

# The Association Between Acculturation and Cardiovascular Disease Risk in Ghanaian and Nigerian-born African Immigrants in the United States: The Afro-Cardiac Study

Yvonne Commodore-Mensah<sup>1</sup>  · Nwakaego Ukonu<sup>2</sup> · Lisa A. Cooper<sup>3</sup> · Charles Agyemang<sup>4</sup> · Cheryl Dennison Himmelfarb<sup>5</sup>

© Springer Science+Business Media, LLC 2017

**Abstract** The burden of cardiovascular disease (CVD) risk in ethnic minorities in the United States (US) is high. Acculturation may worsen or improve cardiovascular health in immigrants. We sought to examine the association between acculturation and elevated cardiovascular disease risk in African immigrants, a growing immigrant population in the US. We conducted a cross-sectional study of Ghanaian and Nigerian born-African immigrants in the US. To determine whether acculturation was associated with having elevated CVD risk (defined as  $\geq 3$  CVD risk factors or Pooled Cohort Equations score  $\geq 7.5\%$ ), we performed unadjusted and adjusted logistic regression analyses. For both outcomes,

sex-specific models were fitted. Participants ( $N = 253$ ) were aged 35–74 years and resided in Baltimore–Washington-D.C. The mean age (SD) was 49.5 (9.2) years and 58% were female. Residing in the US for  $\geq 10$  years was associated with an almost fourfold (95% CI 1.05–14.35) and eightfold (95% CI 2.09–30.80) greater odds of overweight/obesity and elevated CVD risk respectively in males. Females residing in the US for  $\geq 10$  years had 2.60 times (95% CI 1.04–6.551) greater odds of hypertension than newer residents. Participants were classified according to acculturation strategies: Integrationists, 166 (66%); Traditionalists, 80 (32%); Marginalists, 5 (2%); and Assimilationists, 2 (1%). Integrationists had a 0.46 (95% CI 0.24–0.87) lower odds of having  $\geq 3$  CVD risk factors and 0.38 (95% CI 0.18–0.78) lower odds of having elevated CVD risk (Pooled Cohort Equations score  $\geq 7.5\%$ ) than Traditionalists. Although longer length of stay was associated with CVD risk, Integrationists had lower CVD risk than Traditionalists. Our results suggest that coordinated public health responses to the epidemic of CVD risk factors in the US should target this understudied population. Acculturation should be considered as a meaningful contributor of increased CVD risk and acculturation strategies may be used to tailor interventions in African immigrants. Promoting successful integration may reduce immigrants' CVD risk.

✉ Yvonne Commodore-Mensah  
ycommod1@jhu.edu

Nwakaego Ukonu  
aukonu@ufl.edu

Lisa A. Cooper  
lisa.cooper@jhmi.edu

Charles Agyemang  
c.o.agyemang@amc.uva.nl

Cheryl Dennison Himmelfarb  
cdennis4@jhu.edu

- <sup>1</sup> Johns Hopkins School of Nursing, 525 N. Wolfe Street, Room 419, Baltimore, MD 21205, USA
- <sup>2</sup> Counseling Psychology, University of Florida, 945 Center Drive, P.O. Box 112250, Gainesville, FL 32611-2250, USA
- <sup>3</sup> Johns Hopkins School of Medicine and Bloomberg School of Public Health, 2024 East Monument Street, Baltimore, MD 21287, USA
- <sup>4</sup> Amsterdam Medical Centre, University of Amsterdam, Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands
- <sup>5</sup> Johns Hopkins School of Nursing, 525 N. Wolfe Street, Baltimore, MD 21205, USA

**Keywords** Acculturation · Immigrants · Cardiovascular disease · African · Culture · Health disparities · Obesity · Hypertension

## Background

Cardiovascular disease (CVD) is the leading cause of mortality and morbidity in the United States (US), accounting

for over 40% of all deaths, with ethnic minorities bearing a disproportionate burden of disease [1]. The prevalence of CVD risk factors including hypertension, diabetes, overweight/obesity and physical inactivity is also concerning [1].

Current trends in globalization have resulted in the migration of Africans to high-income regions such as Europe and the US. The number of African immigrants in the US has increased about 40-fold between 1990 and 2010 [2]. Despite the epidemic of CVD underway in sub-Saharan Africa (SSA) due to the epidemiological transition [3–6], Africans residing in industrialized societies experience higher CVD risk factors [7–10] compared to Africans residing in Africa.

Similar to other immigrant groups in the US [11–14], acculturation may be associated with elevated CVD risk in African immigrants. Acculturation, defined as the “resulting phenomenon when groups of individuals with different cultures come into continuous first-hand contact with subsequent changes in the cultural patterns of either or both groups [15],” may be detrimental or beneficial to health. For instance, in Hispanics, acculturation is associated with both positive and negative health behaviors [16–18]. Low levels of acculturation have been associated with increased risk for CVD in Hispanic American men and women [17, 19] and a higher prevalence of diabetes and its neuropathic complications in the absence of routine health care [18]. Studies suggesting acculturation increases risk for CVD outnumber those that show that acculturation improves health. In Hispanic and Asian immigrants, increased acculturation is positively associated with greater frequency of smoking [20, 21], poor exercise habits [22], hypertension [23], coronary artery disease, diabetes and carotid artery intima media thickness [24]. The utilization of different measures of acculturation across studies may hamper the ability to compare findings across studies and may also explain the mixed findings.

To our knowledge, there are no published studies on the association between CVD risk and acculturation in African immigrants. Considering the inconsistent relationships between acculturation and CVD observed in other immigrants, we sought to examine this concept in the “Afro-Cardiac Study”. In particular, we assessed the associations between acculturation, CVD risk factors and elevated CVD risk. We hypothesized that the prevalence of CVD risk factors, and elevated global CVD risk would be significantly associated with acculturation.

## Methods

### Study Design and Setting

The “Afro-Cardiac Study” was a cross-sectional epidemiological study of African immigrants (Ghanaian or Nigeria born) residing in the Baltimore–Washington D.C.

metropolitan area. The participants were recruited between January 2013 and May 2014 from seven churches. Ghana and Nigeria were chosen because they are both English-speaking West African countries with similar socio-demographic, political and historical backgrounds. Together they make up 36% of West African immigrants in the Baltimore–Washington D.C. metropolitan area [25]. Quota sampling was used to ensure that comparable proportions of Ghanaians and Nigerians were recruited.

### Participants

Participant eligibility criteria included: (1) adults ages 35–74 years old; (2) self-identifying as an African immigrant born in Ghana or Nigeria, (3) residing in the Baltimore, Washington D.C. metropolitan area, (4) ability to read and write English and provide informed consent. Exclusion criteria included: (1) being pregnant, (2) being born in the US, (3) not providing informed consent, and (4) having a diagnosis of CVD. The Pooled Cohort Equation score was derived from a sample free of clinically diagnosed CVD. The full methods of the Afro-Cardiac Study are published elsewhere [26].

### Variable Definitions and Measurement

#### *Sociodemographic Variables and Health History*

We used a modified version of the World Health Organization (WHO) stepwise approach to chronic disease risk factor surveillance (STEPS) survey [27] to obtain information on sociodemographic variables and health history. The WHO STEPS survey is a simple standardized method for collecting, analyzing and disseminating data on chronic disease risk factors in WHO member countries. Items were tailored to improve relevance to African immigrants residing in the USA. For instance for education, participants were asked, “What is the highest level of education you have completed?”. For income, participants were asked, “Can you give an estimate of the annual household income?”. For employment, they were asked, “Which of the following best describes your employment (main work) status over the past 12 months?”

#### *Cardiovascular Disease Risk Factors and Elevated CVD Risk*

Hypertension diagnosis was defined as self-reported hypertension or history of taking antihypertensives per the Seventh Joint National Committee criteria for the management of high blood pressure (BP) in adults [28]. Three blood pressure measurement were also obtained by trained research assistants using a validated automated device (Lifesource

UA-767 Plus) with appropriate-sized cuffs in a sitting position following at least 5 min of rest.

Overweight/obesity was defined as body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>. A waist circumference (WC)  $>35$  and 40 inches in females and males respectively was considered a CVD risk factor [27]. The mobile stadiometer SECA 213 was to measure height, the SECA 813 to measure weight, and measuring tape for waist and hip circumferences.

We obtained a full fasting lipid-profile [total cholesterol (TC), triglycerides (TG) and high-density lipoprotein cholesterol (HDL-C)] and glucose concentrations with the point-of-care-testing system Cholestech LDX analyser. Hyperlipidemia was defined as self-reported history of taking cholesterol lowering medications or total cholesterol  $\geq 200$  mg/dL. Accuracy and precision of the Cholestech LDX analyser has been previously established [29]. Diabetes was defined as self-reported provider diagnosed diabetes or fasting blood glucose levels  $>126$  mg/dL [30].

Participants reported moderate and vigorous work-related and recreational physical activity in the Global Physical Activity Questionnaire. Participants reporting no engagement in moderate intensity work-related/recreational physical activity ( $<150$  min per week of moderate intensity work-related/recreational physical activity or  $<75$  min per week of vigorous intensity work-related or recreational physical activity) were classified as not meeting the WHO physical activity recommendations [27].

Smoking history was self-reported, and participants were asked to report any history of smoking tobacco products including cigarettes, cigars or pipes.

**Sum of Cardiovascular Disease Risk Factors** We created a composite measure of the number of CVD risk factors (hypertension, diabetes, overweight/obesity, smoking, hyperlipidemia, physical inactivity). Scores ranged from 0 to 6. For analyses, we dichotomized the sum score into  $<3$  and  $\geq 3$  CVD risk factors because having  $\geq 3$  CVD risk factors is associated with a tenfold increase in CVD risk [31, 32]. Participants with  $\geq 3$  CVD risk factors were considered to have an elevated CVD risk.

**Pooled Cohort Equations (PCE) Scores** We calculated sex-specific PCE scores using guidelines by Goff et al [33] to estimate the 10-year primary risk of atherosclerotic cardiovascular disease. Variables included in the PCE score are sex, age, HDL-C, TC, diabetes status, systolic BP, treatment for hypertension, smoking status and race/ethnicity. Participants were considered to be at high risk if their calculated PCE score was  $\geq 7.5\%$  [33].

**Acculturation: Length of US Residence** Length of residence has been used extensively [11, 13] as a proxy measure to determine acculturation level in immigrants. Participants

were asked, “What year did you come to live in the US?” The length of residence was calculated as the current year minus the year of migration to the US. This variable was dichotomized into  $<10$  years versus  $\geq 10$  years. Prior studies have suggested that CVD risk factors increase substantially after residing in the US for  $\geq 10$  years suggesting a threshold effect [13, 34]. Since this proxy measure has several limitations and does not appropriately capture the acculturation phenomenon, we also used a validated acculturation scale—the Modified Psychological Acculturation Scale.

**Acculturation: Modified Psychological Acculturation Scale** We determined acculturation strategies used by participants by calculating a composite mean score from the modified Psychological Acculturation Scale [35, 36], which assesses an individual’s sense of emotional attachment to, belonging within, and understanding of the Anglo American and Latino-Hispanic cultures. The original instrument consisted of ten items on individual’s psychological responses to differing cultural contexts. Items were applied to the American and African cultures and were rated on a five-point Likert scale ranging from “Strongly Disagree to Strongly Agree”. For behavioral acculturation, we asked participants how often they spent time with Americans/Ghanaian/Nigerian people and items were rated from “Never” to “Always”. We also asked participants how many American/Ghanaian/Nigerian friends they had and their responses ranged from “None” to “Very Many”. Cultural identity was assessed with the items “I feel American” and “I feel Ghanaian/Nigerian”. Items were rated on a five-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”.

The acculturation instrument assessed beliefs and behaviors along two dimensions (D1: relative preference for maintaining the Ghanaian/Nigerian ethnocultural group, D2: relative preference for having contact with and participating in the American culture). Scores obtained from D1 and D2 were then used to identify the following acculturation strategies: (a) *Traditionalist*, (b) *Integrationist*, (c) *Assimilationist*, and (d) *Marginalist*. *Traditionalists* resist acculturation, choose not to identify with another culture and retain separate ethnic identification, behaviors, beliefs, practices and values [37]. Per guidelines provided by the instrument developers [37], we defined *Traditionalist* as participants with mean D1 score  $\geq 3$  and mean D2 score  $<3$ . *Integrationists* develop a bicultural orientation and successfully integrate both cultures and identify and feel comfortable with both groups [37]. We defined an *Integrationist* as participants with mean D1 score  $\geq 3$  and mean D2 score  $\geq 3$ . *Assimilationists* lose their original cultural identity and subsequently acquire a new identity in the second culture [37]. We defined *Assimilationists* as participants with mean D2

score  $\geq 3$  and mean D1 score  $< 3$ . *Marginalists* neither identify with the host nor their ethnic culture [37]. We defined *Marginalist* as participants with mean D1 score  $< 3$  and mean D2 score  $< 3$ . The Cronbach's alphas for D1 and D2 were 0.94 and 0.88 respectively in this study.

### Statistical Analyses

The statistical analyses were designed to meet four goals. The first goal was to describe the demographic characteristics, prevalence of CVD risk factors and elevated CVD risk ( $\geq 3$  CVD risk factors and PCE score  $\geq 7.5\%$ ). Continuous variables were reported as mean (SD) and categorical variables were reported as n (%).

The second goal was to determine if there were any significant differences in demographic characteristics, prevalence of CVD risk factors and elevated CVD risk by acculturation strategy. Since only two and five participants were identified as *Assimilationists* and *Marginalists* respectively, comparisons were performed for *Traditionalists* and *Integrationists*. Independent *t* tests and Chi square tests were used to compare continuous and categorical variable respectively. This analysis allowed us to determine the construct validity of the acculturation instrument in this study as significant differences were expected between the two groups on demographic characteristics.

The third goal was to determine whether acculturation was independently associated with each CVD risk factor. Hence, six multiple logistic regression models were fitted with acculturation as the primary independent variable (reference group  $< 10$  years). To account for confounding, we adjusted for age, sex, education, income, insurance and employment. In the model where overweight/obesity was used the main outcome, physical activity was added as a covariate. In the model where the dichotomized PCE score was used as the outcome, age was not included as a confounder because age is used to calculate the PCE score. For each CVD risk factor, we fitted separate models by sex due to the variation in the associations between CVD risk factors and acculturation by sex [21, 38].

Finally, to determine whether acculturation was independently associated with having  $\geq 3$  CVD risk factors or PCE score  $\geq 7.5$ , we performed multivariable logistic regression analyses adjusting for sex, education, insurance status, employment status and length of US residence due to the known confounding relationships between these variables and relationship between acculturation and CVD risk [39–41]. A two-tailed alpha ( $\alpha$ ) of 0.05 was specified in all analyses.

## Results

### Sample Characteristics

We recruited 256 African immigrants (Ghanaian and Nigerian-born) and three participants were excluded from the analysis due to missing data. The demographic characteristics and CVD risk profile of the sample are presented in Tables 1 and 2 and Fig. 1. The mean age of participants was 49.5 (9.2) years and 58% were female. Also, 60% had at least a college education, however, this did not translate to higher incomes. Only 35% reported a household income of \$50,000 with males reporting significantly higher household income than females (47% vs. 28%;  $P = 0.0007$ ). Notably, only 50% had health insurance. Together, green-card holders and US citizens were significantly more likely to have health insurance than those on visas or those who declined to provide residency status (61% vs. 20%;  $P < 0.0001$ ).

The mean SBP and DBP were 128.4 (19.3) and 80.3 (10.9) mmHg. Over half (64%) of those who had hypertension were on antihypertensive treatment and half of those had controlled BP. The mean BMI was remarkably high at 29.8 (4.8) kg/m<sup>2</sup> and half of the participants had a high waist circumference ( $> 35$  females,  $> 40$  males). With regards to physical activity, 47% of participants reported low moderate ( $< 150$  min/week) or vigorous ( $< 75$  min/week) work-related or leisure physical activity.

### Association Between Acculturation Strategy and Demographic Characteristics

To establish construct validity of the acculturation strategies that were identified, we examined expected associations with demographic variables (see Table 3). The associations

**Table 1** Demographic characteristics (N = 253)

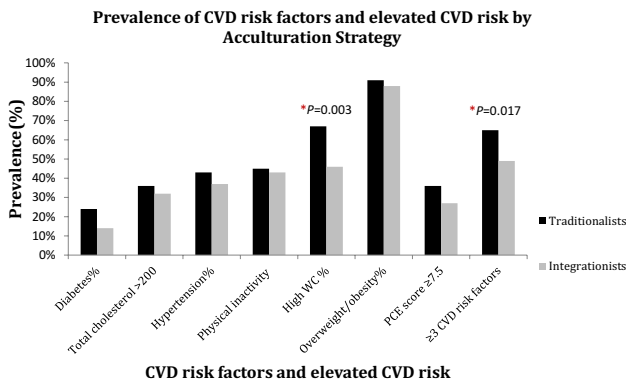
Demographic characteristic [Mean (SD) or N (%)]	Males (n = 106)	Females (n = 147)	P value
Age	49.7 $\pm$ 9.2	49.3 $\pm$ 9.2	0.7196
More than High School Education	86 (82)	101 (71)	<b>0.042</b>
Employed	81 (90)	100 (72)	<b>0.001</b>
Household income			
<\$25,000	16 (15)	28 (20)	<b>0.007</b>
\$25,000–\$50,000	39 (38)	74 (52)	
>\$50,000	49 (47)	39 (28)	
Health Insurance, yes	56 (55)	71 (49)	0.387
$\geq 10$ years of US residence	81 (76)	89 (61)	0.008
Green-card/citizen	84 (80)	110 (75)	0.385
Ghanaians	60 (57)	92 (63)	0.338
Nigerians	46 (43)	55 (37)	

Bolded values are statistically significant values  $p < 0.05$

**Table 2** Cardiovascular disease risk profile of the sample (N=253)

Characteristic [Mean (SD) or N (%)]	Males (n=106)	Females (n=147)	P value
Mean SBP (mmHg)	130 ± 20	127 ± 19	0.223
Mean DBP (mmHg)	80 ± 12	81 ± 10	0.594
Hypertension diagnosis	40 (39)	58 (41)	0.785
Hypertension treatment	17 (36)	46 (64)	<b>0.003</b>
Hypertension control (on antihypertensives)	12 (71)	18 (42)	<b>0.045</b>
Diabetes	14 (15)	16 (12)	0.449
Low density lipoprotein-cholesterol(LDL-C)	110 ± 30	103 ± 41	0.202
LDL-C ≥130 (%)	38 (36)	46 (31)	0.448
High density lipoprotein-cholesterol (HDL-C)	49 ± 15	58 ± 19	<b>&lt;0.001</b>
HDL-C <40 (M)/<50 (F) (%)	25 (24)	49 (33)	0.093
Total cholesterol (TC)	178 ± 30	184 ± 37	0.242
TC ≥200	28 (26)	41 (28)	0.795
Triglycerides (TG)	113 ± 84	104 ± 89	0.375
TG ≥200	11 (10)	12 (8)	0.546
Body mass index (kg/m <sup>2</sup> )	28 ± 4	31 ± 5	<b>&lt;0.001</b>
Normal	20 (19)	10 (7)	<b>0.002</b>
Overweight	51 (49)	61 (43)	
Obese	33 (32)	72 (50)	
Waist circumference >35 (females)/>40 (males)	24 (23)	103 (75)	<b>&lt;0.001</b>
Current smoker, yes	1 (1)	0 (0)	0.236
Physical inactivity	58 (57)	77 (55)	0.754
Pooled Cohort Equation score	7.7 ± 6	5 ± 7	<b>0.002</b>
<7.5% (vs. ≥7.5%)	45 (42)	92 (63)	<b>0.047</b>

Bolded values are statistically significant values p<0.05  
 DBP diastolic blood pressure; SBP systolic blood pressure



**Fig. 1** Prevalence of CVD risk factors and elevated CVD risk by acculturation strategy

were performed for those identified as *Traditionalists* and *Integrationists* because only two were *Assimilationists* and five were *Marginalists*. As shown in Table 3, *Traditionalists* were more often female than were *integrationists* (75% vs. 25%,  $P < 0.0001$ ). *Integrationists* were younger than *Traditionalists* when they migrated to the US. Also, *Integrationists* had resided in the US an average of 4 years longer than

*Traditionalists*, had spent a greater percentage of their lives in the US, and were more likely to be employed and to report significantly higher incomes than *Traditionalists*.

**Association Between Acculturation Strategy and CVD Risk**

As illustrated in Fig. 1, the prevalence of CVD risk factors and elevated CVD risk ( $\geq 3$  CVD risk factors and PCE score  $\geq 7.5\%$ ) was generally higher in *Traditionalists* than *Integrationists*. A significant difference was observed in the prevalence of high waist circumference (67% vs. 46%,  $P = 0.003$ ) and having  $\geq 3$  CVD risk factors (65% vs. 49%,  $P = 0.017$ ) respectively. Although not shown in Fig. 1, hypertensive *Integrationists* were more likely to have controlled BP than hypertensive *Traditionalists* (54% vs. 26%,  $P = 0.010$ ).

**Association Between Length of Residence and CVD Risk Factors and Elevated CVD Risk**

As outlined in Tables 4 and 5, we observed that residing in the US for  $\geq 10$  years was significantly associated with an almost fourfold (95% CI 1.05–14.35) greater odds of being

**Table 3** Comparison of socio-demographic variables by acculturation strategy (N=253)

Characteristic [Mean (SD) or N (%)]	Traditionalist N=80	Integrationist N=166	P value*
Female	60 (75)	81 (49)	<0.0001
Age at migration (years)	39.5 (11.5)	33.9 (8.0)	<0.0001
Years of US residence (≥10)	44 (55)	124 (75)	<b>0.0003</b>
Employed	56 (70)	139 (84)	<b>0.013</b>
Income (n, %)			
<\$25,000	21 (26)	22 (13)	<b>0.006</b>
\$25,000–\$50,000	39 (49)	73 (44)	
>\$50,000	20 (25)	71 (43)	
Green-card/citizen (n, %)	61 (76)	127 (77)	0.836
Health insurance (n, %)	37 (46)	90 (54)	0.241

Bolded values are statistically significant values p < 0.05

\*T test/ $\chi^2$  test comparing Traditionalist to Integrationist

**Table 4** Association between CVD risk factors, elevated CVD risk and length of residence: males (N=106)

	≥10 years		≥10 years	
	OR	95% CI	AOR <sup>a</sup>	95% CI
<b>CVD risk factors</b>				
Overweight/obesity	<b>3.47</b>	<b>1.23–9.97</b>	<b>3.89</b>	<b>1.05–14.35</b>
Hypertension	1.89	0.70–5.03	0.61	0.17–2.14
Hyperlipidemia (TC >200)	1.18	0.42–3.34	1.2	0.35–4.13
Diabetes	6.18	0.77–49.51	3.97	0.42–37.44
Physical inactivity	0.76	0.2–1.93	0.49	0.15–1.59
<b>Elevated CVD risk</b>				
≥3 CVD risk factors	2.27	0.86–6.03	1.22	0.39–3.85
≥7.5% PCE score	<b>6.48</b>	<b>1.79–23.37</b>	<b>8.02</b>	<b>2.09–30.80<sup>b</sup></b>

Bolded values are statistically significant values p < 0.05

OR odds ratio, AOR adjusted odds ratio, CI confidence interval, TC total cholesterol

<sup>a</sup>Adjusted for age, education, income, insurance, employment

<sup>b</sup>Adjusted for education, income, insurance, employment

overweight or obese in males but this relationship did not hold in females. Male participants who had resided in the US for ≥10 years had an eightfold (95% CI 2.09–30.80) greater odds of having a high PCE score than those who had resided in the US for <10 years. This relationship was not observed in females. Female participants who had resided in the US for ≥10 years had 2.60 (95% CI 1.04–6.551) greater odds of hypertension than those who were newer residents. However, this relationship did not hold in males.

**Association Between Acculturation and Elevated CVD Risk**

Since acculturation was operationalized by length of US residence and acculturation strategy we used both

**Table 5** Association between CVD risk factors, elevated CVD risk and length of residence: females (N=147)

	≥10 years		≥10 years	
	OR	95% CI	AOR <sup>b</sup>	95% CI
<b>CVD risk factors</b>				
Overweight/obesity	2.49	0.67–9.26	1.48	0.34–6.41 <sup>a</sup>
Hypertension	<b>2.67</b>	<b>1.29–5.52</b>	<b>2.6</b>	<b>1.04–6.51<sup>a</sup></b>
Hyperlipidemia (TC >200)	1.03	0.49–2.15	1.1	0.41–2.48 <sup>a</sup>
Diabetes	0.73	0.29–1.82	0.58	0.18–1.91 <sup>a</sup>
Physical inactivity	0.55	0.27–1.10	0.88	0.39–2.02 <sup>a</sup>
<b>Elevated CVD risk</b>				
≥3 CVD risk factors	1.32	0.66–2.61	1.21	0.52–2.81 <sup>a</sup>
≥7.5% PCE score	0.78	0.36–1.69	2.2	0.79–6.06 <sup>b</sup>

Bolded values are statistically significant values p < 0.05

OR odds ratio, AOR adjusted odds ratio, CI confidence interval, TC total cholesterol

Significant OR and AOR at P < 0.05

<sup>a</sup>Adjusted for age, education, income, insurance, employment

<sup>b</sup>Adjusted for education, income, insurance, employment

variables separately in the multivariable logistic regression analyses (see Table 6). In the adjusted analysis, each additional year of residence in the US was significantly associated with having ≥3 CVD risk factors (AOR 1.06, 95% CI –1.03 to 1.10) and PCE score ≥7.5% (AOR 1.09, 95% CI 1.05–1.13). In the adjusted analysis with acculturation strategy as the main predictor, we observed that *Integrationists* had a 0.46 (95% CI 0.24–0.87) lower odds of having ≥3 CVD risk factors and 0.38 (95% CI 0.18–0.78) lower odds of having a PCE score ≥7.5% than *Traditionalists*. We also adjusted for years of US residence in the latter model because there was a significant difference in years of US residence comparing *Traditionalists* to *Integrationists*.

**Table 6** Association between Acculturation and elevated CVD risk ( $\geq 3$  CVD risk factors or PCE score  $\geq 7.5\%$ )

Variables	Unadjusted		Adjusted	
	OR	95% CI	AOR	95% CI
$\geq 3$ CVD risk factors				
Length of US residence (years) <sup>a</sup>	<b>1.03</b>	<b>1.00–1.07</b>	<b>1.06</b>	<b>1.03–1.10</b>
Acculturation strategies <sup>b</sup>				
Traditionalist	Ref	Ref	Ref	Ref
Integrationist	<b>0.51</b>	<b>0.29–0.89</b>	<b>0.46</b>	<b>0.24–0.87</b>
$\geq 7.5\%$ PCE score				
Length of US residence (years)	<b>1.06</b>	<b>1.02–1.09</b>	<b>1.09</b>	<b>1.05–1.13</b>
Acculturation strategies <sup>b</sup>				
Traditionalist	Ref	Ref	Ref	Ref
Integrationist	0.63	0.36, 1.12	<b>0.38</b>	<b>0.18–0.78</b>

Bolded values are statistically significant values  $p < 0.05$

<sup>a</sup>Adjusted for sex, education, income, insurance status, employment status

<sup>b</sup>Adjusted for sex, years of US residence, education, income, insurance status, employment status, *Ref* reference group

## Discussion

The primary objectives of this study were to examine the associations between acculturation and CVD risk factors as well as elevated CVD risk in African immigrants. As hypothesized, acculturation was significantly associated with the prevalence of CVD risk factors and elevated CVD risk. However, we observed paradoxical findings when the two measures of acculturation were compared. Using length of residence as a proxy and unidimensional measure of acculturation suggested that longer residence in the US increased CVD risk. By using a validated acculturation instrument, we gained a better understanding of the relationship between acculturation and CVD risk. Our main finding was that although Integrationists had resided in the US longer than Traditionalists, they had a lower CVD risk. This finding highlights the benefit of using multidimensional and validated scales to assess acculturation.

The prevalence of CVD risk factors and elevated CVD risk was high in this group of African immigrants. Overweight/obesity was the most prevalent and smoking was the least prevalent CVD risk factor. Our results are identical to those observed in African immigrants in The Netherlands where the prevalence of overweight/obesity, hypertension and physical activity were high but the prevalence of smoking was very low [42].

We found evidence supporting the moderating role of sex on the relationship between CVD risk factors, elevated CVD risk and length of US residence. In males increasing years of US residence was associated with a higher odds of

overweight/obesity and PCE score  $\geq 7.5\%$ . Among immigrants in high income countries, men are more likely than females to suffer the consequences of the nutritional transition and to gain excess weight [43]. In females however, mixed findings were observed which might be explained by the complex interplay of cultural influences on body image, physical activity and food choices. Several studies have reported a high prevalence of overweight/obesity in Ghanaians and Nigerians [4, 7, 44] residing in SSA. It is plausible that with increased years of US residence they may continue to gain excess weight and increase their CVD risk. Considering the growing size of the African immigrant population in the US, early clinical and public health intervention on reducing the prevalence of overweight/obesity may be a crucial opportunity to prevent the development of metabolic diseases.

Increased years of residence in the US was also associated with higher odds of having elevated CVD risk (PCE score  $\geq 7.5\%$ ) in males but not in females. However, females who had resided in the US for  $\geq 10$  years had a 2.6 greater odds of having hypertension than those who lived in the US for  $< 10$  years. Studies of other immigrant groups in industrialized societies have revealed each additional year of residence is associated with increased odds of hypertension [45–47].

Dietary and physical activity acculturation was not measured in this study; these may account for increased CVD risk. This may be due to shifts from traditional diets to diets that are high in sugar, cholesterol and fat [48] and an increased frequency of sedentary activities [48, 49]. In this study, the overall prevalence of physical inactivity was high, highlighting a need for public health interventions to reduce sedentary behaviors. In Abubakari et al study [5] of West African populations, physical activity was associated with older age, female gender and urban residence. Thus, it is likely that as West Africans age and migrate to developed countries such as the US, a deterioration of physical activity levels may result. Longitudinal studies of African immigrant are however needed to support this assertion.

Generally, immigrants face more barriers to access to health care services [39, 50, 51] than their US-born counterparts. Only half of the participants in this study had health insurance. This finding has serious health implications because health insurance moderates the association between acculturation and health status [39]. Having adequate health insurance facilitates the utilization of preventive services, improves general health, physical functioning, health outcomes in acute and chronic diseases [52] and is associated with a 40% decreased likelihood of premature death [53].

A unique feature of this study was the measurement of acculturation strategies with a validated instrument. We observed that acculturation strategies differed between participants, with the majority of participants classified as *Traditionalists* and *Integrationists*. These patterns of

acculturation fit well into Berry's [37] acculturation framework and suggest that the process of acculturation differs among African immigrants, with some becoming integrated into the US society and others adhering almost completely to their culture. Only five participants were identified as *Marginalists*; this is not surprising as "people rarely choose such an option" [54]. Hence, it is unlikely that African immigrants have no attachment to their ethnic culture. Furthermore, meaningful relations were found between the acculturation strategies, age at migration, length of US residence, employment status and income level, which further supports the validity of the acculturation instrument. We found females were overrepresented in the *Traditionalist* strategy group. Notably, findings about the sex-specific nature of acculturation are inconsistent; with some studies reporting significantly higher acculturation to the host culture in males in comparison to females [47, 55] while others finding no significant difference [56].

We observed that *Integrationists* had a lower adjusted odds of having elevated CVD risk than *Traditionalists*. Health beliefs, health care utilization and self-care behaviors may have accounted for the difference in CVD risk and hypertension control between *Integrationists* and *Traditionalists*. Although both groups were about equally insured, health insurance alone may not necessarily guarantee access to primary care [57] which is necessary for CVD risk management. It is plausible that *Traditionalists* may stick to traditional practices such as herbal medicine and may not value preventative care.

One of the limitations of this study is that our sample may not be representative of the general African immigrant population, limiting the generalizability of our results. This convenience sample was recruited from churches and it is possible that church goers may have significantly different health behaviors than non-church attendants. In the absence of a sampling frame for African immigrants in the US, this recruitment strategy allowed successful recruitment of a socio-economically diverse sample. Since this was a cross-sectional study, no temporal trends can be established. Also, this study was limited to Ghanaian and Nigerian-born immigrants and so their demographic characteristics and health behaviors may not reflect the larger African immigrant population in the Baltimore, Washington, D.C. area and beyond. Our definition of high CVD risk as having  $\geq 3$  CVD risk factors may be limited in the sense that it doesn't allow us to capture which CVD risk factors conferred a higher risk. However, the study has strengths that are worth noting. To our knowledge, this is the first study examining the association between acculturation and CVD risk in African immigrants. By focusing on an understudied immigrant population and examining contextual factors that may contribute to the acculturation process and CVD risk, we have contributed

to the literature on the association between acculturation and health.

## Conclusions

As African immigrants become integrated into the US society, it is imperative that we better understand how unhealthy acculturation practices may be prevented. We observed that participants who were *Integrationists* had lower risk for CVD and had higher rates of blood pressure control than those who were *Traditionalists*. Hence, promoting the successful integration into US society may reduce CVD risk in new African immigrants. Results obtained from this study will inform longitudinal studies assessing the evolution of CVD risk and the long-term impact of acculturation on CVD risk. Our results suggest that coordinated public health responses to the epidemic of CVD risk factors and poor health behaviors in the US should target understudied immigrant populations and acculturation should be considered as a meaningful determinant of CVD risk.

**Funding** This study was funded by was supported by a pilot fund award to the Center of Excellence for Cardiovascular Health in Vulnerable Populations (P30NR011409) at Johns Hopkins University School of Nursing. L.A.C was supported by a grant from the National Heart, Lung, and Blood Institute (K24 HLHL083113). The funders played no role in the study design, data collection and analysis, the decision to publish, or preparation of the manuscript.

## Compliance with Ethical Standards

**Conflict of interest** All authors declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Johns Hopkins Medicine Institutional Review Board provided ethics approval for this study.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

## References

1. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Blaha MJ, et al. Heart disease and stroke statistics—2014 update: a report from the American Heart Association. *Circulation*. 2014;129:e28–e292.
2. Terrazas A. African Immigrants in the United States. *Migration Information Source* 2009.
3. Mensah GA. A heart-healthy and "stroke-free" world through policy development, systems change, and environmental supports: a 2020 vision for sub-Saharan Africa. *Ethn Dis*. 2003;13:S4–12.



4. Commodore-Mensah Y, Samuel LJ, Dennison-Himmelfarb CR, Agyemang C. Hypertension and overweight/obesity in Ghanaians and Nigerians living in West Africa and industrialized countries: a systematic review. *J Hypertens*. 2014;32:464–72.
5. Abubakari AR, Lauder W, Jones MC, Kirk A, Agyemang C, Bhopal RS. Prevalence and time trends in diabetes and physical inactivity among adult West African populations: the epidemic has arrived. *Public Health*. 2009;123:602–14.
6. Bosu WK. An overview of the nutrition transition in West Africa: implications for non-communicable diseases. *Proc Nutr Soc*. 2014;74:466–77.
7. Agyemang C, Owusu-Dabo E, de Jonge A, Martins D, Ogedegbe G, Stronks K. Overweight and obesity among Ghanaian residents in The Netherlands: how do they weigh against their urban and rural counterparts in Ghana? *Public Health Nutr*. 2009;12:909–16.
8. Saleh A, Amanatidis S, Samman S. Cross-sectional study of diet and risk factors for metabolic diseases in a Ghanaian population in Sydney, Australia. *Asia Pac J Clin Nutr*. 2002;11:210–6.
9. Agyemang C, Bindraban N, Mairuhu G, Montfrans G, Koopmans R, Stronks K. SUNSET (Surinamese in The Netherlands: Study on Ethnicity and Health) Study Group. Prevalence, awareness, treatment, and control of hypertension among Black Surinamese, South Asian Surinamese and White Dutch in Amsterdam, The Netherlands: the SUNSET study. *J Hypertens*. 2005;23:1971–7.
10. Commodore-Mensah Y, Hill M, Allen J, Cooper LA, Blumenthal R, Agyemang C, Himmelfarb CD. Sex differences in cardiovascular disease risk of Ghanaian and Nigerian-born West African immigrants in the United States: the Afro-Cardiac Study. *J Am Heart Assoc*. 2016;5 2:e002385.
11. Diez Roux AV, Detrano R, Jackson S, Jacobs DR Jr, Schreiner PJ, Shea S, Szklo M. Acculturation and socioeconomic position as predictors of coronary calcification in a multiethnic sample. *Circulation*. 2005;112:1557–65.
12. Campbell TC, Parpia B, Chen J. Diet, lifestyle, and the etiology of coronary artery disease: the Cornell China study. *Am J Cardiol*. 1998;82:18T–21T.
13. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. *JAMA*. 2004;292:2860–7.
14. Commodore-Mensah Y, Ukonu N, Obisesan O, Aboagye JK, Agyemang C, Reilly CM, et al. Length of residence in the United States is associated with a higher prevalence of cardiometabolic risk factors in immigrants: a contemporary analysis of the National Health Interview Survey. *J Am Heart Assoc*. 2016;5:e004059.
15. Redfield R, Linton R, Herskovits M. Memorandum for the study of acculturation. *Am Anthropol*. 1936;38:149–52.
16. Stern MP, Knapp JA, Hazuda HP, Haffner SM, Patterson JK, Mitchell BD. Genetic and environmental determinants of type II diabetes in Mexican Americans. Is there a “descending limb” to the modernization/diabetes relationship? *Diabetes Care*. 1991;14:649–54.
17. Hazuda HP, Haffner SM, Stern MP, Eifler CW. Effects of acculturation and socioeconomic status on obesity and diabetes in Mexican Americans. The San Antonio Heart Study. *Am J Epidemiol*. 1988;128:1289–301.
18. Mainous AG 3rd, Majeed A, Koopman RJ, Baker R, Everett CJ, Tilley BC, Diaz VA. Acculturation and diabetes among Hispanics: evidence from the 1999–2002 National Health and Nutrition Examination Survey. *Public Health Rep*. 2006;121:60–6.
19. Mainous AG 3rd, Diaz VA, Geesey ME. Acculturation and healthy lifestyle among Latinos with diabetes. *Ann Fam Med*. 2008;6:131–7.
20. Detjen MG, Nieto FJ, Trentham-Dietz A, Fleming M, Chasan-Taber L. Acculturation and cigarette smoking among pregnant Hispanic women residing in the United States. *Am J Public Health*. 2007;97:2040–7.
21. Coreil J, Ray LA, Markides KS. Predictors of smoking among Mexican-Americans: findings from the Hispanic HANES. *Prev Med*. 1991;20:508–17.
22. Chakraborty BM, Mueller WH, Reeves R, Poston WS 2nd, Holscher DM, Quill B, et al. Migration history, health behaviors, and cardiovascular disease risk factors in overweight Mexican-American women. *Ethn Dis*. 2003;13:94–108.
23. Kaplan MS, Chang C, Newsom JT, McFarland BH. Acculturation status and hypertension among Asian immigrants in Canada. *J Epidemiol Community Health*. 2002;56:455–6.
24. Dodani S, Dong L. Acculturation, coronary artery disease and carotid intima media thickness in South Asian immigrants—unique population with increased risk. *Ethn Dis*. 2011;21:314–21.
25. Kent M. Immigration and America’s Black population. *Popul Bull*. 2007;62:1–16.
26. Commodore-Mensah Y, Sampah M, Berko C, Cudjoe J, Abu-Bon-srah N, Obisesan O, et al. The Afro-Cardiac Study: cardiovascular disease risk and acculturation in West African immigrants in the United States: rationale and study design. *J Immigr Minor Health*. 2015;18(6):1301–8
27. World Health Organization. STEPwise approach to surveillance (STEPS). Geneva: WHO; 2008.
28. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA*. 2003;289:2560–72.
29. Panz VR, Raal FJ, Paiker J, Immelman R, Miles H. Performance of the CardioChek PA and Cholestech LDX point-of-care analysers compared to clinical diagnostic laboratory methods for the measurement of lipids. *Cardiovasc J S Afr*. 2005;16:112–7.
30. American Diabetes Association. Standards of medical care in diabetes—2011. *Diabetes Care*. 2011; 34 Suppl 1:S11–61.
31. National Heart, Lung, and Blood Institute. Heart disease risk factor multiplier effect in midlife women. 2014.
32. National Heart, Lung, and Blood Institute. Who is at risk for heart disease? NHLBI, NIH. 2014.
33. Goff DC Jr, Lloyd-Jones DM, Bennett G, Coady S, D’Agostino RB S, Gibbons R, et al. 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. *Circulation*. 2013;136(8). doi:10.1161/01.cir.0000437741.48606.98.
34. Kandula NR, Diez-Roux AV, Chan C, Daviglius ML, Jackson SA, Ni H, Schreiner PJ. Association of acculturation levels and prevalence of diabetes in the multi-ethnic study of atherosclerosis (MESA). *Diabetes Care*. 2008;31:1621–8.
35. Tropp LR, Erkut S, Coll CG, Alarcon O, Vazquez Garcia HA. Psychological acculturation: development of a new measure for Puerto Ricans on the U.S. mainland. *Educ Psychol Meas*. 1999;59:351–67.
36. Stevens GWJM, Pels TVM, Vollebergh WAM, Crijnen AAM. Patterns of psychological acculturation in adult and adolescent Moroccan immigrants living in The Netherlands. *J Cross Cult Psychol*. 2004;35:689–704.
37. Berry JW. Acculturation and adaptation: health consequences of culture contact among circumpolar peoples. *Arct Med Res*. 1990;49:142–50.
38. Markides KS, Lee DJ, Ray LA. Acculturation and hypertension in Mexican Americans. *Ethn Dis*. 1993;3:70–4.
39. Lee S, O’Neill A, Park J, Scully L, Shenassa E. Health insurance moderates the association between immigrant length of stay and health status. *J Immigr Minor Health*. 2012;14:345–9.
40. Lutsey PL, Diez Roux AV, Jacobs DR Jr, Burke GL, Harman J, Shea S, Folsom AR. Associations of acculturation and socioeconomic status with subclinical cardiovascular disease in

- the multi-ethnic study of atherosclerosis. *Am J Public Health*. 2008;98:1963–70.
41. Koya DL, Egede LE. Association between length of residence and cardiovascular disease risk factors among an ethnically diverse group of United States immigrants. *J Gen Intern Med*. 2007;22:841–6.
  42. Agyemang C, Nicolaou M, Boateng L, Dijkshoorn H, van de Born BJ, Stronks K. Prevalence, awareness, treatment, and control of hypertension among Ghanaian population in Amsterdam, The Netherlands: the GHAIA study. *Eur J Prev Cardiol*. 2012;20:938–46.
  43. Delavari M, Sonderlund AL, Swinburn B, Mellor D, Renzaho A. Acculturation and obesity among migrant populations in high income countries—a systematic review. *BMC Public Health*. 2013;13:458.
  44. Abubakari AR, Bhopal RS. Systematic review on the prevalence of diabetes, overweight/obesity and physical inactivity in Ghanaians and Nigerians. *Public Health*. 2008;122:173–82.
  45. Moran A, Roux AV, Jackson SA, Kramer H, Manolio TA, Shrager S, Shea S. Acculturation is associated with hypertension in a multiethnic sample. *Am J Hypertens*. 2007;20:354–63.
  46. Steffen PR, Smith TB, Larson M, Butler L. Acculturation to Western society as a risk factor for high blood pressure: a meta-analytic review. *Psychosom Med*. 2006;68:386–97.
  47. Marmot MG, Syme SL. Acculturation and coronary heart disease in Japanese–Americans. *Am J Epidemiol*. 1976;104:225–47.
  48. Okafor MT, Carter-Pokras OD, Zhan M. Greater dietary acculturation (dietary change) is associated with poorer current self-rated health among african immigrant adults. *J Nutr Educ Behav*. 2014;46:226–35.
  49. Unger JB, Reynolds K, Shakib S, Spruijt-Metz D, Sun P, Johnson CA. Acculturation, physical activity, and fast-food consumption among Asian-American and Hispanic adolescents. *J Community Health*. 2004;29:467–81.
  50. Ku L, Matani S. Left out: immigrants' access to health care and insurance. *Health Aff (Millwood)*. 2001;20:247–56.
  51. Mahmoud I, Hou XY. Immigrants and the utilization of hospital emergency departments. *World J Emerg Med*. 2012;3:245–50.
  52. McWilliams JM. Health consequences of uninsurance among adults in the United States: recent evidence and implications. *Milbank Q*. 2009;87:443–94.
  53. Wilper AP, Woolhandler S, Lasser KE, McCormick D, Bor DH, Himmelstein DU. Health insurance and mortality in US adults. *Am J Public Health*. 2009;99:2289–95.
  54. Berry JW. Contexts of acculturation. In: Sam DL, Berry JW, editors. *Cambridge handbook of acculturation psychology*. New York: Cambridge University Press; 2006. pp. 27–42.
  55. Arcia E, Skinner M, Bailey D, Correa V. Models of acculturation and health behaviors among Latino immigrants to the US. *Soc Sci Med*. 2001;53:41–53.
  56. Sadowsky GR, Lai EWM, Plake B. Moderating effects of socio-cultural variables on acculturation attitudes of Hispanics and Asian Americans. *J Couns Dev*. 1992;71:53–69.
  57. Cykert S, Kissling G, Layson R, Hansen C. Health insurance does not guarantee access to primary care: a national study of physicians' acceptance of publicly insured patients. *J Gen Intern Med*. 1995;10:345–8.