J Immigrant Minority Health (2016) 18:1301–1308
DOI 10.1007/s10903-015-0291-0

ORIGINAL PAPER

The Afro-Cardiac Study: Cardiovascular Disease Risk and Acculturation in West African Immigrants in the United States: Rationale and Study Design

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Published online: 1 October 2015

Abstract Cardiovascular disease (CVD) remains the leading cause of death in the United States (US). African-descent populations bear a disproportionate burden of CVD risk factors. With the increase in the number of West African immigrants (WAIs) to the US over the past decades, it is imperative to specifically study this new and substantial subset of the African-descent population and how acculturation impacts their CVD risk. The Afro-Cardiac study, a community-based cross-sectional study of adult WAIs in the Baltimore–Washington metropolis. Guided by the PRECEDE–PROCEED model, we used a modification of the World Health Organization Steps survey to collect data on demographics, socioeconomic status, migration-related factors and behaviors. We obtained physical, biochemical, acculturation measurements as well as a socio-demographic and health history. Our study provides critical data on the CVD risk of WAIs. The framework used is valuable for future epidemiological studies addressing CVD risk and acculturation among immigrants.

Keywords African immigrants · Cardiovascular disease · Immigrants · Acculturation

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Introduction

Cardiovascular disease (CVD) remains the leading cause of death in the United States (US), where 1 in 3 deaths is attributable to CVD [1]. There is high prevalence of CVD risk factors and poor health behaviors such as smoking, obesity, hypertension (HTN), hypercholesterolemia, physical inactivity, and diabetes mellitus, which the Framingham Heart Study [2, 3] and INTERHEART Study [4] have demonstrated to synergistically increase CVD morbidity and mortality.

Similarly, CVD is a growing cause of death and disability in Sub-Saharan Africa (SSA), where increasing prevalence of its risk factors is attributable to the "epidemiological transition". The latter is characterized by the superimposition of non-communicable diseases on communicable diseases [5]. Several systematic reviews have provided evidence supporting the increased prevalence of CVD risk factors and poor health behaviors in SSA [6–8]. Overweight/obesity prevalence in Ghana and Nigeria ranges from 20–62 to 4–49 %, respectively [6]. Time trend analyses suggests that diabetes prevalence increased by more than 300 % between 1985 and 2000 in urban Nigeria [9, 10]. Hence, it is plausible that the CVD risk profile for twenty-first century African immigrants is poorer than for those who emigrated from SSA decades prior.

There has been an increase in the number of African immigrants from SSA to the USA in the past two decades. The size of this population grew 40-fold between 1960 and 2007, from 35,555 to 1.4 million, with 36 % from West Africa [11]. Together, Ghanaian and Nigerian immigrants make up more than one-third of African Immigrants in the USA. The U.S. Census Bureau's 2008–2012 American Community Survey enumerated 161,000 African immigrants in the Washington, DC metropolitan area, accounting for 13 % of the area's total immigrant population, which is three times the national percentage of 4 % [12].

Despite the growing presence of this population in the US, to date, there are limited published epidemiological studies on the prevalence of CVD risk factors and poor health behaviors in this population. This research gap stems from the fact that African immigrants in the US are typically lumped into the racial category of "Black/African-American" along with African-Americans and African-Caribbeans. Although African-Americans derive the majority of their African ancestry from West Africans, European admixture underlying the genetic makeup of African-Americans often hinders drawing generalizable conclusions to all African-descent populations [13, 14]. WAIs are therefore a critical population in which to study the impact of environmental, lifestyle and cultural changes on the occurrence of CVD in African-descent populations. Studying the evolution of CVD in new WAIs will provide valuable insight into reasons for higher CVD morbidity and mortality in their African-American counterparts. Obtaining comparable data on WAIs in different global contexts will also enhance our understanding of how gene-environment interactions result in variable CVD in African-descent populations.

According to the "healthy immigrant effect" [15, 16], it may be assumed that African immigrants are healthier than their host population due to self-selection and immigration policies, which largely deny immigrants with serious health problems entry into the US. However, it is well known that the health of immigrants declines or improves with increasing years of residence in the new countries through the loss of culture-specific health protective effects or adoption of health behaviors of the host society [16–18]. Changes in socio-economic conditions, food supply, health systems and policies, and cultural traditions [19–22] experienced by immigrants have been posited as reasons for deteriorating or improving health in immigrants. Hence, "The Afro-Cardiac study" sought to examine the relationships between behavioral, environmental, social and cultural factors among Ghanaian and Nigerian-born African immigrants residing in the US and how these relate to their CVD risk. The specific aims of the study are to examine in Ghanaian and Nigerian-born African immigrants:

1. Prevalence of CVD risk factors [body mass index (BMI), hypertension, high blood glucose, high total cholesterol, low high-density lipoprotein cholesterol] and related health behaviors [smoking, physical activity and healthy diet].
2. Distribution of 10-year Pooled Cohort Equations (PCE) scores.
3. Predisposing, reinforcing and enabling factors as predictors of CVD risk factors, health behaviors and PCE scores.
4. Association between acculturation and CVD risk.

Conceptual Framework

A modification of the PRECEDE–PROCEED model (PPM) [23], illustrated in Fig. 1, was used as the conceptual framework for the study. We believe that this framework is useful in guiding future CVD prevention efforts in the population. It integrates health assessment, health education, social action, and behavioral change and maintenance principles. According to the PPM, the precise social, behavioral, environmental, genetic, and ecological determinants of health must be assessed to facilitate effective program design and implementation. Hence, the Afro-Cardiac study 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.

Methods

Design and Setting

The "Afro-Cardiac" study was a community-based cross-sectional study of Ghanaian and Nigerian-born African immigrants aged 35–74 years and residing in the Baltimore–Washington, metropolitan area. Ghana and Nigeria were chosen because they are both English-speaking West African countries, and together make up the largest percentage (approximately 60 %) of West Africans in the US [12]. The estimated total population of Ghanaian and Nigerian immigrants in the Washington, DC metropolitan area from 2008 to 2012 was 38,000 which is 24 % of the African-born population [12].

Participants

Study participants were eligible based on the following criteria: (1) adults aged between 35 and 74 years of age at time of enrolment, (2) self-identify as WAI born in Ghana

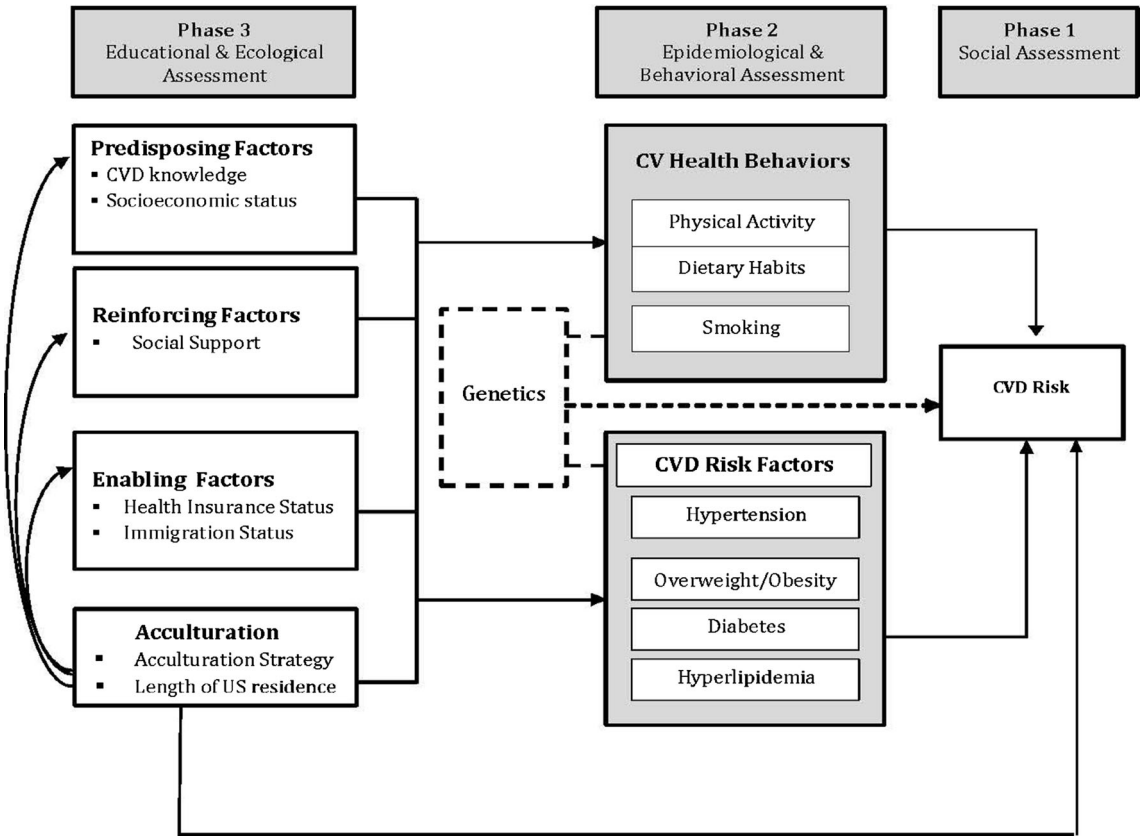

Fig. 1 Conceptual framework for the Afro-Cardiac study

or Nigeria, (3) reside in the Baltimore, Washington, DC metropolitan area as defined by the US Census Bureau and (4) able to read and write English and provide informed consent. We limited participation to adults aged 35–74 because that age range closely resembled that of the old original Framingham Heart Study cohort [24] and the PCE cohorts [25]. Study participants were excluded from the study if they were pregnant, born in the US or a country other than Ghana or Nigeria, or did not provide informed consent. Participants with diagnosed CVD were also excluded from this study as the 10-year PCE score derived from a sample free of clinically diagnosed CVD.

Sample Size Determination for a Prevalence Survey, with Finite Population Correction

With an estimated population size of 25,000 WAI residing in the Washington, DC metropolitan area [26], and assuming a conservative estimate of a 50 % prevalence of HTN and overweight/obesity, precision of 6 and 95 % confidence interval, a sample size of 264 was computed as the minimum sample size necessary to determine the prevalence of HTN and overweight/obesity in this population. Using Green's [27] rule of thumb for determining regression sample sizes, [$N > 50 + 8$ m (m = number of independent variables)] a minimum sample size of 106 participants each from Ghana and Nigeria was required to achieve Aims 3 and 4.

Recruitment Procedures

Participants were recruited between January 2013 and May 2014 from African churches in the sampling area. African churches were identified through an online search of churches attended by African immigrants and religious leaders at identified churches were contacted to inform them about the on-going study. The religious leaders who expressed interest in the study gave permission for recruitment and performance of study procedures on their premises. The church leaders made announcements in the weeks preceding the study and in some instances, allowed the principal investigator to address the congregation directly. Additionally, study flyers were posted in the recruitment sites at least 2 weeks prior to the date of recruitment at each church. Potential participants were asked to fast for 12 h before attending church and all examinations were conducted in the morning.

Informed Consent and Data Collection Procedures

The research team consisted of physicians, nurses, pharmacists and students affiliated with Johns Hopkins University and Medical Institutions who volunteered to assist with data collection and were trained on all study procedures including obtaining informed consent and research compliance. On the day of recruitment, the research team described the study to potential participants and obtained informed consent from eligible participants. Individuals who were interested in participating completed a brief screen to determine their eligibility. To avoid loss to follow-up during the time between consent and data collection, the research team administered data collection instruments and obtained capillary blood samples immediately following recruitment and consent.

Questionnaire/Interview

We used a modified version of the World Health Organization (WHO) Stepwise Approach to chronic disease risk factor surveillance (STEPS) Survey [28]. 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 WAI residing in the USA. For instance "Cluster/Centre/Village name" was changed to "Zip code". The final questionnaire included items on demographics (age, sex, marital status, household composition), socioeconomic status (educational and employment status, occupational status and household income), migration-related factors (age migration and acculturation), psychosocial factors (social support), health status (self-reported general health and presence/history of diseases, family history of diseases), health behavior (physical activity, dietary habits, alcohol and smoking) and heart disease knowledge by utilizing appropriate validated measures and instruments (Table 1). The ENRICHD Social Support Inventory (ESSI) [29] is a seven-item measure assesses emotional, instrumental, and structural social support with responses ranging from "None of the time" to "All of the time". A Cronbach's α of 0.88 has been previously reported for the ESSI [30]. The Heart Disease Fact Questionnaire [31] contains 25 items and assesses knowledge of respondents' knowledge of CVD risk factors with "True" or "False" responses. This instrument demonstrates adequate internal consistency, with Kuder–Richardson-20 formula of 0.77 [31]. The utilization of the WHO STEPS survey in this study enhances the comparability of the results obtained from this study to epidemiological studies conducted in West Africa.

Physical Measurements

Research assistants performed physical measurements with validated devices according to standardized operational procedures. Physical examinations consisted of assessment of anthropometrics (weight, height, waist circumference and hip circumference and systolic and diastolic blood pressure) (Table 1). The mobile stadiometer SECA 213 was used for height measurement, the SECA 813 for weight measurement, and measuring tape for waist and hip circumference. The anthropometric measures were obtained once. Blood pressure was measured three times using a validated automated device (Lifesource UA-767 Plus) with appropriate-sized cuffs in a sitting position following at least 5 min of rest. HTN was defined as self-reported HTN or history of taking antihypertensives per the Seventh Joint National Committee (JNC-7) criteria for the management of high BP in adults [32]. Overweight was defined as BMI $\geq$ 25 and $<$30 kg/m^2 and obesity is defined as BMI $\geq$ 30 kg/m^2 [33]. Waist circumference (WC) and waist-to-hip ratio (WHR) were measured in addition to BMI because the presence of central adiposity is more highly correlated with CVD risk factors than elevated BMI [34]. A WC $>$ 35 inches and 40 in. and WHR $>$ 0.85 and 0.90 in females and males, respectively were considered CVD risk factors [28]. HTN was defined as self-reported HTN or history of taking antihypertensives per the Seventh Joint National Committee (JNC-7) criteria for the management of high BP in adults [32].

Biochemical Measurements

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 POCT instrument-Cholestech LDX analyzer (Cholestech Corporation, Hayward, CA, USA). Accuracy and precision of the Cholestech LDX analyzer has been previously established [35]. Quality controls checks were performed on the Cholestech LDX analyzer prior to each data collection. LDL-C levels were measured indirectly using the Friedewald equation. Hyperlipidemia was defined as self-reported history of taking cholesterol-lowering medications or total cholesterol $\geq$200 mg/dl. Diabetes was defined as self-reported provider-diagnosed diabetes or fasting blood glucose levels greater than 126 mg/dl [36]. Fasting glucose levels were measured with the Cholestech LDX analyzer. In this community-based setting, point of care testing provided advantages over laboratory testing in that the former was cost-effective, less-invasive and enabled timely feedback to participants.

Table 1 Variables measures 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
Medical history	HTN and diabetes history	Self-report in modified WHO STEPS
Predisposing factors	Socio-economic status (employment and educational status)	Self-report in modified WHO STEPS
	Heart disease knowledge	Heart disease fact questionnaire
Reinforcing factors	Social support	Enriched social support inventory (ESSI)
Enabling factors	Health insurance status	Self-report in modified WHO STEPS
	Immigration status	Self-report in modified WHO STEPS
Acculturation	Psychological acculturation	Modified psychological acculturation scale.
	Length of US residence	Self-report in modified WHO STEPS
Health behaviors	Smoking status, physical activity, dietary intake	Self-report WHO STEPS
Blood pressure	Systolic and diastolic blood pressure, measured three times in a sitting position after at least 5 min 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

Acculturation Measurement

Acculturation was measured using length of residence as a proxy, in conjunction with a modified version of the Psychological Acculturation Scale. Length of residence has been used extensively [37, 38] as a proxy measure to determine acculturation level in immigrants and is useful in circumstances where using a more comprehensive acculturation measure is non-feasible [39]. To determine the length of residence in this study, participants were asked to respond to the question: "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. In addition to examining length of residence as a continuous variable, we dichotomized this variable into the categories of <10 years versus ≥ 10 years. We used this categorization because previous studies have suggested that CVD risk factors increase substantially after residing in the US for ≥ 10 years, which suggests a threshold effect [37, 40].

The Psychological Acculturation Scale was originally developed by Tropp et al. [41] to assess 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 10 items soliciting individual's psychological responses to differing cultural contexts. Items were applied to both the American and African culture and were rated on a five-point Likert scale ranging from "Strongly Disagree to Strongly Agree." Two additional items were added to the acculturation instrument to assess behavioral acculturation. Participants were asked how often they spend time with Americans, Ghanaians or Nigerians with prompts corresponding to these items rated from "Never" to "Always". They were also asked how many American/Ghanaian/Nigerian friends they have 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". In a Dutch study of Moroccan immigrants, Cronbach's alphas of 0.85 and 0.73 were obtained for the Dutch and Moroccan subscales respectively [42].

Brief Risk Factor Counseling and Remuneration

Following data collection, participants received brief individualized counseling on a heart healthy lifestyle. An AHA booklet titled "Controlling Your Risk Factors: Our Guide to Reducing Your Risk of Heart Attack and Stroke" and a written summary of the participant's CVD risk profile was provided. Participants were encouraged to share with their primary care providers. All study procedures were conducted in private rooms on the church premises.

Discussion

Several lines of evidence have shown that African-descent populations in the US are disproportionately affected by risk factors for CVD [43, 44]. For instance, "Blacks/

African-Americans" in the US are about twice more likely to develop type 2 diabetes or HTN, be obese and have higher CVD morbidity and mortality and compared to Non-Hispanic Whites [43, 45]. Lifestyle behaviors, genetic predispositions and cultural beliefs and practices account for these disparities. However, there has been insufficient research conducted to explain why these disparities exist [46, 47].

Historically, African immigrants and African-Americans have been studied as one racial group in the US, although health outcomes may differ in African-descent populations due to differences in socioeconomic status [48] and genetic admixture [13]. The practice of grouping of all African-descent populations into the "Black/African-American" category without consideration of country of origin, masks socioeconomic and cultural differences and needs re-evaluation [49]. Recent immigrants from SSA are a growing ethnic minority population in the US with a 40-fold increase in the population between 1960 and 2007, from 35,555 to 1.4 million [11]. In spite of the increasing number of WAIs in the US, the health status of this population remains largely unexamined. This population also remains inadequately integrated into public health programs and policies. This dearth of data is problematic because CVD is a leading cause of morbidity and mortality in this population, likely due to the "epidemiological transition" [50]. Sub-Saharan African countries including Ghana and Nigeria are facing significant challenges with managing the burden of CVD risk factors and associated complications [6, 8].

However, comparative studies of African-descent populations residing in developed regions such as Europe have shown a higher prevalence of CVD risk factors than their counterparts residing in Sub-Saharan Africa [51–53]. Furthermore, direct WAIs in Europe are disproportionately affected by CVD than other African descent populations migrated via the Caribbean [54]. In light of the growing population of African immigrants in the US, and their evolving health profiles resulting from the epidemiological transition, the paradigm on CVD disparities must progress to reflect the diversity of the African-descent population in the US [55].

Ancestry interacts with environment to contribute to CVD risk. For example, studies of populations of West-African origin (West Africa, Caribbean and US) show a gradient of CVD risk with the lowest and highest levels observed in West Africa and the US, respectively [53, 56, 57]. The Ni-Hon-San Study, which compared CVD rates and risk factors in a relatively homogeneous sample of Japanese men living in Japan, Hawaii, and California, showed that coronary heart disease and stroke mortality rates in Hawaii were intermediate between rates in Japan and California and gradients in cardiovascular risk factors were similar to the gradients in disease rates [58]. The lines of evidence presented above demonstrate that migration to industrialized regions and environmental context may contribute to CVD.

Additionally, considerable heterogeneity is observed in immigrant populations in the US. For instance, the Hispanic Community Health Study/Study of Latinos HCHS/SOL [59], a multicenter, prospective, population-based study of 16,000 adults of Cuban, Dominican, Mexican, Puerto Rican, Central American and South American backgrounds, revealed a variation in CVD risk factors by country of origin, with higher CVD risk observed among participants with Puerto Rican background, lower SES, and higher levels of acculturation. Likewise, the African immigrant population is not homogenous. Addressing the health of African immigrants poses significant challenges due to the heterogeneity of cultures, socio-economic status and effects of acculturation. In order to appropriately disentangle the complex relationships between the diverse risk factors, a relatively homogenous population must be studied using a highly standardized approach. The Afro-Cardiac study has addressed this research challenge by purposively recruiting Ghanaians and Nigerians, two of the largest WAI populations in the US, instead of studying the African immigrant population in the US as a homogenous population.

To date, there have been no large-scale epidemiological studies exploring the prevalence of CVD risk and the association with acculturation in WAIs residing in the US. Hence, the Afro-Cardiac study was designed to address the significant gaps in literature among WAIs in the US and obtain preliminary data on the prevalence of CVD risk factors and the association between acculturation and CVD risk. Similar to other immigrant groups, WAIs are exposed to different socioeconomic conditions, diets, health systems and policies, and cultural traditions, which may increase their CVD [20–22, 60]. Migration has important implications for health and the World Health Organization Global Consultation on Migrant Health [61] has called for an improvement of health systems in industrialized countries to address the health needs of immigrants. The Afro-Cardiac study is consistent with this call, by addressing CVD risk in immigrants from a low-resource, developing region (West Africa) to an industrialized Western nation (US).

The migration of WAI to the US provides a unique opportunity to improve our understanding of the health of African-Americans who derive their African ancestry from Africans that were brought to the US from West Africa [13]. The Afro-Cardiac study provides a foundation for future epidemiological studies addressing CVD risk and acculturation among African immigrants in the US and should provide critical data for understanding the health of recent WAI in the US.

Acknowledgments This study was supported by pilot funding from National Institute of Nursing Research (NINR) [1P30NR011409]. We would like to acknowledge all the research assistants (Felicia Sam, Grace Onayiga, Kojo Amoakwah, Audrey Addaquay-Corey, Selase Agudu-Morgan, Loretta Odro and Jonathan Aboagye) who participated in data collection as well as the leaders of the community-based organized organizations that allowed data collection to occur on their premises. Finally, we thank the study participants who dedicated their time to advance our understanding of CVD risk among WAIs.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest to disclose.

Ethics The Johns Hopkins Medicine Institutional Review Board provided ethics approval.

Informed Consent All subjects provided written informed consent before being enrolled in the study.

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