIC is a biracial cohort. In Jackson, MS, a representative sample was enrolled exclusively from the Black residents of the city. For the present investigation, we included Black people from the Jackson, MS site of the ARIC study who attended their third examination visit and underwent routine echocardiography (“visit 3” 1993–1996; N=1871, mean age 59 years). This sample was used to describe the prevalence of various ACC/AHA HF stages in midlife in Black people. The study protocol was approved by the Institutional Review Board of the parent study (ARIC) and all participants provided written informed consent.

Echocardiographic Methods

The design of the echocardiographic protocol for the ARIC study at visit 3 has been described elsewhere.³⁶ Briefly, images were acquired using the Acuson XP128/10c echocardiography machine (GPS medical). A single cardiologist performed all echocardiographic readings. The interventricular septal thickness, posterior wall thickness, LV internal dimensions in end-diastole and systole, left atrium diameter, and aortic root diameter were obtained using M mode according to the conventions established by the American Society of Echocardiography at the time of the index examination. LV mass was derived using the formula described by Devereux et al using the M-mode data.³⁷ LV systolic function was considered reduced if left ventricular ejection fraction (LVEF) was <50%. LVEF was derived semiquantitatively using a modified Quinones technique and visual assessment of the LV apex. Abnormal LV structure and LVEF were used to classify Stage B HF and defined as the following: abnormal LVEF, regional wall motion abnormality, and LV hypertrophy (based on criteria of de Simone et al³⁸).

Cardiovascular Disease Risk Factors

Hypertension was classified based on self-reported medication use or the average of measured blood pressure readings of $\geq 140/90$ mm Hg at any ARIC visit consistent with prior reports.³¹ Diabetes mellitus was defined based on self-report of a physician diagnosis of

diabetes mellitus, antidiabetic medication use, fasting glucose ≥ 126 mg/dL, or nonfasting glucose ≥ 200 mg/dL. Body mass index was assessed at visit 3, and obesity was defined as body mass index ≥ 30 kg/m². Estimated glomerular filtration rate was calculated from visit 4 serum creatinine using the creatinine-based Chronic Kidney Disease Epidemiology Collaboration equation.³⁹

Definition of ACC/AHA HF Stages and Related Methods Including Covariate Definitions

Table 1 lists the criteria used for determining the prevalence of different HF stages at visit 3. For this purpose, a combination of clinical covariates, echocardiographic criteria, and definitions of clinical outcome events were used.⁴⁰

Outcome Events

Cardiovascular disease (CVD) events and all-cause mortality in ARIC were ascertained via continuous surveillance of hospitalizations and death certificates, annual telephone follow-up with the participant or a proxy, and linkage with the National Death Index. Incident coronary heart disease (CHD) was defined as a first occurrence of either adjudicated hospitalization for definite/probable myocardial infarction, or death caused by CHD.⁴¹ Fatal CHD was defined as the subset of incident CHD events that were confirmed to be

Table 1. ACC/AHA Heart Failure Staging System

HF Stage	Criteria for Definition
Healthy/0	Healthy participants, no cardiovascular risk factors, no symptoms of dyspnea or physical sign of edema
A	Presence of at least 1 of the following HF risk factors: <ul style="list-style-type: none"> • Hypertension (SBP/DBP $\geq 140/90$ mm Hg) • Diabetes mellitus (fasting glucose ≥ 126 mg/dL or use of diabetes mellitus medication) • Obesity (BMI ≥ 30 kg/m²) • Smoking (current smokers or smokers during the past year) • Dyslipidemia (total/HDL > 5 or triglycerides ≥ 150 mg/dL or use of lipid-lowering treatment) • Coronary artery disease (excluding myocardial infarction) but no cardiac structural/functional abnormality on imaging studies
B	Presence of any of the following: <ul style="list-style-type: none"> • Prior clinical myocardial infarction (ARIC definition) • Echocardiographic evidence of asymptomatic left ventricular systolic dysfunction: left ventricular ejection fraction of < 0.50 (corresponding to visual assessment of left ventricular ejection fraction [qualitative variable] and also by M-mode measurements of fractional shortening of < 0.29) • Left ventricular hypertrophy (LVH) = (LV Mass/ht^{2.7}) > 51 g/m^(2.7)³⁸ • Regional wall motion abnormality • Left ventricular enlargement
C/D	Presence of HF using ARIC criteria: <ul style="list-style-type: none"> • Based on review of hospitalization records for any evidence of relevant HF symptoms (new onset or worsening of shortness of breath, edema, paroxysmal nocturnal dyspnea, orthopnea, or hypoxia) or any mention of HF as the reason for the hospitalization. If the hospitalization included such evidence, a second more detailed abstraction of the medical records was completed that included recording elements of HF diagnostic criteria (based on Framingham, modified Boston, National Health and Nutrition Examination Survey, and Gothenburg criteria), HF diagnostic scheme using ICD-9-CM codes, diagnostic tests (imaging tests), biomarkers, and medications (see references^{31,40}).

ACC/AHA indicates American College of Cardiology/American Heart Association; ARIC, Atherosclerosis Risk in Communities Study; BMI, body mass index; HDL, high-density lipoprotein; HF, heart failure; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; and SBP/DBP, systolic blood pressure/diastolic blood pressure.

definite fatal CHD events. Incident stroke was defined as a first occurrence of adjudicated hospitalization or death caused by definite/probable ischemic stroke.⁴² For the present investigation, atherosclerotic CVD was defined as CHD or stroke or peripheral arterial disease. Incident clinical HF was defined as the first occurrence of a physician-adjudicated diagnosis of HF hospitalization during follow-up after visit 3, or presence at visit 5 of a self-report of HF or treatment for HF among those without a prior HF hospitalization with at least 1 of the following supportive criteria: (1) subsequent confirmation of HF by a treating physician or the participant, or (2) a blood NT-terminal pro-B-type natriuretic peptide concentration ≥ 125 pg/mL at visit 5.^{31,40}

Statistical Analysis

We assessed the prevalence of HF stages for pooled sexes at visit 3. We repeated analyses separately for women versus men and also stratified by age less than

or equal to the median age of 58 years versus >58 years, given reports of the occurrence of early onset of LV remodeling and overt HF in younger Black adults.

We estimated the incidence rates of overt HF, atherosclerotic CVD (composite of coronary artery disease, cerebrovascular disease, and peripheral arterial disease), death caused by atherosclerotic CVD, and all-cause mortality on follow-up according to HF Stage at visit 3. Kaplan–Meier curves were used to display cumulative incidence of individual events on follow-up (separately for each outcome), and the differences among the various HF stage strata tested using the log-rank test. Individuals with prevalent myocardial infarction were excluded from Stage B (N=89) for these analyses because they are a very high-risk group within this HF stage.

We used Cox proportional hazards regression to compare the relative risk of individual events (expressed as hazards ratios and their 95% CI; separate analyses for each individual event subtype) in participants with Stages B and C/D compared with the referent group of

Table 2. Characteristics of the Black Participants at ARIC Visit 3 According to Heart Failure Stage

Characteristics	Healthy/0 (N=71)	A (N=386)	B (N=1253)	C/D (N=161)	P Value*
Prevalence, %	3.8	20.6	67.0	8.6	
Age, y	55±4	57±5	58±5	58±5	<0.001
Women, %	56.3	65.0	63.1	78.9	<0.001
BMI, kg/m ²	25.7±2.5	27.7±4.6	31.4±5.8	34.6±7.6	<0.001
Normal weight, %	39.4	30.8	11.9	9.4	<0.001
Overweight, %	60.6	39.2	35.0	23.1	
Obese, %	0.0 (0)	30.0	53.1	67.5	
Systolic BP	116±11	124±17	131±19	133±19	<0.001
Diastolic BP	72±8	75±10	77±11	78±10	<0.001
Hypertension, %	0.0	46.3	57.2	84.4	<0.001
Antihypertensive Medication, %	0.0	42.9	51.7	83.7	<0.001
Diabetes mellitus, %	0.0	15.8	25.6	47.5	<0.001
Current smokers, %	0.0	20.8	20.2	16.3	<0.001
Total: HDL ratio	3.25±1.03	3.94±1.36	3.96±1.30	3.98±1.21	<0.001
Triglycerides, mg/dL	81.4±35.0	113.1±77.3	111.1±58.5	123.0±61.3	<0.001
Estimated GFR	96.4±16.5	93.5±17.3	94.2±17.6	91.5±20.0	<0.001
History of myocardial infarction, %	0.0	0.0	7.1	20.5	<0.001
E/A Ratio	1.97±0.52	1.72±0.46	1.64±0.47	1.51±0.59	<0.001
LV hypertrophy, %	0.0	0.0	98.8	85.1	<0.001
Ejection fraction, %					
Normal	100	100	96.4	88.8	<0.001
Mild	0	0	1.7	5.6	
Moderate	0	0	1.0	2.5	
Severe	0	0	0.9	3.1	

Definition of HF Stages in ARIC: Stage 0: Healthy, no risk factors; Stage A: presence of HF risk factors (hypertension, current smoking, obesity, total cholesterol ≥ 200 , diabetes mellitus, obesity, coronary artery disease), no cardiac structural/functional abnormality; Stage B: presence of prior myocardial infarction, LV systolic dysfunction, LV hypertrophy (see Table 1 for definitions); Stage C/D: Prevalent clinical HF. ARIC indicates Atherosclerosis Risk in Communities Study; BP, blood pressure; GFR, glomerular filtration rate; HDL, high-density lipoprotein; HF, heart failure; and LV, left ventricular.

*Trend test P value using analysis of variance for continuous variables and Cochran-Mantel-Haenszel test for categorical variables.

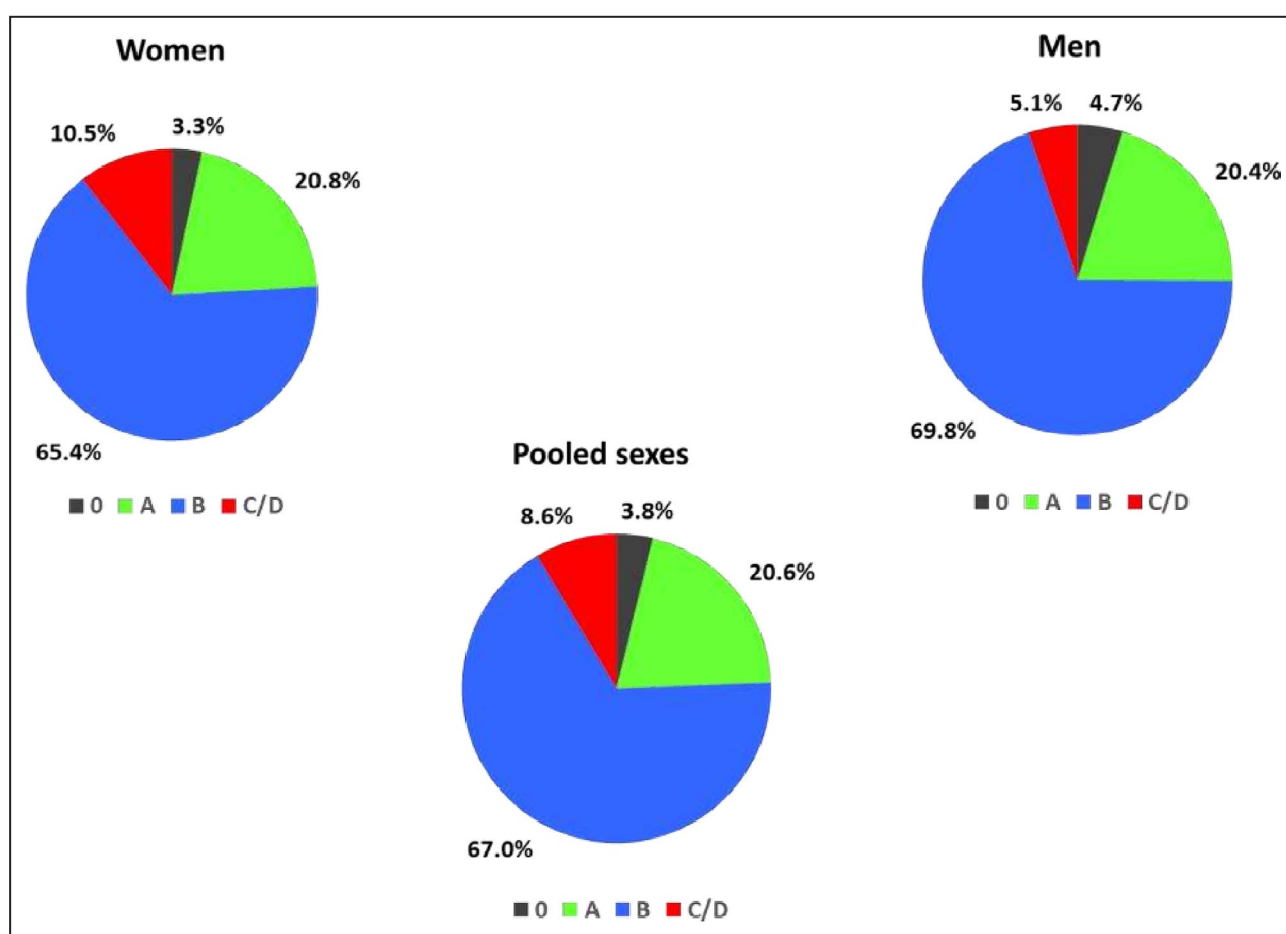


Figure 1. Prevalence of heart failure stages in Black people at ARIC visit 3 data for pooled sexes and by sex. ARIC indicates Atherosclerosis Risk in Communities Study.

individuals with Stage A after confirming that the assumption of proportionality of hazards was met. The referent group was Stage A because there were too few events in participants with Stage 0 for reliable estimations.

We performed secondary analyses where we modeled time to CVD events and overt HF with the following 3 tests: (1) compare model fitness between model 1 (CVD risk factors alone), and models 2, 3 (additional

inclusion of echocardiographic abnormality, left ventricular hypertrophy [model 2], LV dysfunction [model 3]); (2) test whether regression coefficient for hypertension and echocardiographic abnormalities are different from zero in models 2 and 3; and (3) evaluate the C-statistic for the 3 models.

All analyses were conducted using SAS software versions 9.4 and Kaplan–Meier curves generated

Table 3. Sex-Specific Prevalence of AHA/ACC HF Stages at ARIC Visit 3: Overall and at or Below Versus Above Median Age (≤58 Versus >58) Y (N=1871)

HF Stages	Women, N (%)			Men, N (%)		
	≤ Median Age	>Median Age	All Ages	≤ Median Age	>Median Age	All Ages
Total (no.)	650	559	1209	364	298	662
Healthy/0	29 (4.5)	11 (2.0)	40 (3.3)	24 (6.6)	7 (2.4)	31 (4.7)
A	147 (22.6)	104 (18.6)	251 (20.8)	86 (23.6)	49 (16.4)	135 (20.4)
B	425 (65.4)	366 (65.4)	791 (65.4)	241 (66.2)	221 (74.2)	462 (69.8)
C/D	49 (7.5)	78 (14.0)	127 (10.5)	13 (3.6)	21 (7.1)	34 (5.1)

ACC/AHA indicates American College of Cardiology/American Heart Association; ARIC, Atherosclerosis Risk in Communities Study; and HF, heart failure.

Table 4. Event Rates of Incident Clinical HF, CVD Events and CVD Death, and All-Cause Deaths Across Visit 3 HF Stages (N=1782) Compared With Stage A as the Sole Reference Group

HF Stage	0	A	B	C/D	Pooled
Clinical HF					
Cases/no. at risk	3/71	48/386	231/1164	NA	282/11621
Total-person-y	1276	6480	17 913	NA	28 793
Event rates*	2.4 (0.8–7.3)	7.4 (5.6–9.8)	12.9 (11.3–14.7)	NA	9.8 (8.7–11.0)
Hazard ratio†		Referent	1.75 (1.28–2.39)	NA	...
CVD‡					
Cases/no. at risk	1/71	61/379	257/1127	42/132	361/1709
Total-person-y	1294	6297	17 384	1724	26 698
Event rates*	0.8 (0.1–5.5)	9.7 (7.5–12.5)	14.8 (13.1–16.7)	24.4 (18.0–33.0)	13.8 (12.2–15.0)
Hazard ratio†		Referent	1.48 (1.12–1.95)	2.66 (1.79–3.96)	...
CVD death					
Cases/no. at risk	2/71	19/386	115/1164	44/161	180/1782
Total-person-y	1307	6805	19 469	2239	29 820
Event rates*	1.5 (0.4–6.1)	2.8 (1.8–4.4)	5.9 (4.9–7.1)	19.6 (14.6–26.4)	6.0 (5.2–7.0)
Hazard ratio†		Referent	2.06 (1.27–3.35)	7.41 (4.30–12.75)	...
All-cause mortality					
Cases/no. at risk	10/71	92/386	402/1164	94/161	598/1782
Total-person-y	1307	6805	19 469	2239	29 821
Event rates*	7.6 (4.1–14.2)	13.5 (11.0–16.6)	20.6 (18.7–22.8)	42.0 (34.3–51.4)	20.1 (18.5–21.7)
Hazard ratio†		Referent	1.49 (1.19–1.87)	3.24 (2.43–4.34)	...

Heart Failure stage A was the referent group because of too few events in the Stage 0 group. We excluded prevalent MI from stage B (N=89) for these analyses. Individuals with prevalent CVD in each stage were excluded for analyses of CVD incidence. CVD indicates cardiovascular disease; HF, heart failure; and MI, myocardial infarction.

*Per 1000 person-y (95% CI).

†Age- and sex-adjusted hazard ratios (95% CI) for baseline HF stages.

‡Excluding HF.

using R version 3.5.2. A 2-sided *P* value of <0.05 was used to denote statistical significance. SKM had access to all study data and takes responsibility for its integrity and data analysis.

RESULTS

Prevalence of HF Stages in Midlife

The baseline characteristics of study participants at visit 3 are shown according to their HF stage (Table 2). At visit 3 (median age 58 years), very few individuals were healthy (Stage 0). Nearly 20% of the participants were grouped as Stage A and almost two thirds of them were categorized as HF stage B (Figure 1). Prevalence of HF stage C/D was twice as high in women (10.5%) compared with men (5.1%). The prevalence of risk factors, CHD, and echocardiographic evidence of left ventricular hypertrophy or LV systolic dysfunction increased across the HF stages (by definition). The vast majority (89%) of participants with prevalent Stage C/D HF had a normal LVEF (Table 2).

Table 3 shows the prevalence of HF stages in women and men stratified by median age ≤58 years versus >58 years at visit 3. Nearly 63% of women and 66% of

men below age 58 years were categorized as Stage B HF.

Incidence of Adverse CVD Events and Deaths

On follow-up after visit 3 (median 19.0 years, range 1.3 to 20.8 years), 309 participants experienced clinical HF, 390 incurred a new atherosclerotic CVD event, 208 died because of CVD, and 651 individuals died overall. In the subset without prevalent myocardial infarction in stage B (N=1782), there were 282 HF events, 361 CVD events, 180 CVD deaths, and 598 deaths.

Incidence rates per 1000 person-years for overt HF, CVD, and death, respectively, were Stage 0, 2.4, 0.8, and 7.6; Stage A, 7.4, 9.7, and 13.5; and Stage B, 13.6, 15.9, and 22.0. Table 4 shows the incidence rates of these events on follow-up after visit 3 according to HF stage at that visit (89 individuals with prevalent myocardial infarction in Stage B were excluded for these analyses). Figure 2 Panels A-D show the Kaplan–Meier curves for individual outcomes according to HF stage and the corresponding log-rank *P* values. Very few events were observed in the minority of participants who were healthy at visit 3. Absolute event rates for each of the event subtypes escalated across the HF stages. The absolute incidence rates

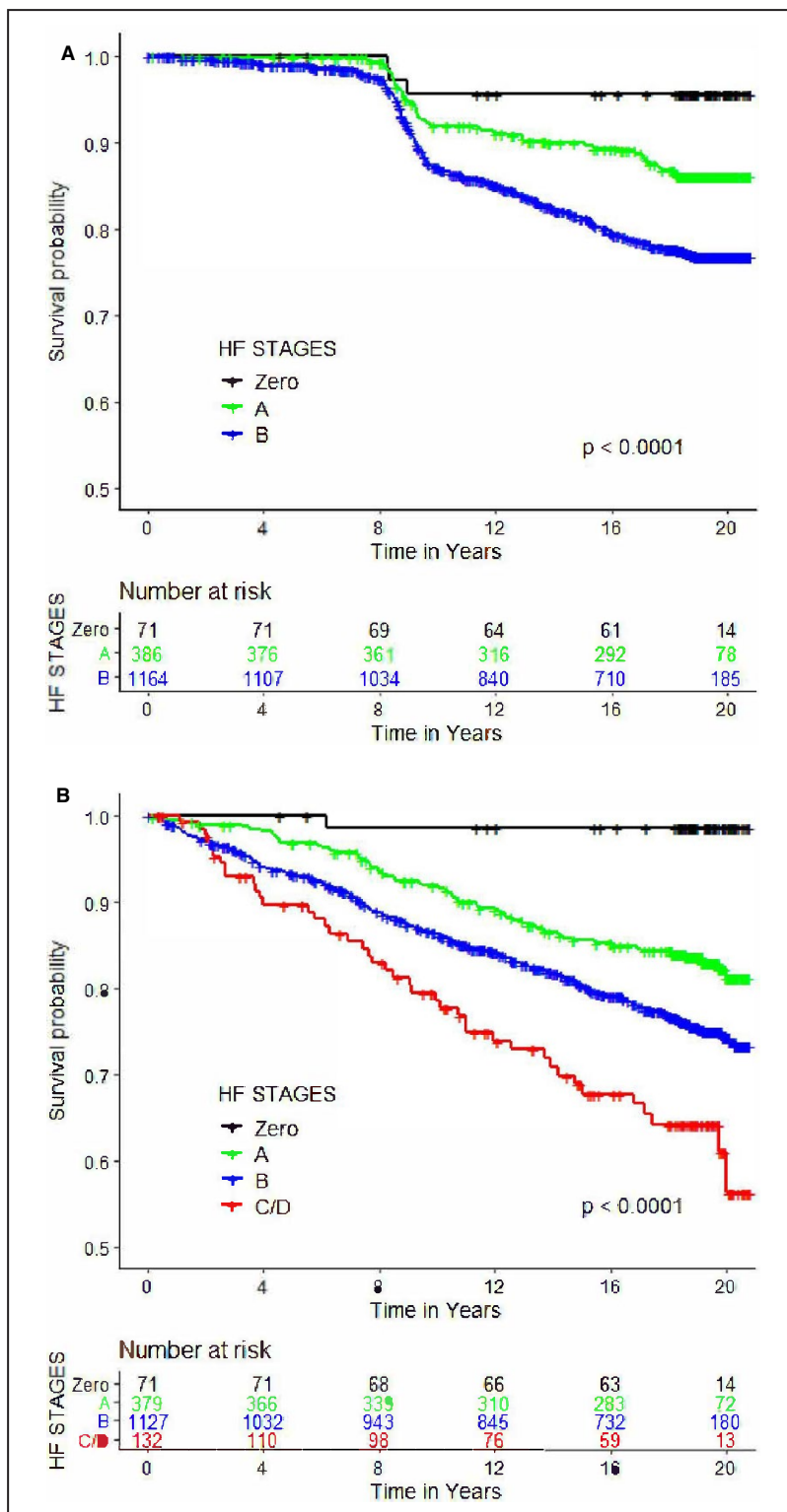


Figure 2. Kaplan–Meier plots for outcomes grouped by heart failure stages. **A**, Incident clinical HF. **B**, CVD events. **C**, CVD death. **D**, All-cause death. The numbers of subjects at risk by HF stages are noted at each time point. *P* values indicate the log-rank test. Individuals with prevalent MI in Stage B were excluded for these analyses. Additionally, participants with prevalent CVD were excluded for analyses of incident CVD. Prevalent HF events at visit 5 (but after visit 3) that did not have an exact time of onset were deemed to have occurred at the midpoint between the 2 examinations for participants, which accounts for the steep change in slope between 8 and 12 y of follow-up. CVD indicates cardiovascular disease; HF, heart failure; and MI, myocardial infarction.

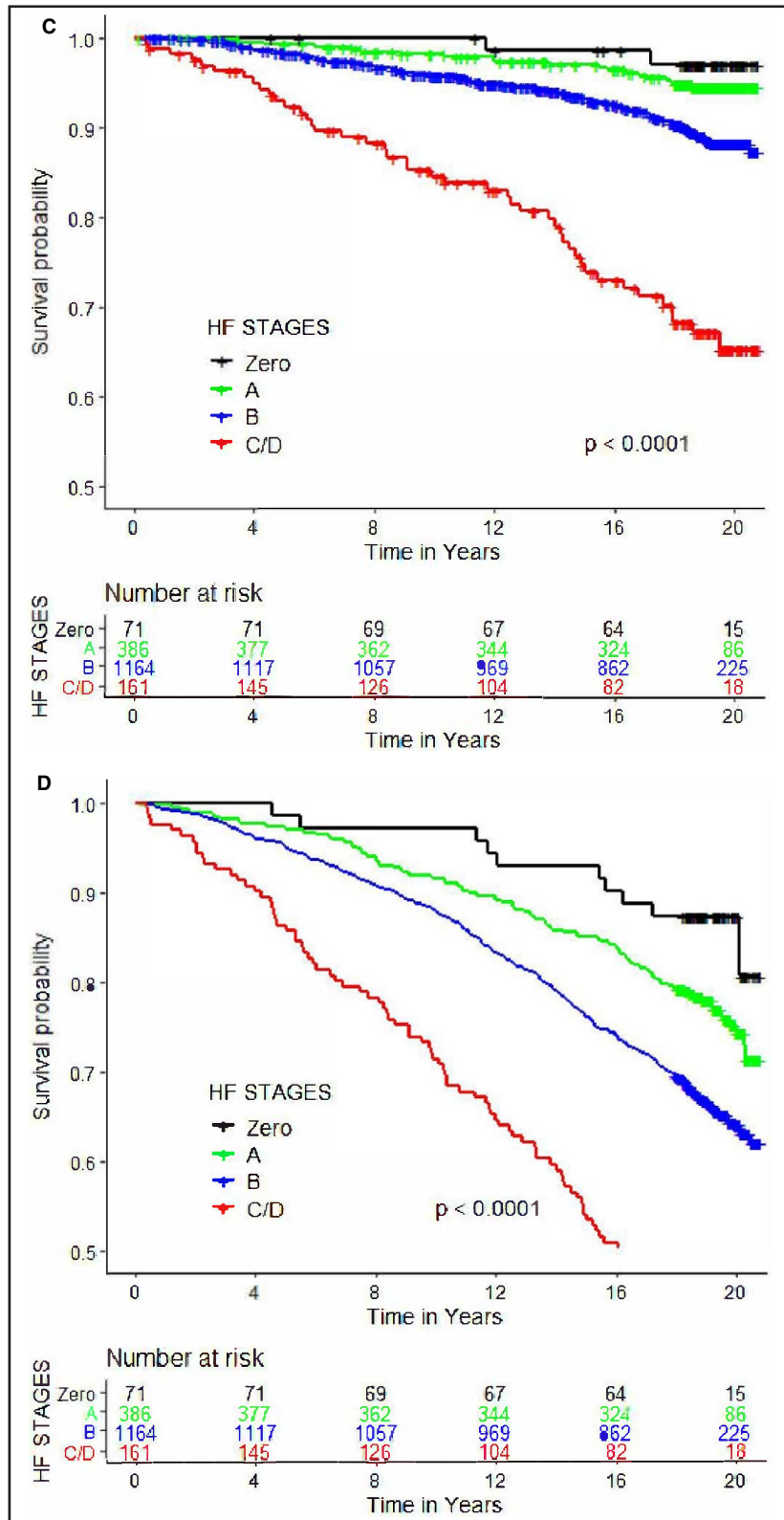


Figure 2. Continued

for atherosclerotic CVD and death were higher than the rates of overt HF among people with Stage B HF. Compared with the referent group (Stage A), those with Stage B HF experienced a 1.5 to 2-fold increased

risk of developing clinical HF, an atherosclerotic CVD event, or death from any cause. Stage C/D HF was associated with a very high incidence rate of CVD and mortality. In analyses stratifying by median age at visit

Table 5. Association of Events After Visit 3 With HF Stages at That Visit Stratified by Median Age (58 y)

HF Stage [†]	Hazard Ratios for Events (95% CI)							
	Clinical HF Events*		CVD Events*		CVD Death*		All-Cause Death*	
	Age ≤ Median (130/708)	Age >Median (152/913)	Age ≤ Median (201/760)	Age >Median (160/949)	Age ≤ Median (122/807)	Age >Median (58/975)	Age ≤ Median (376/807)	Age >Median (222/975)
A	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
B	1.9 (1.2–3.1)	1.6 (1.1–2.5)	1.4 (0.9–2.1)	1.5 (1.0–2.3)	2.2 (1.2–4.1)	1.8 (0.9–3.9)	1.6 (1.2–2.2)	1.3 (0.9–1.9)
C/D	...	...	3.0 (1.9–5.0)	1.7 (0.8–3.6)	7.4 (3.7–14.7)	7.0 (2.8–17.5)	3.5 (2.4–5.0)	2.9 (1.8–4.7)
P for interaction [‡]	0.63		0.21		0.21		0.59	

CVD indicates cardiovascular disease; HF, heart failure; and MI, myocardial infarction.

*We provide the number of events for each outcome within each age category and the total number of participants.

[†]HF stage A formed the referent group in all tests. We excluded prevalent MI in heart stage B (N=89).

[‡]P value for interaction of HF stage with median age.

3 (58 years), no effect modification by age was observed for various risks associated with the HF stages (Table 5).

In secondary analyses (Table 6), we evaluated the incremental contributions of left ventricular hypertrophy and LV dysfunction beyond CVD risk factors to the risk of developing incident clinical HF and CVD (separate analyses for both outcomes and for both echocardiographic variables). For both incident clinical HF and incident CVD, a model with echocardiographic LV dysfunction in addition to hypertension was a better fit than one with hypertension only, although the model C-statistic was essentially unchanged across models 1 to 3 for both events.

DISCUSSION

The present investigations describe the prevalence of various ACC/AHA HF stages in midlife in community-dwelling Black participants in the ARIC study. Our principal findings are 3-fold. First, very few individuals had a healthy profile in our sample at the initial visit. In contrast, a very high proportion of Black people have Stage B HF characterized by structural heart disease in midlife, including in individuals below the median age of 58 years. The high prevalence of Stage B was consistent across the 2 sexes. In parallel, we observed a relatively high prevalence of overt HF (Stage C/D) in this age group in both sexes, with prevalence in women being twice as high as that in men (10.5% versus 5.1%, respectively). HF with preserved ejection fraction was predominant in those with Stage C/D HF.

Second, longitudinal follow-up of participants after the initial visit (visit 3) demonstrated that individuals with Stage B HF are at very high risk for developing atherosclerotic CVD, CVD death, and death from all causes. Although the relative risk of developing overt HF was 1.75-fold higher in those with Stage B HF (compared with the referent group with Stage A), participants in this group were more likely to develop atherosclerotic CVD or die than to incur clinical HF (in terms of absolute rates of these CVD events).

Third, the presence of echocardiographic left ventricular hypertrophy and LV dysfunction was associated with the risk of developing clinical HF and CVD.

Comparison With the Published Literature

Several reports have been published on the prevalence of ACC/AHA HF stages in White people in the community in the United States.^{43,44} In these reports between 50% and 80% of older White adults (age 70 years) had Stage B HF per the AHA/ACC classification system, whereas only 15% to 20% had Stage A HF.^{43,44} It is striking that we observed a similar very high prevalence

Table 6. Association of CVD Risk Factors and Echocardiographic Abnormality With Incidence of Clinical HF and CVD Events

Predictors	Hazard Ratio (95% CI) for Incident Clinical HF			Hazard Ratio (95% CI) for Incident CVD		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Age, per unit	1.02 (0.99–1.04)	1.02 (0.99–1.04)	1.02 (0.99–1.04)	1.06 (1.04–1.08)	1.05 (1.03–1.07)	1.05 (1.03–1.07)
Male sex	1.37 (1.08–1.82)	1.31 (1.01–1.71)	1.32 (1.02–1.72)	1.61 (1.28–2.01)	1.55 (1.24–1.94)	1.55 (1.24–1.95)
Body mass index, per unit	1.03 (1.01–1.05)	1.02 (1.00–1.05)	1.03 (1.01–1.05)	1.01 (0.99–1.03)	1.01 (0.99–1.03)	1.01 (0.99–1.03)
Diabetes mellitus	1.69 (1.29–2.22)	1.65 (1.26–2.15)	1.67 (1.27–2.18)	2.07 (1.65–2.60)	2.02 (1.61–2.54)	2.03 (1.61–2.55)
Current smoking	1.58 (1.17–2.12)	1.45 (1.07–1.96)	1.48 (1.09–1.99)	2.14 (1.67–2.75)	1.98 (1.54–2.56)	1.99 (1.54–2.57)
Total: HDL ratio, per unit	1.07 (0.99–1.17)	1.08 (0.99–1.18)	1.08 (0.99–1.18)	1.14 (1.06–1.21)	1.13 (1.06–1.21)	1.13 (1.06–1.21)
Hypertension	1.73 (1.34–2.23)	1.64 (1.27–2.13)	1.67 (1.29–2.17)	1.95 (1.55–2.46)	1.90 (1.51–2.40)	1.91 (1.51–2.40)
Echocardiographic abnormality						
LVH or LV dysfunction*		1.59 (1.10–2.30)			1.58 (1.15–2.16)	
LVH*	...	1.40 (1.01–1.94)		...	1.05 (0.81–1.36)	...
LV dysfunction*	...	...	1.70 (1.18–2.45)	...	...	1.60 (1.18–2.17)
Metric						
Model Fitness (p for 1 vs 2 & 1 vs 3)	...	<0.003	<0.007	...	0.001	<0.001
b _{htn} [†]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
b _{LVH/LVDYS} [†]		0.002			0.015	
b _{LVH} [†]	...	0.042		...	0.97	
b _{LVDYS} [†]	...		0.004	...		<0.001
C-Statistic±SE	0.76±0.027	0.75±0.027	0.75±0.027	0.65±0.021	0.65±0.021	0.65±0.021

We performed 3 tests (1) to compare a model fitness between models 1 vs 2 and 1 vs 3 using likelihood ratio test, (2) tested whether regression coefficient for hypertension, LVH, and LV dysfunction are different from zero, and (3) evaluated the C-statistic (± SE) for all models. CVD indicates cardiovascular disease; HDL, high-density lipoprotein; HF, heart failure; LV, left ventricular; and LVH, left ventricular hypertrophy.

*LVH: LV mass/height^{2.7} ≥51 g/m^{2.7}; LVDYS: LV systolic dysfunction, ejection fraction <0.50, or fractional shortening <0.29.

[†]P values for testing the regression coefficients (bi=0).

of Stages B HF in Black people in midlife (67% at visit 3, median age 58 years) in the present investigation. It is noteworthy that a separate evaluation of the ARIC cohort at an older age (mean age 75 years)³¹ demonstrated a much lower prevalence of Stage B HF of ≈25%, suggesting perhaps that the numbers of individuals with Stage B HF may decrease with aging, presumably because of cardiovascular morbidity and mortality.

Overall, our data are consistent with a greater burden of subclinical disease at a younger age in Black people in the CARDIA (Coronary Artery Disease Risk in young Adults) study.^{15,16} As noted previously, our observations in ARIC may stem from the greater burden of risk factors for HF in Black people^{13,20,21} as well as to their greater propensity to develop adverse LV remodeling upon exposure to these risk factors.²² The higher prevalence of Stage C/D HF in Black people in midlife is consistent with prior reports^{11,12} underscoring the development of overt HF at a relatively young age in Black people.

Prevalence of HF stage C/D at visit 3 was higher in women (10.5%) than in men (5.1%) in our investigation. This striking sex-related difference in prevalent HF in young Black people has not been highlighted

previously. It is noteworthy that in a previous report that underscored the occurrence of HF at a young age in Black people, a larger proportion of Black women (62%) were represented than Black men (38%), with the point estimate of cumulative incidence of HF being slightly higher in women compared with men (1.1% versus 0.9%, respectively).¹¹

We observed higher rates of atherosclerotic CVD and death (relative to incident HF) during long-term follow-up in people with Stage B HF at visit 3. The high mortality experienced by Black people with Stage B HF in midlife may explain why the prevalence of this stage is much lower in elderly Black people, as noted above.³¹ Other investigators¹⁴ also have reported that Black people with multiple HF risk factors may be more prone to experience CVD and death, rather than HF.

Strengths and Limitations

Our study is strengthened by the assessment of HF stages at a key time point in life in Black people in the community (ie, middle age). The comprehensive assessment of the prognosis of different HF stages in midlife is an additional strength. Nonetheless, several

limitations warrant acknowledgment. It is important to note that our data represent a period from 2 decades ago. It is likely that temporal trends in the prevalence of risk factors such as obesity and diabetes mellitus may influence the current prevalence of HF stages in middle-aged Black people. Additionally, a direct comparison with prevalence of HF stages in middle-aged Black people versus White people in the ARIC study was not feasible because echocardiography was performed only in Black participants at the Jackson site at visit 3 of the cohort. Unlike a recent report³¹ that used more comprehensive echocardiographic data (including data on LV diastolic dysfunction and measures of LV strain) to better evaluate the true burden of Stage B HF in Black people, we used simpler echocardiographic criteria for Stage B HF in the present investigation. This may have resulted in an inflation of prevalence of Stage A HF, and an underestimation of the relative prevalence of Stage B HF. The lack of availability of more sophisticated echocardiographic assessment at visit 3 could have biased our estimates of prevalence of HF stages; in a recent report, 14% of the participants were reclassified from Stage A to Stage B HF with the use of more novel measures of LV impairment.³¹ Also, our participants were recruited from a single community site, which may limit the generalizability of our findings.

Clinical Implications

Our observations on a large community-based sample of Black people underscore the low prevalence of a healthy risk factor profile over their life course. We also observed a strikingly high prevalence of structural heart disease (Stage B HF) in midlife; similar high proportions of prevalence of Stage B HF are seen in much older White people in other reports. The high prevalence of Stage C/D HF in middle-aged Black individuals, especially so in Black women, warrants further investigation. Overall, these findings are consistent with the “telescoping in time” of adverse LV remodeling in Black people in the general population, relative to White people. The high burden of both HF risk factors and structural heart disease in midlife is marked by substantial CVD and mortality risk on follow-up. Overall, our observations underscore the critical need to screen for and detect both HF risk factors and structural heart disease earlier in their life course in Black people, and to treat modifiable risk factors optimally to reduce their burden of CVD in midlife and overt HF in later life.

CONCLUSIONS

In our large community-based sample of middle-aged Black people assessed for prevalence of

ACC/AHA HF stages, we observed a very high burden of structural heart disease (Stage B) in midlife. Additionally, the higher prevalence of Stage B HF in midlife was a marker of CVD and all-cause mortality risk (rather than purely a marker of HF risk). Additional investigations of younger Black people are necessary to elucidate the basis of their substantial burden of structural heart disease, and of prevalent Stage C/D HF in Black women. Such studies may identify modifiable risk factors that can be targeted to mitigate the elevated mortality risk in middle-aged Black people, and alleviate their overall burden of subclinical and overt disease in midlife.

ARTICLE INFORMATION

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Affiliations

From the Section of Preventive Medicine, Department of Medicine (R.S.V.) and Section of Cardiology, Department of Medicine (R.S.V.), Boston University School of Medicine, Boston, MA; Department of Epidemiology, Boston University School of Public Health, Boston, MA (R.S.V.); Department of Medicine, University of Mississippi Medical Center, Jackson, MS (S.K.M., W.B., O.B.O., K.R.B., T.H.M., E.F.); Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD (K.M.); and Division of Cardiology, Department of Medicine, University of North Carolina at Chapel Hill, NC (P.P.C.).

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Disclosures

None.

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