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American Heart Association's Life's Simple 7: Avoiding Heart Failure and Preserving Cardiac Structure and Function

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Abstract

BACKGROUND—Many people may underappreciate the role of lifestyle in avoiding heart failure. We estimated whether greater adherence in middle age to American Heart Association's Life's Simple 7 guidelines -- on smoking, body mass, physical activity, diet, cholesterol, blood pressure, and glucose -- is associated with lower lifetime risk of heart failure and greater preservation of cardiac structure and function in old age.

METHODS—We studied the population-based Atherosclerosis Risk in Communities Study cohort of 13,462 adults aged 45-64 years in 1987-89. From the 1987-89 risk factor measurements, we created a Life's Simple 7 score (range 0-14, giving 2 points for ideal, 1 point for intermediate, and 0 points for poor components). We identified 2,218 incident heart failure events using surveillance of hospital discharge and death codes through 2011.

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In addition, in 4,855 participants free of clinical cardiovascular disease in 2011-13, we performed echocardiography from which we quantified left ventricular hypertrophy and diastolic dysfunction.

RESULTS—One in four participants (25.5%) developed heart failure through age 85. Yet, this lifetime heart failure risk was 14.4% for those with a middle-age Life's Simple 7 score of 10-14 (optimal), 26.8% for a score of 5-9 (average), and 48.6% for a score of 0-4 (inadequate). Among those with no clinical cardiovascular event, the prevalence of left ventricular hypertrophy in late life was approximately 40% as common, and diastolic dysfunction was approximately 60% as common, among those with an optimal middle-age Life's Simple 7 score compared with an inadequate score.

CONCLUSIONS—Greater achievement of American Heart Association's Life's Simple 7 in middle-age is associated with a lower lifetime occurrence of heart failure and greater preservation of cardiac structure and function.

Keywords

Heart failure; Risk factors; Prospective study

Americans' lifetime risk of heart failure is substantial. Epidemiologists have estimated that lifetime risk of heart failure was one in five in the Framingham Heart Study,[1] one in three in the Rotterdam Study,[2] and 20-45% among various sex-ethnic groups in the Cardiovascular Lifetime Risk Pooling Project.[3] Because heart failure risk is so high, primary prevention must be a public health priority.

For primary prevention of overall cardiovascular disease, the American Heart Association (AHA) recommends that Americans follow "Life's Simple 7." Life's Simple 7 describe ideal, intermediate and poor levels of cardiovascular disease risk factors or behaviors, namely, smoking, body mass index, physical activity, diet, total cholesterol, blood pressure, and fasting serum glucose.[4] The Atherosclerosis Risk in Communities (ARIC) Study documented that the number of ideal Simple 7 factors achieved is associated strongly and inversely with later incidence of total cardiovascular disease,[5] heart failure,[6,7] and cancer.[8] Yet, no publication, to our knowledge, has specifically addressed the degree to which following Life's Simple 7 might lower lifetime heart failure risk or preserve cardiac structure and function to old age.

We therefore analyzed ARIC data, with longer follow-up than previously available, to examine whether greater adherence to Life's Simple 7 in middle age is associated with (a) reduced incidence rates and lifetime risk of heart failure and (b) greater preservation of cardiac structure and function among elderly participants without a history of heart failure or myocardial infarction.

METHODS

Study Population

The ARIC Study[9] enrolled 15,792 men and women aged 45 to 64 years in 1987-1989, in four U.S. communities: Forsyth Co., NC, Jackson, MS (African Americans only), suburban

Minneapolis, MN, and Washington Co., MD. The investigators followed the cohort for incident cardiovascular disease events and conducted four subsequent examinations, including an echocardiogram at Visit 5 in 2011-2013, approximately 25 years after baseline. The institutional review committees at each study center approved the methods, and staff obtained informed participant consent.

Measurement of Life's Simple 7

We used the ARIC baseline visit, when participants were middle-aged, as the point for assessment and classification of Life's Simple 7 characteristics. Measurements included a food frequency questionnaire, physical activity, body mass index, smoking, total cholesterol, seated blood pressure after a 5 minute rest, and fasting glucose.[9] We classified each factor according to AHA's Simple 7 categories of ideal, intermediate, or poor.[4,5] (Supplemental Table) For example, the respective ideal, intermediate, and poor body mass categories are <25, 25-29.99, and ≥30 kg/m^3.

Heart Failure and Myocardial Infarction Occurrence

We defined preexisting heart failure at baseline as the following: (a) an affirmative response to "Were any of the medications you took during the last 2 weeks for heart failure?" or (b) Stage 3 or "manifest heart failure," based on symptoms and signs, using Gothenburg criteria.[10,11] We defined preexisting coronary heart disease at baseline by self-reported prior physician diagnosis of myocardial infarction or coronary revascularization, or by prevalent myocardial infarction by 12-lead ECG.

To identify incident events through December 31, 2011, ARIC staff contacted participants annually, identified hospitalizations and deaths during the prior year, and surveyed discharge lists from local hospitals and death certificates from state vital statistics offices.[12] We defined incident heart failure as the first occurrence of either a hospitalization that included an International Classification of Diseases, 9th Revision (ICD-9) discharge code of 428 (428.0 to 428.9) among the primary or secondary diagnoses or else a death certificate with an ICD-9 code of 428 or an ICD-10 code of I50 among the listed or underlying causes of death.[11] Incident myocardial infarction was defined by combinations of chest pain symptoms, ECG changes, and cardiac biomarkers.[12]

Visit 5 Echocardiographic Data

Using the same model of equipment, trained echo technicians in the four ARIC sites obtained images in the parasternal long- and short-axis and apical 4-chamber views.[13] We measured, in triplicate from the 2D views, left ventricular dimensions, volumes, and wall thickness, and took Doppler measures of mitral inflow and mitral annular relaxation velocities following the recommendations of the American Society of Echocardiography (ASE).[14]

For this report, we focused on three echocardiographic measures obtained in 2011-2013 — left ventricular hypertrophy, left ventricular systolic dysfunction, and left ventricular diastolic dysfunction — among participants at Visit 5 with no history of heart failure or myocardial infarction through 2011. ARIC determined left ventricular mass according to

ASE recommendations and indexed to height to the power of 2.7. We then defined left ventricular hypertrophy as left ventricular mass indexed to body surface area >95 g/m^2 in women and >115 g/m^2 in men. We defined systolic dysfunction as an left ventricular ejection fraction <50%. We defined diastolic dysfunction as a ratio of E wave velocity to early mitral annular relaxation velocity assessed at the septal mitral annulus (E/E′ratio) >15, which previous research showed accurately identifies left ventricular diastolic pressure.[15]

Statistical Analysis

We categorized baseline (middle-age) achievement of Life's Simple 7 in two ways for analysis. Firstly, we simply counted the number of ideal Life's Simple 7 components (Supplemental Table) that each participant met. Secondly, we a priori created a score, used in previous studies,[16] in which each component was given points of 0, 1, or 2 to represent poor, intermediate, or ideal health categories, respectively, and these were summed to yield a Life's Simple 7 score. This score was grouped as 0-4 (inadequate), 5-9 (average), and 10-14 (optimal) for cardiovascular health.

Analysis of Heart Failure Occurrence

Of the 15,792 participants at ARIC baseline, we excluded those who were: not white or African American (n=48), had prevalent heart failure (n=751) or uncertain heart failure status (n=284), were not fasting for 8 hours (n=461), had missing dietary data or had implausible energy intake (n=298), had incomplete information on other Life's Simple 7 components (n=371), or had uncertain myocardial infarction status (n=117). This left 13,462 participants (n=10,194 whites and 3,268 African Americans) for the present analyses relating Life's Simple 7 to incident heart failure.

Except where indicated, we used SAS, Version 9.3 (SAS Institute, Inc., Cary, NC) for analyses. We calculated incidence rates of heart failure and 95% confidence intervals using Poisson regression. We calculated hazard ratios and 95% confidence intervals of incident heart failure using a Cox proportional hazards model that accounted for the competing risk of death,[17] via the stcrreg function in Stata, release 12 (StataCorp, College Station, TX). We estimated lifetime risk of heart failure using a published method,[18] which employs a Kaplan Meier analysis that incorporates competing risks, with deaths from other causes as competing events. One of the assumptions of this competing risk model is that each failure mechanism leading to a particular type of failure (i.e., failure mode) proceeds independently of every other one, at least until a failure occurs. We estimated lifetime risk for heart failure from age 45 to age 85 years, with death free of heart failure as the competing event. Because the ARIC age range at baseline was broad, we also computed age-stratified estimates which verified no birth cohort effects.

Analysis of Cardiac Structure and Function

Of the 6,538 participants at Visit 5 (response rate=65% of ARIC participants still alive), we restricted the sample to 5,758 who had complete data for echocardiography and middle-aged data for Life's Simple 7. We then excluded participants with heart failure present or missing at baseline (n=196), coronary heart disease present or missing at baseline (n=144), incident

heart failure (n=297) or myocardial infarction (n=254) through 2011, or race other than black or white (n=12), yielding a final sample size of 4,855.

We calculated the prevalences of left ventricular hypertrophy, diastolic dysfunction, and systolic dysfunction in relation to Life's Simple 7 categories, and corresponding odds ratios using logistic regression. To adjust for possible bias due to selective attrition before Visit 5 due to death or dropouts, we calculated inverse probability weights as described in Supplemental Methods. We applied the calculated weights to multivariable logistic models for each measure of cardiac structure and function with the Life's Simple 7 score as the main independent variable, using robust variance estimators for calculation of 95% confidence intervals.

RESULTS

Heart Failure Incidence in Relation to Life's Simple 7

Among 13,462 ARIC participants initially free of heart failure at ages 45-64, the mean (standard deviation) age was 54.1 (5.8) years, 24.3% were African American, and 54.6% were women. We followed them for a median of 22.5 years and identified 2,218 incident heart failure events. As shown in Table 1, participants having ≥4 ideal components of Life's Simple 7 in middle-age had less than one third the heart failure incidence rate of those with no ideal health components. Moreover, each of the 7 ideal components of Life's Simple 7 was independently associated with reduced heart failure incidence (data not shown).

The lifetime risk of heart failure, through age 85, was 25.5% (95% CI: 24.1%, 26.6%) overall, but it ranged from 12.3% in those with 5-7 ideal components in middle-age to approximately 45% for those with 0 ideal components (Table 1). When we excluded participants who had coronary heart disease at baseline or an incident myocardial infarction during follow-up, lifetime risk was reduced to 21.3% (95% CI: 19.9%, 22.5%) overall, but still was strongly related to Life's Simple 7 (Table 1).

Lifetime heart failure risk was 23.9% (95% CI: 22.4%, 25.2%) in whites and 30.6% (95% CI: 27.4, 33.0%) in African Americans. Compared to whites, African Americans were proportionately less likely to have ideal cardiovascular health metrics. For example, 887 of 3,268 African Americans (27.1%) had <2 ideal, among the seven cardiovascular disease health metrics, whereas 1,459 of 10,194 whites (14.3%) had <2 ideal metrics (Table 1). Yet, within each ideal health frequency group, the incidence rates and lifetime risks of heart failure were only slightly higher for African Americans than whites. Thus, the ethnic differences in heart failure rates in ARIC appear largely due to higher risk factor levels in African Americans than whites.

As shown in Table 2, on the Life's Simple 7 score (range 0-14, giving 2 points for ideal, 1 point for intermediate, and 0 points for poor components), 7% of the ARIC sample were "inadequate," 65% "average," and 28% "optimal." The Life's Simple 7 score was strongly and inversely associated with incidence and lifetime risk of heart failure. For example, the lifetime risk was 14.4% for those with an optimal score of 10-14, 26.8% for those with an average score of 5-9, and 48.6% for those with an inadequate score of 0-4. This association

was similar (p for interactions in hazard ratios >0.25) for men and women and for African Americans and whites (Table 2). Figure 1 further depicts the lifetime risk of heart failure for African Americans and whites in relation to the Life's Simple 7 score.

Cardiac Structure and Function, in Participants Free of Heart Failure and Myocardial Infarction, in Relation to Life's Simple 7

Among the 4,855 ARIC participants free of coronary heart disease at baseline, who did not have a clinical heart failure or myocardial infarction event by 2011, the mean (standard deviation) Visit 5 age in 2011-2013 was 75.3 (5.1) years, 20.1% were African American, and 59.5% were women. On the Visit 5 echocardiogram, 9.4% had left ventricular hypertrophy, 19.6% had diastolic dysfunction defined by an E/E′ratio >15, and 1.6% had systolic dysfunction. As shown in Table 3, the prevalence of left ventricular hypertrophy in those with an optimal Life's Simple 7 score, in middle age, was 40% that of those with an inadequate score (left ventricular hypertrophy 6.7% vs. 16.5%, respectively, adjusted odds ratio = 0.37). Diastolic dysfunction at Visit 5 was approximately 60% as common with an optimal score (16.2%) versus an inadequate score (27.1%) on Life's Simple 7 score in middle age (adjusted odds ratio = 0.43). Systolic dysfunction was half as common (1.2% for optimal versus 2.4% for inadequate), but the adjusted odds ratio was nonsignificant.

DISCUSSION

In this prospective middle-aged cohort followed 25 years, one in four participants sustained a hospitalized or fatal heart failure event by age 85 years. However, those, who in middle age met more of AHA Life's Simple 7 metrics, had substantially lower lifetime risk of heart failure – approximately 30% of the lifetime risk for those with our "optimal" Life's Simple 7 score and 55% of the lifetime risk for an "average" score, compared with an "inadequate" score. Furthermore, among those who had not yet sustained a heart failure event or myocardial infarction during follow-up through 2011, echocardiographic left ventricular hypertrophy in 2011-2013 was 40% as common, diastolic dysfunction was 60% as common, and systolic dysfunction nonsignificantly less common for participants with an optimal versus an inadequate Life's Simple 7 score in middle age. This suggests that achieving Life's Simple 7 metrics in mid-life can help preserve cardiac function in late-life.

AHA initiated the Life's Simple 7 campaign to prevent cardiovascular disease by encouraging adults to avoid seven established cardiovascular disease risk factors.[4] Greater achievement of Life's Simple 7 is associated not only with lower incidence of heart failure, but also with lower rates of coronary heart disease,[5] stroke,[16] cognitive impairment,[19] diabetes,[20] chronic kidney disease,[21] and cancer.[8] Although few Americans are able to achieve all ideal cardiovascular health metrics, due to genetics or lifestyle, acheving some ideal or intermediate metrics is associated with better health than is achieving none.

We focused on lifetime risk of heart failure because many health care providers may be unaware how high heart failure risk is, and because, compared with traditional incidence rates, lifetime risk estimates are less biased by competing mortality.[17] Our estimate of lifetime heart failure risk by age 85 being one in four is similar to previous studies,[1-3] although estimates vary according to the maximum age cutoff used. We chose 85 years

because, so far, few ARIC participants have lived beyond age 90. Regardless of the age cutoff, it is apparent that many Americans will develop heart failure, and African Americans more than whites.[3] Yet, ARIC has demonstrated previously,[6] and reconfirmed here, that the ethnic disparity in heart failure in this cohort is largely due to African Americans having more cardiovascular disease risk factors than whites, as opposed to a greater heart failure risk within comparable risk factor categories. Our study's good news is that greater achievement of Life's Simple 7 in middle-age is associated with reduced heart failure risk in both African Americans and whites.

We chose left ventricular hypertrophy, diastolic dysfunction, and systolic dysfunction as the echocardiographic parameters, because these are related to greater risk of heart failure and mortality and because they limit patients physically. We could have used other ways to define diastolic dysfunction, but an E/E′ratio >15 is a reasonable approach.[22] Mild diastolic dysfunction is common in elderly adults, and it is uncertain how many of the ARIC participants with these subclinical abnormalities will suffer untoward consequences. Yet, clearly those who achieved more Life Simple 7 metrics in middle-age had better cardiac structure and function in late life.

While we provide novel information from a large, carefully assessed cohort, some limitations of our study warrant discussion. Firstly, we studied hospitalized or fatal heart failure based on ICD codes, as ARIC did not originally plan or have the resources to validate all heart failure events or outpatient heart failure. The validity of ICD codes is very good[23,24] and most heart failure patients diagnosed in the outpatient setting will eventually be hospitalized.[23] Our lifetime heart failure risk estimate obviously may have been greater than one in four had we found all outpatient events and followed participants through age 100. Yet, our focus on moderate to severe heart failure should not change the conclusion that greater achievement of Life's Simple 7 in middle-age is associated with less heart failure risk. Furthermore, similar associations of Life's Simple 7 with cardiac structure and function in those free of heart failure or myocardial infarction suggest that our findings are broadly generalizable.

Secondly the African Americans in ARIC lived in two centers (Jackson, MS and Forsyth County, NC), whereas the whites lived in Forsyth County, suburban Minneapolis, and Washington County, MD. Although this complicates direct comparisons of lifetime heart failure risk in African Americans versus whites, the ARIC African American participants clearly had poorer Life's Simple 7 risk factors, which contributed greatly to their higher lifetime heart failure risk. Thus, African Americans appear to have a great potential for heart failure prevention by optimizing Life's Simple 7.

Thirdly, we focused on a single measure of Life's Simple 7 in middle-age, because we were interested in the potential of heart failure prevention starting in mid-life. During more than 2 decades of follow-up, many participants' Life's Simple 7 categorization certainly would have changed, and this likely would have weakened the observed association with echocardiographic measures at Visit 5. In a future report, ARIC will examine the more complicated question of whether changes in Life's Simple 7 levels are associated inversely with late-life cardiac structure and function.

CONCLUSION

Greater achievement of AHA's Life's Simple 7 in middle-age is associated with a lower lifetime occurrence of heart failure and with greater preservation of cardiac structure and function in late life. Since ARIC is not a clinical trial, we cannot prove cause and effect, but all of the Life's Simple 7 risk factors and health behaviors are believed to be causative, and clinical trial evidence supports the value of reducing most of them. To lessen the public health burden of heart failure,[7] cardiovascular disease, and potentially other chronic diseases, health professionals need to encourage the public to optimize lifestyle-related risk factors before middle age.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Clinical Significance

- One in four middle-aged adults will develop heart failure if they survive to age 85.
- Enabling patients to reach middle age with few cardiovascular risk factors will greatly preserve their cardiac function and reduce their lifetime risk of heart failure.

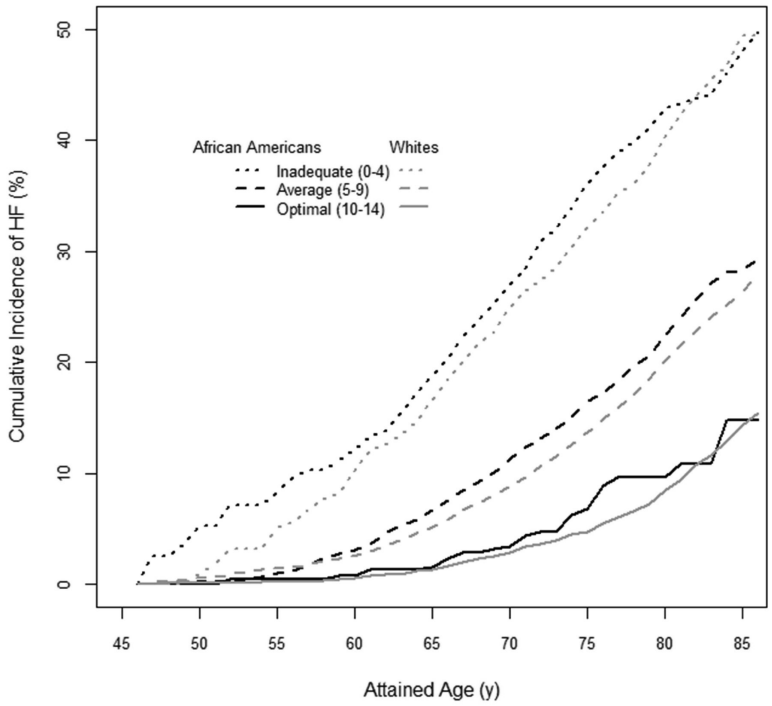

Figure 1.

Race-Specific Lifetime Risk of Heart Failure (HF) in Relation to Three Categories of an AHA Life's Simple 7 Score, ARIC, 1987-2011

Table 1

Heart Failure (HF) Incidence and Lifetime Risk in Relation to Number of Ideal AHA Life's Simple 7 Components, ARIC, 1987 to 2011

# of ideal Simple 7 components	Participants at risk (N)	(%)	HF events (N)	Person-years	HF Incidence Rate (95% CI)*	Hazard Ratio (95% CI)†	Lifetime HF Risk (%) (95% CI)‡	Lifetime HF Risk (%), in absence of MI (95% CI)‖
					All			
0	350	2.6	122	5,521	22.1 (18.5, 26.4)	1 (Ref)	45.1 (35.0, 52.0)	40.7 (28.7, 48.8)
1	1,996	14.8	558	35,499	15.7 (14.5, 17.1)	0.75 (0.43, 0.64)	39.0 (34.9, 42.1)	33.7 (29.2, 37.1)
2	3,432	25.5	688	64,742	10.6 (9.9, 11.5)	0.52 (0.43, 0.64)	28.0 (25.5, 30.0)	24.1 (21.4, 26.3)
3	3,587	26.6	523	71,444	7.3 (6.7, 8.0)	0.39 (0.31, 0.48)	23.1 (20.4, 25.1)	19.4 (16.7, 21.5)
4	2,467	18.3	236	51,219	4.6 (4.1, 5.2)	0.27 (0.22, 0.34)	16.6 (13.4, 19.1)	13.2 (10.0, 15.7)
5	1,234	9.2	71	26,666	2.7 (2.1, 3.4)	0.17 (0.13, 0.23)		
6	379	2.8	20	8,291	2.4 (1.6, 3.7)	0.17 (0.11, 0.28)	12.3 (8.8, 15.2)§	10.5 (7.1, 13.4)§
7	17	0.1	0	377	0	--		
					African Americans			
0	144	4.4	56	2,200	25.5 (19.6, 33.1)	1 (Ref)	45.4 (33.1, 55.4)	45.9 (30.4, 57.9)
1	743	22.7	216	13,151	16.4 (14.4, 18.8)	0.72 (0.53, 0.97)	40.9 (33.8, 46.3)	36.8 (29.1, 42.6)
2	1,057	32.3	219	19,751	11.1 (9.7, 12.7)	0.50 (0.37, 0.68)	28.5 (23.9, 32.0)	25.0 (20.3, 28.8)
3	815	24.9	125	15,917	7.9 (6.6, 9.4)	0.37 (0.27, 0.51)	26.5 (19.9, 31.4)	24.7 (17.9, 29.8)
4	383	11.7	47	7,573	6.2 (4.7, 8.3)	0.31 (0.21, 0.46)	20.1 (10.6, 27.0)	16.9 (7.2, 24.0)
5	103	3.2	4	2,184	1.8 (6.9, 4.9)	0.10 (0.04, 0.28)		
6	22	0.7	2	467	4.3 (1.1, 17.1)	0.23 (0.05, 0.96)	5.8 (1.1, 10.4)§	5.9 (1.1, 10.6)§
7	1	0.0	0	22	0	--		
					Whites			
0	206	2.0	66	3,321	19.9 (15.6, 25.3)	1 (Ref)	45.3 (30.5, 55.0)	37.6 (19.7, 48.6)
1	1,253	12.3	342	22,348	15.3 (13.8, 17.0)	0.76 (0.57, 1.00)	37.9 (33.0, 41.8)	31.8 (26.3, 36.0)
2	2,375	23.3	469	44,991	10.4 (9.5, 11.4)	0.53 (0.41, 0.70)	27.8 (24.8, 30.2)	23.6 (20.3, 26.1)
3	2,772	27.2	398	55,527	7.2 (6.5, 7.9)	0.39 (0.30, 0.52)	22.3 (19.3, 24.6)	18.2 (15.2, 20.5)
4	2,084	20.4	189	43,646	4.3 (3.8, 5.0)	0.27 (0.20, 0.36)	16.1 (12.7, 18.7)	12.6 (9.2, 15.2)
5	1,131	11.1	67	24,482	2.7 (2.2, 3.5)	0.19 (0.13, 0.26)		
6	357	3.5	18	7,824	2.3 (1.4, 3.7)	0.17 (0.10, 0.29)	12.5 (8.9, 15.6)§	10.7 (7.1, 13.8)§
7	16	0.2	0	355	0	--		

AHA = American Heart Association; ARIC = Atherosclerosis Risk in Communities; CHD = coronary heart disease; CI = confidence interval; HF = heart failure; MI = myocardial infarction; N = number.

*Per 1,000 person-years.

†Adjusted for age, sex, prevalent CHD, competing risk of death, and race (All).

‡Lifetime risk (%), adjusted for risk of non-HF death, calculated starting at index age 45 years over a follow-up of 40 years (maximum age 85 years).

§Those with 5-7 ideal health metrics were combined due to few HF events.

// Those with prevalent CHD or interim myocardial infarction events (N=1,761) are excluded.

Table 2

Heart Failure (HF) Incidence and Lifetime Risk in Relation to Three Categories of an AHA Life's Simple 7 Score, ARIC, 1987 to 2011

Category	Participants at risk (N)	HF events (N)	Person-years	HF Incidence Rate (95% CI)*	Hazard Ratio (95% CI)†	Lifetime HF Risk (%) (95% CI)‡
Overall						
Inadequate (0-4)	947	353	14,956	23.6 (21.3, 26.2)	1 (Ref)	48.6 (42.5, 53.3)
Average (5-9)	8,685	1,592	167,189	9.5 (9.1, 10.0)	0.45 (0.40, 0.51)	26.8 (25.1, 28.1)
Optimal (10-14)	3,830	273	81,613	3.3 (3.0, 3.8)	0.19 (0.16, 0.22)	14.4 (11.9, 16.4)
African Americans						
Inadequate (0-4)	471	171	7,488	23.9 (20.7, 27.8)	1 (Ref)	48.0 (39.4, 54.7)
Average (5-9)	2,409	462	45,636	10.1 (9.2, 11.1)	0.46 (0.39, 0.55)	28.3 (24.9, 30.9)
Optimal (10-14)	388	28	8,141	3.4 (2.4, 5.0)	0.19 (0.12, 0.28)	14.8 (6.1, 21.6)
Whites						
Inadequate (0-4)	476	174	7, 468	23.3 (20.1, 27.0)	1 (Ref)	49.4 (40.7, 55.5)
Average (5-9)	6,276	1,130	121,554	9.3 (8.8, 9.9)	0.43 (0.36, 0.51)	26.3 (24.4, 27.8)
Optimal (10-14)	3,442	245	73,473	3.3 (2.9, 3.8)	0.19 (0.15, 0.23)	14.3 (11.7, 16.4)
Women						
Inadequate (0-4)	558	205	9,300	22.0 (19.2, 25.3)	1 (Ref)	48.7 (41.3, 54.8)
Average (5-9)	4,436	721	88,647	8.1 (7.6, 8.7)	0.42 (0.36, 0.50)	24.4 (22.2, 26.2)
Optimal (10-14)	2,354	137	51,128	2.7 (2.3, 3.2)	0.17 (0.13, 0.21)	13.0 (9.9, 15.7)
Men						
Inadequate (0-4)	389	148	5,656	26.2 (22.3, 30.7)	1 (Ref)	49.1 (38.0, 56.1)
Average (5-9)	4,249	871	78,543	11.1 (10.4, 11.9)	0.49 (0.40, 0.59)	29.3 (26.6, 31.2)
Optimal (10-14)	1,476	136	30,485	4.5 (3.8, 5.3)	0.22 (0.17, 0.28)	16.2 (12.3, 19.3)

AHA = American Heart Association; ARIC = Atherosclerosis Risk in Communities; CHD = coronary heart disease; CI = confidence interval; HF = heart failure; N = number.

*Per 1,000 person-years.

†Adjusted for age, sex (except where stratified), race (except where stratified), prevalent CHD, and competing risk of death.

‡Lifetime risk (%), adjusted for risk of death, calculated starting at index age 45 years over a follow-up of 40 years (maximum age 85 years).

Table 3

Prevalences and Odds Ratios (OR) of Left Ventricular Hypertrophy, Diastolic Dysfunction, or Systolic Dysfunction, Among 4,855 ARIC Participants Free of Clinical Heart Failure and Myocardial Infarction in 2011-2013, in Relation to an AHA Life's Simple 7 Score in 1987-1989

Life's Simple 7 Score	Total N	Left Ventricular Hypertrophy*		Diastolic Dysfunction[15]†		Systolic Dysfunction‡	
		%	OR (95% CI)§	%	OR (95% CI)§	%	OR (95% CI)§
Inadequate (0-4)	134	16.5	1 (Ref.)	27.1	1 (Ref.)	2.4	
Average (5-9)	2666	11.1	0.63 (0.36, 1.10)	21.8	0.69 (0.43, 1.12)	1.9	1 (Ref.)//
Optimal (10-14)	2055	6.7	0.37 (0.20, 0.66)	16.2	0.43 (0.26, 0.69)	1.2	0.79 (0.43, 1.44)

AHA = American Heart Association; ARIC = Atherosclerosis Risk in Communities; CI = confidence interval; N = number; OR = odds ratio.

*Left ventricular hypertrophy defined as left ventricular mass indexed to body surface area >95 g/m^2 in women and >115 g/m^2 in men.

†Diastolic dysfunction as reflected by an E/E' ratio >15.

‡Systolic dysfunction defined as left ventricular ejection fraction <50%.

§Odds ratio is adjusted for visit 5 (2011-2013) non-response, as well as age, race, and sex.

//Inadequate and average were combined owing to few participants in the inadequate group.