ORIGINAL RESEARCH

Sex Differences in Cardiovascular Disease Risk of Ghanaian- and Nigerian-Born West African Immigrants in the United States: The Afro-Cardiac Study

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***Background*—**The number of African immigrants in the United States grew 40-fold between 1960 and 2007, from 35 355 to 1.4 million, with a large majority from West Africa. This study sought to examine the prevalence of cardiovascular disease (CVD) risk factors and global CVD risk and to identify independent predictors of increased CVD risk among West African immigrants in the United States.

***Methods and Results*—**This cross-sectional study assessed West African (Ghanaian and Nigerian) immigrants aged 35–74 years in the Baltimore–Washington metropolitan area. The mean age of participants was 49.5±9.2 years, and 58% were female. The majority (95%) had ≥1 of the 6 CVD risk factors. Smoking was least prevalent, and overweight or obesity was most prevalent, with 88% having a body mass index (in kg/m^2) ≥25; 16% had a prior diagnosis of diabetes or had fasting blood glucose levels ≥126 mg/dL. In addition, 44% were physically inactive. Among women, employment and health insurance were associated with odds of 0.09 (95% CI 0.033–0.29) and 0.25 (95% CI 0.09–0.67), respectively, of having a Pooled Cohort Equations estimate ≥7.5% in the multivariable logistic regression analysis. Among men, higher social support was associated with 0.90 (95% CI 0.83–0.98) lower odds of having ≥3 CVD risk factors but not with having a Pooled Cohort Equations estimate ≥7.5%.

***Conclusions*—**The prevalence of CVD risk factors among West African immigrants was particularly high. Being employed and having health insurance were associated with lower CVD risk in women, but only higher social support was associated with lower CVD risk in men. **(*J Am Heart Assoc*. 2016;5:e002385 doi: 10.1161/JAHA.115.002385)**

Key Words: African immigrants • cardiovascular disease • migrant health

Cardiovascular disease (CVD) remains the leading cause of death in the United States. Considering that 1 in 3 deaths is attributable to CVD and that the prevalence of CVD risk factors remains high, CVD represents a major public health challenge.[1] The Framingham Heart Study and other landmark studies[2–4] have demonstrated that CVD risk factors—smoking, obesity, hypertension, hyperlipidemia, physical inactivity, and diabetes mellitus—synergistically increase CVD risk and death. Likewise, in sub-Saharan Africa, CVD is becoming a leading cause of morbidity and mortality because of the increasing prevalence of CVD risk factors attributed to the "epidemiological transition," characterized by shifts in disease and mortality patterns from infectious diseases to noncommunicable diseases as major causes of morbidity and mortality.[5,6]

The influx of African immigrants from sub-Saharan Africa to the United States in the past 2 decades has been unprecedented. The size of this population grew 40-fold between 1960 and 2007, from 35 555 to 1.4 million persons, with 36% originating from West Africa.[7] Together, Ghanaian and Nigerian immigrants make up >30% of African immigrants in the United States. According to the US Census Bureau's 2005 American Community Survey, 114 000 African immigrants in the Washington metropolitan area accounted for about 11% of the area's total immigrant population.[8] Although this immigrant population continues to burgeon, little is known about the CVD risk profile. This research gap stems from the fact that African immigrants in the United States are often lumped into the racial category of *black* or *African American*, along with African American and Afro-Caribbean persons.[9]

The "healthy immigrant effect,"[10,11] which suggests that new immigrants are healthier than their host counterparts due

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to self-selection and immigration policies, is a well-accepted phenomenon; however, through acculturation, the health of immigrants declines or improves with increasing years of residence in high-income countries through the loss of culture-specific health-protective practices or adoption of health behaviors of the host society.[11–13] Changes in socioeconomic conditions, food supply, health systems and policies, and cultural traditions[14–17] experienced by immigrants have been posited as reasons for deteriorating or improving health.

The purpose of the Afro-Cardiac Study was to examine the prevalence of CVD risk factors; global CVD risk (measured with the Pooled Cohort Equations [PCE] score); and independent socioeconomic, demographic, and behavioral factors associated with increased CVD risk in West African immigrants (WAI).

Methods

Conceptual Framework

A modification of the PRECEDE–PROCEED model,[18] illustrated in Figure 1, was used as the conceptual framework for the study. It integrates health assessment, health education, social action, and behavioral change and maintenance principles. According to this model, the precise social, behavioral, environmental, genetic, and ecological determinants of health must be assessed to facilitate effective program design and implementation; therefore, we assessed the social, behavioral, economic, and cultural factors thought to be predisposing, reinforcing, or enabling determinants of elevated CVD risk as the first phase in this program of research. The model has also been applied to diverse populations including adult hypertensive periurban South African patients,[19] elderly hypertensive Korean immigrants,[20] diabetic Chinese older adults, and low-income Hispanic immigrants.[21]

Design and Setting

The Afro-Cardiac Study was a community-based, cross-sectional study among first-generation WAI aged 35 to 74 years who were born in Ghana or Nigeria and residing in the Baltimore–Washington metropolitan area.[22] This study targeted Ghanaian and Nigerian WAI, 2 of the largest African immigrant populations in the United States, with an estimated total population of 25 000 in the Washington metropolitan area.[8] In the absence of a population frame of WAI in the United States, convenience sampling was used. Participants were recruited between January 2013 and May 2014.

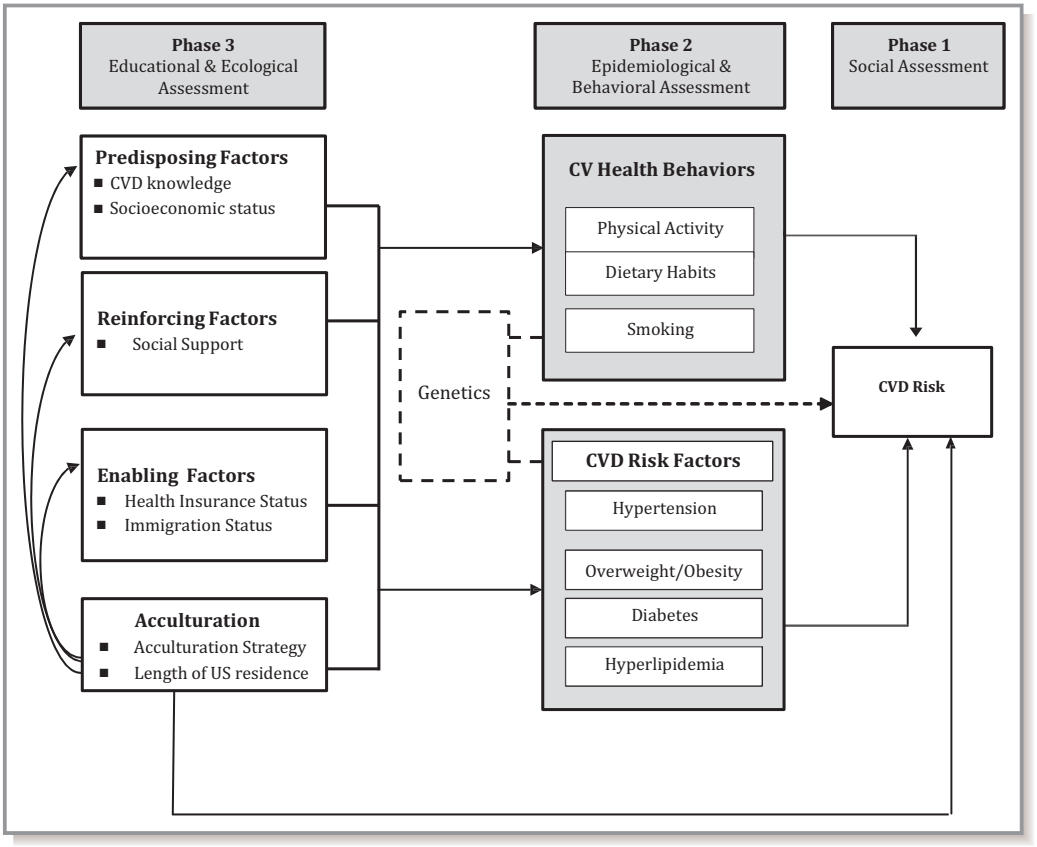

Figure 1. Conceptual framework: modified PRECEDE-PROCEED model. CV indicates cardiovascular; CVD, cardiovascular disease.

Participants

We recruited participants from 7 different churches attended by African immigrants. Participants were eligible based on the following criteria: (1) adults aged between 35 and 74 years at the time of enrollment, (2) self-identify as WAI born in Ghana and Nigeria, (3) reside in the Baltimore–Washington metropolitan area, and (4) able to read and write English and provide informed consent. Study participants were excluded from the study if they were pregnant or born in the United States. Participants with diagnosed CVD were also excluded because the PCE estimate is derived from participants free of diagnosed CVD. A flow diagram of recruitment and enrollment is provided in Figure 2.

Ethics

This study was approved by the institutional review board of Johns Hopkins Medicine.

Measurements

Research assistants performed physical measurements with validated devices according to standardized operational procedures. Study procedures were performed in private rooms provided by the leaders of the churches. Physical examinations consisted of assessment of anthropometrics (weight, height, waist circumference and hip circumference, and systolic and diastolic blood pressure) (Table 1). For each participant, a full fasting lipid profile (total cholesterol [TC], triglycerides [TG], and high-density lipoprotein cholesterol [HDL-C]) and glucose concentrations were obtained with a finger stick and measured using the point-of-care testing instrument Cholestech LDX analyzer (Cholestech Corporation). Accuracy and precision of the Cholestech LDX analyzer has been established previously.[26]

Variable Definitions

A description of variables, measures, and instruments used in the study is provided in Table 1. Hypertension was defined as self-reported hypertension or history of taking antihypertensives per the Seventh Joint National Committee criteria for management of high blood pressure in adults.[27]

Overweight/obesity was defined as body mass index (BMI; in kg/m^2) $\geq$25. Waist circumference and waist-to-hip ratio were measured in addition to BMI because the presence of central adiposity is more highly correlated with CVD risk factors than elevated BMI.[28] Waist circumference >35 and 40 in for women and men, respectively, and a waist-to-hip ratio >0.85 and 0.90, respectively, were considered CVD risk factors.[23]

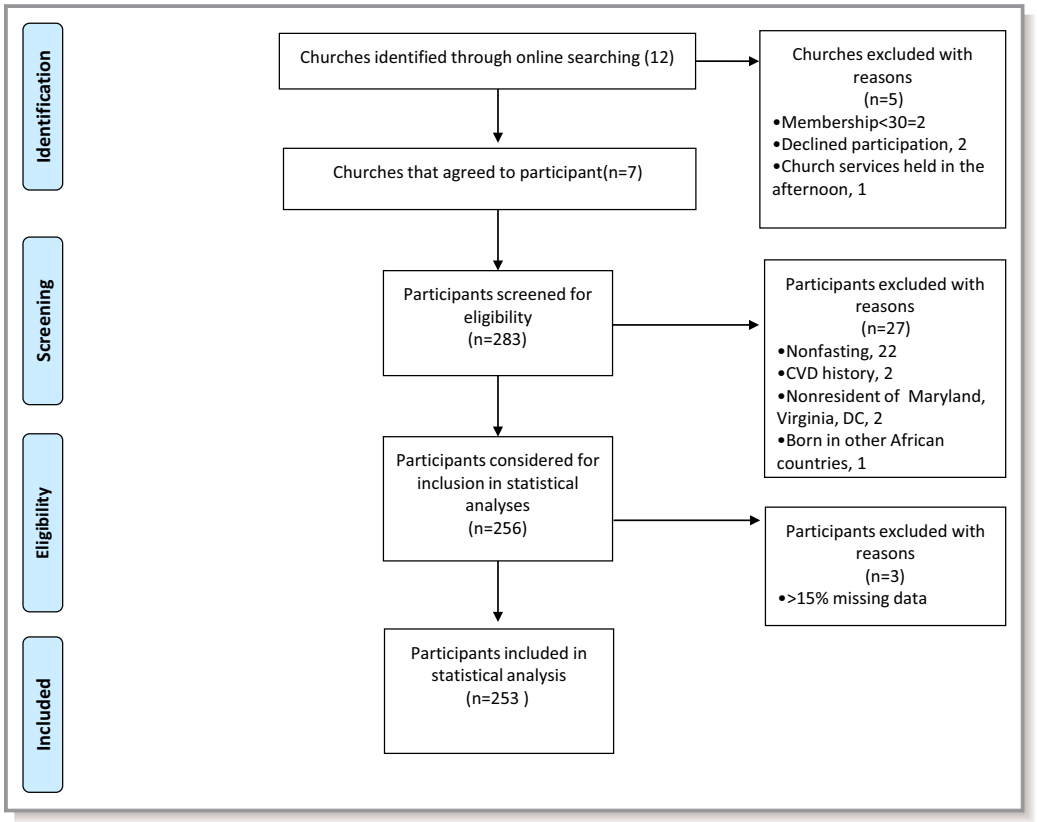

Figure 2. Flow diagram of recruitment and enrollment. CVD indicates cardiovascular disease; DC, District of Columbia.

Table 1. Variables Measures and Instruments in the Afro-Cardiac Study

Themes	Variable	Questionnaire Instrument/Measures
Demographics	Age, age at migration, sex, marital status, insurance status	Self-report in modified WHO STEPS[23]
Medical history	HTN and diabetes history	Self-report in modified WHO STEPS[23]
Predisposing factors	Socioeconomic status (employment and educational status)	Self-report in modified WHO STEPS[23]
	Heart Disease Knowledge	Heart Disease Fact Questionnaire[24]
Reinforcing factors	Social support	ESSI[25]
Enabling factors	Health insurance status	Self-report in modified WHO STEPS[23]
	Immigration status	Self-report in modified WHO STEPS[23]
Health behaviors	Smoking status, physical activity, dietary intake	Self-report WHO STEPS[23]
Blood pressure	Systolic and diastolic blood pressure, measured 3 times in a sitting position after at least 5 minutes of rest	LifeSource UA-767 Plus blood pressure monitor
Anthropometrics	Weight	SECA® Robusta 813
	Height	SECA® 213 Stadiometer
	Waist circumference	Measuring tape
	Hip circumference	Measuring tape
	Diabetes	Self-report, fasting blood glucose, Cholestech LDX® analyzer
Lipid profile	Total cholesterol, triglycerides, and high-density lipoprotein cholesterol	Cholestech LDX® analyzer

ESSI indicates Enhancing Recovery in Coronary Heart Disease (ENRICHD) Social Support Inventory; HTN, hypertension; STEPS, STEPwise Approach to Surveillance; WHO, World Health Organization.

Hyperlipidemia was defined as self-reported history of taking cholesterol-lowering medications or TC ≥200 mg/dL. Diabetes was defined as self-reported provider-diagnosed diabetes or fasting blood glucose levels >126 mg/dL.[29] Sociodemographic variables and health history data were obtained with a modified version of the World Health Organization (WHO) STEPwise Approach to Surveillance (STEPS) survey.[23] The WHO STEPS survey is a simple standardized method for collecting, analyzing, and disseminating data on chronic disease risk factors in WHO member countries. We tailored some questions in the survey to improve relevance to WAI in the United States.

Social support, a reinforcing factor, was operationalized as scores on the Enhancing Recovery in Coronary Heart Disease (ENRICHD) Social Support Inventory (ESSI).[25] The ESSI is a 7-item self-administered survey that measures 3 defining attributes of social support including emotional, instrumental, and structural social support. The individual items on the ESSI are summed for a total score ranging from 8 to 34, with higher scores representing greater social support.

CVD knowledge was assessed with the Heart Disease Fact Questionnaire,[24] a 25-item questionnaire containing true or false questions on knowledge of CVD risk in diabetes. Items in the questionnaire include "A person always knows when they have heart disease," "Smoking is a risk factor for heart disease," and "People with diabetes rarely have high cholesterol." The scores range from 0 to 25, with higher scores corresponding to higher levels of knowledge of CVD risk.

Measures of Global CVD Risk

PCE Score

We calculated sex-specific PCE scores using guidelines by Goff et al[30] to estimate the risk of atherosclerotic CVD. This risk score has been shown to predict 10-year risk for developing atherosclerotic CVD, defined as coronary death or nonfatal myocardial infarction or fatal or nonfatal stroke. Variables in the PCE score included sex, age, HDL-C, TC, diabetes status, systolic blood pressure, treatment for hypertension, smoking status, and race. Participants were considered to be at "elevated" risk if the predicted PCE score was ≥7.5%, based on prior work by Goff et al.[30]

Summative measure of CVD risk factors

Because having ≥3 CVD risk factors is associated with a 10-fold increase in CVD risk,[31,32] we created a summative measure of the number of CVD risk factors because of this "multiplier effect" of CVD risk factors in both sexes. We dichotomized this variable into <3 and ≥3 CVD risk factors.

Statistical Methods

We used independent *t* tests and chi-square tests to determine differences in the sociodemographic, demographic, and behavioral factors and CVD risk by sex. Categorical data were summarized using percentages. Continuous data were

reported using mean±SD. To determine whether the variables in our conceptual framework, derived from the PRECEDE-PROCEED model,[18] independently predicted having ≥3 CVD risk factors and PCE estimates ≥7.5%, we performed unadjusted and adjusted logistic regression analyses. For both outcomes, we fitted separate logistic regression models for men and women due to the variation in prevalence of CVD risk factors by sex. For the outcome of ≥3 CVD risk factors, age was included as a covariate in the adjusted model, along with the other predisposing, reinforcing, and enabling factors. For the outcome of PCE estimates ≥7.5%, age was not included because age is a component of the outcome (PCE score ≥7.5%), and chronological age is the dominant risk factor in the PCE score.[33] We considered a 2-tailed α with $P<0.05$ to be statistically significant for all analyses and used Stata13 (StataCorp) to perform all statistical analyses.

Results

Sample Characteristics

We recruited 256 WAI, although 3 participants were excluded from the analysis because of missing data. Participants were recruited from 7 churches in the Baltimore–Washington metropolitan area. The demographics of the sample are presented in Table 2. The mean age of participants was 49.5±9.2 years, 58% were female, and 60% had at least a college education; however, a high level of education did not translate into higher income because only 36% reported household income >$50 000. Only 52% had health insurance, and 77% reported being green card holders or US citizens. Together, green card holders and US citizens were more likely to be insured than those on visas or those who declined to provide that information (61% versus 20%, $P<0.001$). A total of 152 participants (60%) were born in Ghana, and the rest were born in Nigeria.

CVD Risk

CVD risk factors are summarized in Table 2, and the distribution of CVD risk factors is illustrated in Figure 3. As shown in Figure 4, the majority of participants (95%) had at least 1 and 54% of participants had ≥3 of the 6 CVD risk factors. Women were more likely than men to have ≥3 CVD risk factors (63% versus 42%, $P=0.002$), whereas men were more likely than women to have a PCE estimate ≥7.5% (35% versus 23%, $P=0.047$). Figure 5 illustrates that the distribution of PCE estimates in this study is similar to that of the

Table 2. Demographics of Sample

Characteristic	Total (N=253)	Male (n=106)	Female (n=147)	*P* Value for Comparison of Male and Female
Age, mean±SD	49.5±9.2	49.7±9.2	49.3±9.2	0.7196
Educational status				
Less than high school	61 (25)	19 (18)	42 (29)	0.055
High school	38 (15)	14 (13)	24 (17)	
College or higher	150 (60)	72 (69)	77 (54)	
Employed	181 (79)	81 (90)	100 (72)	0.001*
Household Income				
<$25 000	44 (18)	16 (15)	28 (20)	0.007*
$25 000 to $50 000	113 (46)	39 (38)	74 (52)	
>$50 000	88 (36)	49 (47)	39 (28)	
Health insurance, yes	127 (52)	56 (55)	71 (49)	0.387
≥10 years of US residence (%)	170 (67)	81 (76)	89 (61)	0.008*
Green card/citizen	194 (77)	84 (80)	110 (75)	0.385
Country of birth				
Ghana	152 (60)	60 (57)	92 (63)	0.338
Nigeria	101 (40)	46 (43)	55 (37)	
ESSI score, mean±SD	28.7±5.5	28.5±6.0	28.9±5.1	0.6006
HDFQ score, mean±SD	20.6±2.8	20.4±2.9	20.7±2.7	0.3731

Data are shown as n (%) except as indicated. ESSI indicates Enhancing Recovery in Coronary Heart Disease (ENRICHD) Social Support Inventory; HDFQ, Heart Disease Fact Questionnaire.
*$P<0.05$.

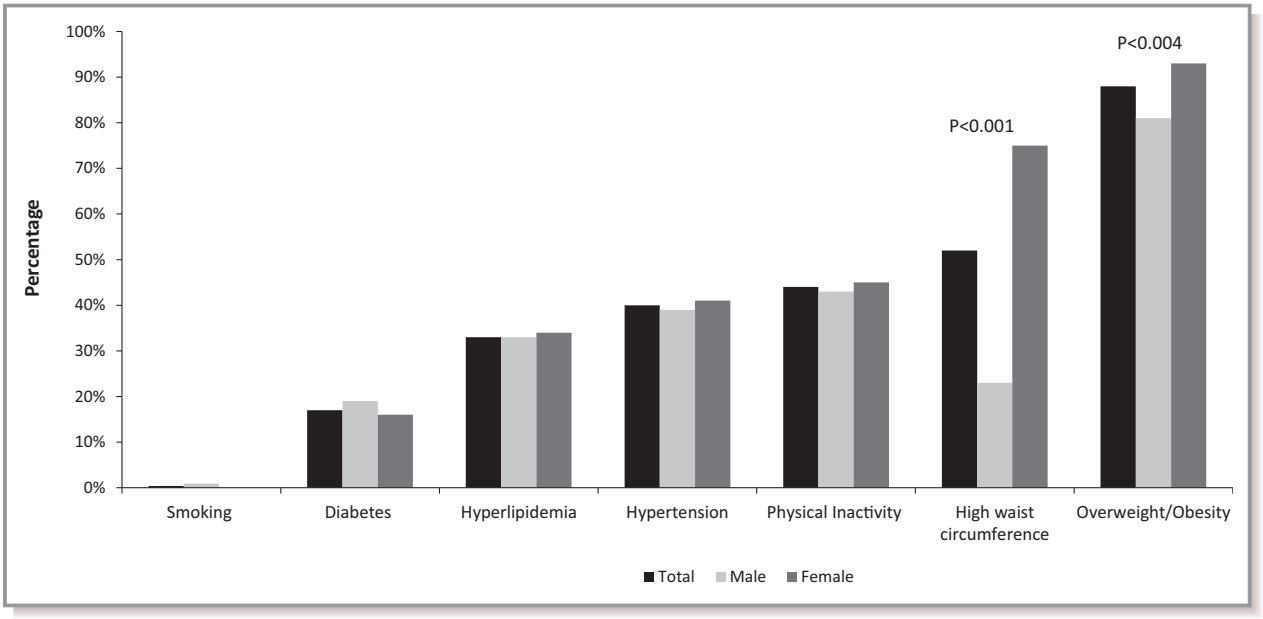

Figure 3. Prevalence of cardiovascular disease risk factors by sex.

general US population. PCE scores estimated the 10-year atherosclerotic CVD risk as very low (<2.5%) for 34% and very high (≥20%) for 13% of participants.

Hypertension

Mean systolic and diastolic blood pressures were 128±19 and 80±11 mm Hg, respectively (Table 3). Hypertension (prior diagnosis of hypertension or on antihypertensive medications) was present among 40% of the participants. Among nonhypertensive participants, 16% had elevated blood pressure, defined as mean systolic blood pressure ≥140 mm Hg or mean diastolic blood pressure ≥90 mmHg. In addition, 53% of those who had hypertension were on antihypertensive treatment, with women more likely than men to report taking antihypertensive medication (64% versus 36%, *P*=0.003). Although women were significantly more likely to be treated for hypertension, men (71%) were more likely than

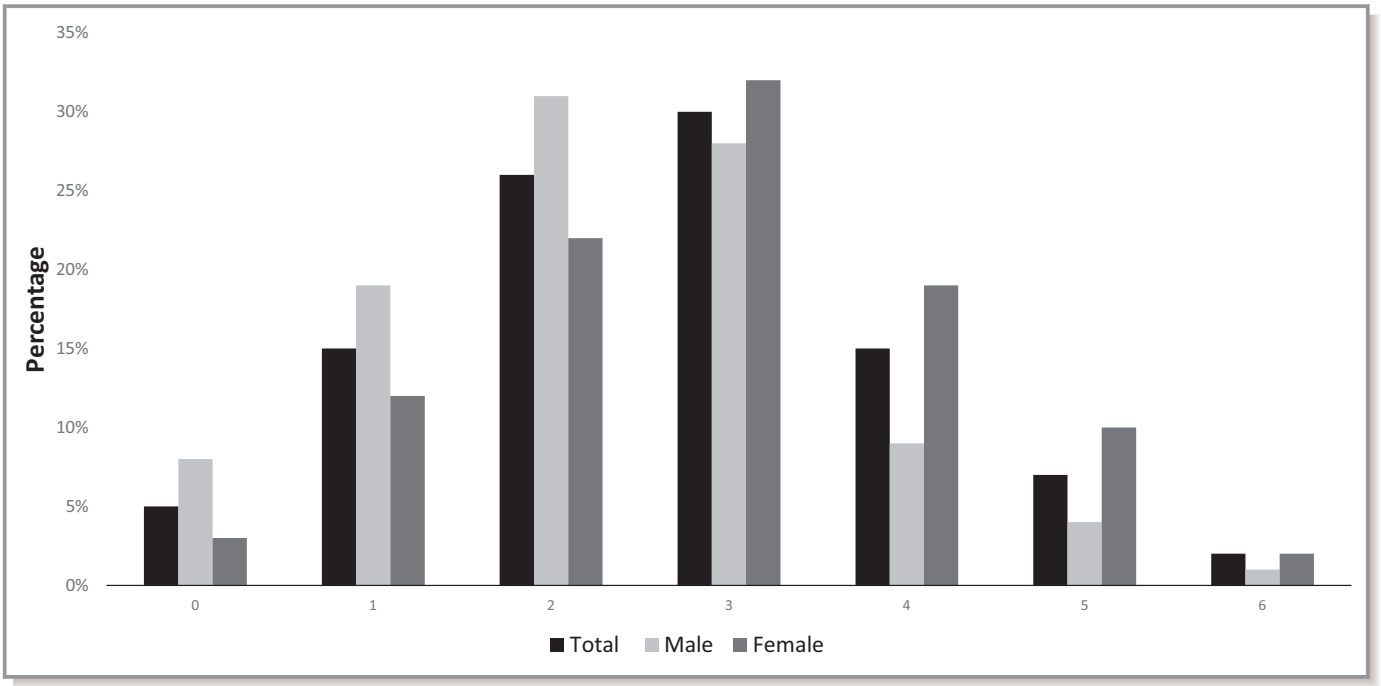

Figure 4. Number of cardiovascular disease risk factors in the sample.

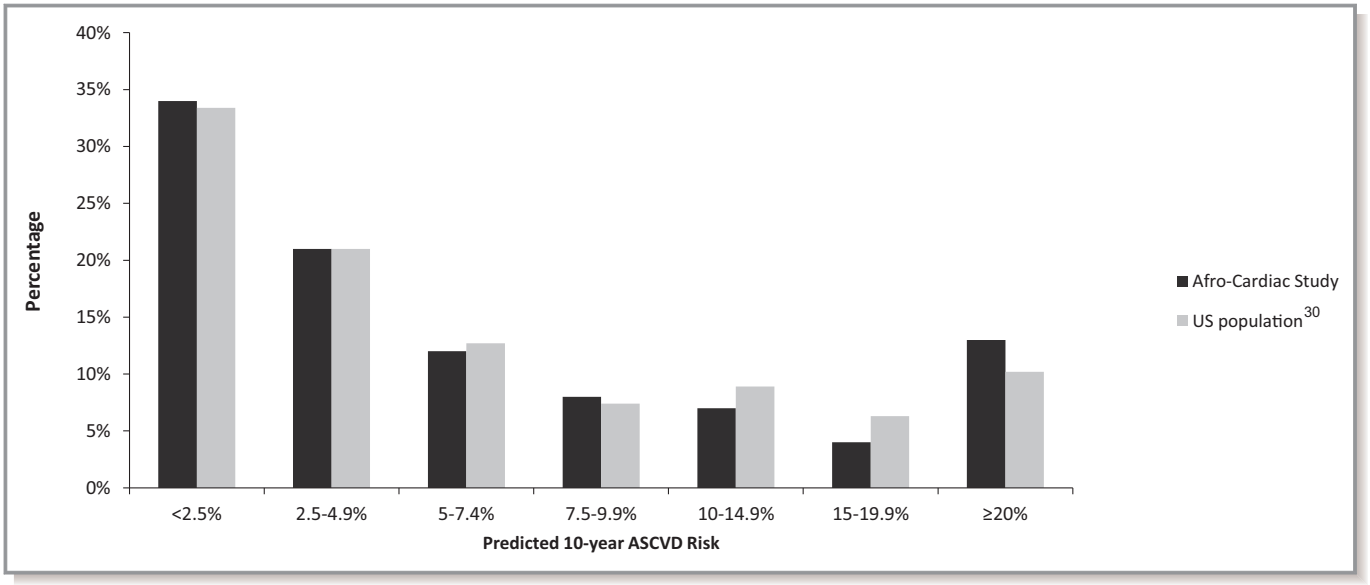

Figure 5. Comparison of Pooled Cohort Equation scores in the Afro-Cardiac Study to the US population.

women (42%) to have their blood pressure controlled (*P*=0.045). There was a strong association (*P*=0.004) between high waist circumference and hypertension in women but not in men (*P*=0.359).

Overweight/Obesity and Central Adiposity

Mean BMI was 29.8±4.8, with women having significantly higher BMI than men (31±5.1 versus 28±3.9, *P*<0.00001) (Table 4). Similarly, 93% of women were considered overweight/obese in contrast to 81% of men (*P*=0.002). With regard to central adiposity, 23% of men had higher prevalence than women (75%) (*P*<0.0001). Similar results were obtained with waist-to-hip ratio at 69% of women versus 47% of men (*P*=0.001).

Diabetes

Overall, 16% of the participants had a prior diagnosis of diabetes or had fasting blood glucose levels ≥126 mg/dL (Table 2). Women were significantly more likely to take medications to control their diabetes than their male counterparts (80% versus 43%, *P*=0.039). Of the diagnosed diabetic participants, there was no significant difference in diabetes control by sex. We identified 15 participants (6%) who had no prior diagnosis of diabetes but who had elevated fasting blood glucose (≥126 mg/dL).

Hyperlipidemia

Mean TC was 181±34 mg/dL, and 32% of participants had TC ≥200 mg/dL. Only 2 (15%) of the 14 participants who had hypercholesterolemia reported taking cholesterol-lowering medications. Mean LDL-C was 106±37 mg/dL, and 62% of participants had LDL-C ≥100 mg/dL. A third of participants had low HDL-C (<40 mg/dL in men, <50 mg/dL in women). Mean TG was 108±87 mg/dL, and only 9% of the sample had elevated TG (≥200 mg/dL) (Table 2).

Physical Inactivity

Almost half (44%) of participants reported inadequate moderate (<150 min/week) or vigorous (<75 min/week) work-related or leisure physical activity. Of those participants, 29% reported participating in no work-related or leisure physical activity. Based on WHO recommended levels of physical activity, only 56% met the recommended weekly physical activity guidelines, with no significant sex differences (Table 3).

Determinants of Elevated CVD Risk (≥3 CVD Risk Factors or PCE Score ≥7.5%)

The predisposing, enabling, and reinforcing factors associated with having ≥3 CVD risk factors or PCE score ≥7.5% are reported in Tables 4 and 5, respectively. Analyses were stratified because of sex-based differences in CVD risk factor prevalence. CVD knowledge (mean score 20.5±2.8 on a 25-point scale), a predisposing factor, was high in this sample but did not independently predict having ≥3 CVD risk factors or a PCE estimate ≥7.5%. Employment status, another predisposing factor, did not independently predict either outcome in men. In women, however, employment was associated with 91% lower odds of having a PCE estimate ≥7.5%. In that model, the interaction term

Table 3. Cardiovascular Disease Risk of Sample

Characteristic	Total (N=253)	Male (n=10 642)	Female (n=14 758)	*P* Value for Comparison of Male and Female
SBP, mm Hg	128±19	130±20	127±19	0.223
DBP, mm Hg	80.3±10.9	79.9±11.6	80.7±10.4	0.594
Elevated blood pressure*	25 (16)	11 (17)	14 (15)	0.784
HTN diagnosis†	98 (40)	40 (39)	58 (41)	0.785
HTN treatment‡	63 (53)	17 (36)	46 (64)	0.003§
HTN control (on antihypertensives)‖	30 (50)	12 (71)	18 (42)	0.045§
HTN control (no antihypertensives)¶	12 (38)	8 (40)	4 (33)	0.706
Diabetes classification#	40 (16)	18 (17)	22 (15)	0.594
Diabetes diagnosis**	30 (13)	14 (15)	16 (12)	0.449
On insulin/oral glycemic agents	19 (65)	7 (50)	12 (80)	0.089
LDL-C	106.0±37.3	109.6±30.3	103.4±41.5	0.202
LDL-C ≥130 (%)	84 (33)	38 (36)	46 (31)	0.448
HDL-C	53.9±17.9	48.8±14.6	57.6±19.2	<0.001§
HDL-C <40 for men/<50 women	74 (29)	25 (24)	49 (33)	0.093
TC	180.9±33.9	178.1±29.7	183.7±37.3	0.242
TC ≥200	69 (27)	28 (26)	41 (28)	0.795
TG	107.5±86.7	113.3±83.9	103.5±88.6	0.375
TG ≥200	23 (9)	11 (10)	12 (8)	0.546
Body mass index, kg/m^2	29.8±4.8	28.4±3.9	30.8±5.1	<0.001§
Normal (18.5–24.9)	30 (12)	20 (19)	10 (7)	0.002§
Overweight (25–29.9)	112 (45)	51 (49)	61 (43)	
Obese (≥30)	105 (43)	33 (32)	72 (50)	
Waist circumference >35 for women/>40 for men	127 (53)	24 (23)	103 (75)	<0.001§
Waist-to-hip ratio >0.90 for men/>0.85 for women	151 (60)	50 (47)	101 (69)	0.001§
Current tobacco smoker	1 (0.4)	1 (1)	0 (0)	0.236
Physical inactivity	135 (56)	58 (57)	77 (55)	0.754
PCE	6.1±6.8	7.7±6.4	5.0±6.9	0.002§
PCE ≥7.5	66 (28)	33 (35)	33 (23)	0.047§
≥3 CVD risk factors	137 (54)	45 (42)	92 (63)	0.002§

CVD indicates cardiovascular disease; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; HTN, hypertension; LDL-C, low-density lipoprotein cholesterol; PCE, Pooled Cohort Equations; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides.

*Defined as proportion of total sample with mean SBP ≥140 mm Hg or mean DBP ≥90 mm Hg.

†Defined as proportion of total sample who self-reported HTN diagnosis or history of taking antihypertensives per Seventh Joint National Committee criteria.

‡Defined as proportion of those diagnosed with HTN who self-reported a history of taking antihypertensives in the past 2 weeks.

§*P*<0.05.

‖Defined as proportion of those diagnosed with HTN and treated with antihypertensives who had mean SBP <140 mm Hg and mean DBP <90 mm Hg.

¶Defined as proportion of those diagnosed with HTN who were not treated with antihypertensives but had mean SBP <140 mm Hg and mean DBP <90 mm Hg.

#Defined as self-reported provider diagnosed diabetes or fasting blood glucose levels >126 mg/dL.

**Defined provider diagnosed diabetes.

between sex and employment was significant (*P*=0.012) The mean ESSI score was 28.7±5.5, with no significant differences by sex. In men, a higher ESSI score was significantly associated with 10% lower odds of having ≥3 CVD risk factors but was not associated with having a PCE estimate ≥7.5%. Notably, the interaction term between sex and social support was not significant (*P*=0.477) for the outcome of ≥3 CVD risk factors. We examined health insurance as an enabling factor and determined that in men, having health insurance was not significantly associated with having ≥3 CVD risk factors or a high PCE estimate; however, in women, having health insurance was

Table 4. Multivariable Logistic Regression Models for Determinants of ≥3 CVD Risk Factors

	Male (n=106)				Female (n=147)			
	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
Variables	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Predisposing factors								
CVD knowledge	1.02 (0.89–1.16)	0.766	1.06 (0.92–1.22)	0.386	1.09 (0.97–1.23)	0.159	1.09 (0.96–1.23)	0.174
Employment, ref (unemployed)	0.59 (0.20–1.79)	0.361	0.76 (0.22–2.55)	0.657	0.54 (0.25–1.20)	0.132	0.55 (0.24–1.27)	0.160
Reinforcing factor								
Social support	0.92 (0.85–0.98)	0.01†2	0.92 (0.85–0.99)	0.024†	0.94 (0.88–1.01)	0.102	0.94 (0.87–1.01)	0.099
Enabling factor								
Health insurance, ref (uninsured)	0.97 (0.44–2.09)	0.938	1.11 (0.48–2.58)	0.807	0.65 (0.33–1.27)	0.210	0.76 (0.38–1.53)	0.439

CVD indicates cardiovascular disease; OR, odds ratio.
*The adjusted models were adjusted for predisposing factors (CVD knowledge and employment), reinforcing factors (social support), enabling factors (health insurance), and age.
†*P*<0.05.

associated with 75% lower odds of having a high PCE estimate. In that model, the interaction term between sex and health insurance was significant (*P*=0.004).

Discussion

We examined the CVD risk profile of WAI and identified theoretically selected factors associated with increased CVD risk. For every 10 participants, 8 had at least 2 CVD risk factors; this result calls for immediate public health intervention. This high burden of CVD risk is troubling, given the relatively young age of the participants; nearly 30% were aged <45 years, and 94% were aged <65 years. The majority of CVD deaths in sub-Saharan Africa occur among persons aged between 30 and 69 years, a range that is 10 years younger than the equivalent age group in Europe and the United States.[34,35] Consequently, WAI in the United States may be at high risk for CVD events at a younger age; however, there are currently no data on CVD events in WAI in the United States to support our assertion.

Using the PRECEDE-PROCEED model,[18] we conceptualized that predisposing (CVD knowledge, employment), reinforcing (social support), and enabling (health insurance) factors would each be associated with having elevated CVD risk. We found a significant negative association between social support and

Table 5. Multivariable Logistic Regression Models for Determinants of PCE Estimate ≥7.5%

	Male (n=106)				Female (n=147)			
	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
Variables	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Predisposing factors								
CVD knowledge	1.04 (0.90–1.18)	0.612	1.08 (0.91–1.28)	0.402	0.93 (0.81–1.06)	0.278	0.89 (0.76–1.03)	0.139
Employment, ref (unemployed)	0.50 (0.17–1.50)	0.214	0.43 (0.12–1.58)	0.204	0.15 (0.07–0.35)	<0.0001†	0.09 (0.033–0.29)	<0.0001†
Reinforcing factor								
Social support	0.95 (0.89–1.01)	0.110	0.93 (0.86–1.00)	0.070	0.98 (0.91–1.05)	0.519	0.89 (0.76–1.03)	0.66
Enabling factor								
Health insurance, ref (uninsured)	1.17 (0.53–2.57)	0.703	1.33 (0.50–3.50)	0.566	0.28 (0.12–0.64)	0.003†	0.25 (0.09–0.67)	0.006†

CVD indicates cardiovascular disease; PCE, Pooled Cohort Equations; OR, odds ratio.
*The adjusted models were adjusted for predisposing factors (CVD knowledge and employment), reinforcing factors (social support), enabling factors (health insurance), and length of US residence (in years). Age was not adjusted for in this model because age is included in the calculation of the PCE score.
†*P*<0.05.

elevated CVD risk in men and a negative relationship between employment and health insurance and elevated CVD risk in women. Epidemiological evidence suggests that low social support is associated with increased incidence of CVD and poor CVD outcomes.[36,37] Immigration is a significant life transition through which previous social networks and social support may be disrupted.

Socioeconomic status is a powerful determinant of health and is inversely associated with CVD in high-income countries[38]; however, this relationship is often paradoxical or weak among ethnic minorities.[39,40] We found that unemployed women were at higher risk for CVD than employed women. With regard to health insurance status, US immigrants have some of the highest uninsured rates: 33.5% of immigrants were uninsured compared with 12.9% of US-born residents.[41] In this study, almost half of the participants reported being uninsured. This finding is troubling because having of health insurance facilitates the utilization of preventive services and improves health outcomes[42] in acute and chronic diseases.[43] Of note, data collection occurred during the implementation of the Patient Protection and Affordable Care Act; therefore, it is possible that current insurance rates in this population may be higher.

Overweight and obesity are well-established CVD risk factors[2,44] and were the most prevalent CVD risk factors in this study. The 88% prevalence (81% of men, 93% of women) of overweight/obesity in our sample is substantially higher than the reported 68% prevalence (73% of men, 64% of women) in US adults[1] and the 76% prevalence (69% of men, 82% of women) in African American adults.[45] Similar findings were observed by Agyemang et al[46] in Dutch Ghanaian immigrants: 90% of participants were overweight/obese. Cultural perceptions may contribute to the high prevalence of overweight/obesity because in West African societies, obesity represents "good living" and is associated with wealth, feminine beauty, and freedom from HIV/AIDS.[47,48]

Central adiposity is also linked to metabolic abnormalities and hypertension.[49,50] In this study, women were more likely to have central adiposity than men. In African immigrants, central adiposity may be more predictive of cardiometabolic disease because, at a lower BMI and waist circumference than African Americans, African immigrants may have more visceral adipose tissue and a higher rate of diabetes and prediabetes than African Americans.[51] In our study, although 88% of participants were considered overweight/obese, only 53% had a high waist circumference. These findings suggest that BMI may not be the most reliable indicator of cardiometabolic health in WAI.

Hypertension is a major public health problem, and in our study, prevalence was 40%. Although hypertension treatment substantially lowers CVD risk, we observed that only half of hypertensive participants were on antihypertensive medications. Hypertension control was achieved in only 50% of those treated. Although not assessed in this study, compliance may be a barrier to hypertension treatment and control in WAI. In qualitative studies by Beune et al, Dutch Ghanaian immigrants stated that they altered their medications for fear of addiction and inability to afford their medications.[52] We observed that men were significantly less likely than women to be taking antihypertensives. Similar results were observed in Dutch Ghanaian men who altered their antihypertensive medications for fear of negative effects on their sexual performance.[52] The high prevalence of hypertension and overweight/obesity in this sample could be attributed to low physical activity reported for Ghanaian and Nigerian participants[53–55] or high consumption of dietary sodium.[56] Concurrently addressing hypertension and overweight/obesity in WAI is critical for preventing target organ damage and CVD, which is more prevalent in persons of African descent.[57]

The high prevalence of diabetes (16%) in this study reflects trends in sub-Saharan Africa, where urban residence is associated with a 2- to 5-fold higher risk of impaired glucose tolerance.[58,59] Oza-Frank and Narayan[60] reported that, compared with other immigrants in the United States, African men ranked second (7.8%) in prevalence of diabetes, and African women ranked third (4.6%). Because African-origin populations are said to be 3 to 5 times more likely to have higher morbidity and mortality from diabetes than European populations,[61] primary prevention strategies are needed. We identified a level of undiagnosed diabetes in participants that suggested secondary prevention efforts including screening and treatment must be improved. O'Connor et al[51] observed that African immigrant men were more likely than African American men to have previously undiagnosed prediabetes (35% versus 22%, $P<0.01$) and diabetes (8% versus 0%, $P<0.01$). The high prevalence of overweight/obesity and central adiposity implies that if adequate and culturally appropriate prevention efforts are not implemented, the prevalence of diabetes in WAI may continue to rise.

Evaluating lipid profile is an integral aspect of assessing CVD risk. In our study, the lipid profile of the participants was favorable compared with the US population. A third of participants had high LDL-C, high TC, and low HDL-C, whereas 1 in 10 had high TG levels. Although persons of African descent typically exhibit a favorable lipid profile characterized by high HDL-C levels,[62,63] it is unlikely that this atheroprotective trait will persist in WAI with the acquisition of other CVD risk factors and increased years of US residence.[64] Elevated TG levels were relatively absent in this group, despite the high prevalence of central adiposity; therefore, the traditional definition of metabolic syndrome, which relies on 5 metabolic risk factors—central adiposity, high TG, low HDL-C, high blood pressure, and high fasting blood glucose—may underestimate the CVD risk of WAI.

Physical inactivity increases the risk of overweight/obesity, CVD, stroke, and metabolic diseases.[65] As in many low-income regions, epidemiological data on physical activity in West Africa is scarce. The WHO estimated that 7.9% of men and 15.1% of women were physically inactive in Ghana[66] and 41% in Nigeria were considered physically inactive.[67] The low levels of physical activity in Africa may be explained in part by environmental and infrastructural barriers such as lack of recreational or sporting facilities.[68] Consequently, prior to migration, West African persons may not engage in recreational physical activity; this poor health behavior may persist after migration. Indeed, in our study, 44% of participants did not meet WHO physical activity recommendations. Increasing physical activity levels in WAI is an important public health challenge and should be addressed with culturally appropriate strategies.

The prevalence of smoking in our study was very low, with only 1 smoker. We believe that our findings corroborate other studies that have found low prevalence of smoking in West African participants. Although reliable estimates of smoking prevalence in sub-Saharan Africa are scant, the prevalence of smoking is 11% among Ghanaian men[69] and 2.6% among Ghanaian women[70]; in Nigeria, 10% of men[71] and 3% of women[72] smoke.

This study has limitations. This study was cross-sectional, so no causal relationships can be established, and we were unable to determine whether the PCE estimate had adequate discrimination. Because participants were recruited from churches, they may not be representative of all WAI in the United States. Participants may have underreported smoking behavior due to social desirability, and health behaviors of church attendees may differ from nonattendees; these aspects may limit the generalizability of our results. Ghanaian- and Nigerian-born WAI residing in the Baltimore–Washington metropolitan area represent a subset of the WAI population in the United States; therefore, these results may not be generalizable to the entire WAI community. There is also the possibility of residual confounding because other pertinent variables including stress, dietary changes, and health care utilization were not measured.

This study also has strengths. To our knowledge, this study is the first community-based epidemiological study of CVD risk in African immigrants in the United States and thus addresses a research gap in an ethnic minority population with scarce data; however, faith-based settings provide access to ethnic minorities and a familiar and reassuring environment for targeting "hard-to-reach" groups and have provided successful recruitment of other immigrants.[73] We also assessed the global atherosclerotic CVD risk using the new PCE estimate recommended by the American Heart Association and the American College of Cardiology[30] to replace the Framingham CVD risk score in black participants.[74] Furthermore, we used a point-of-care testing system that meets all relevant National Cholesterol Education Program guidelines[75] and allowed for the immediate provision of individualized counseling. The use of the WHO STEPS questionnaire enhances the comparability of our results to those obtained in West Africa.

Conclusion

The Afro-Cardiac Study complements the existing literature on CVD epidemiology in immigrants and provides valuable insights in a growing yet understudied population of WAI in the United States. The healthy immigrant effect—described as African immigrants with less obesity and better cardiometabolic health than African Americans[76]—may no longer hold for current WAI. The prevalence of CVD risk factors among relatively young WAI is particularly high. Primary prevention strategies including promotion of healthy lifestyle behaviors, early detection, and adequate control of traditional risk factors are necessary. Early intervention with culturally appropriate medical management and lifestyle changes may represent an opportunity to prevent the health of WAI from deteriorating on migration to the United States. Larger epidemiological studies are needed to confirm our findings.

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