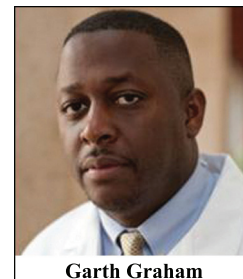


Disparities in Cardiovascular Disease Risk in the United States

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Abstract: This is a comprehensive narrative review of the literature on the current science and evidence of population-level differences in risk factors for heart disease among different racial and ethnic population in the United States (U.S.). It begins by discussing the importance of population-level risk assessment of heart disease in light of the growth rate of specific minority populations in the U.S. It describes the population-level dynamics for racial and ethnic minorities: a higher overall prevalence of risk factors for coronary artery disease that are unrecognized and therefore not treated, which increases their likelihood of experiencing adverse outcome and, therefore, potentially higher morbidity and mortality. It discusses the rate of Acute Coronary Syndrome (ACS) in minority communities. Minority patients with ACS are at greater risk of myocardial infarction (MI), rehospitalization, and death from ACS. They also are less likely than non-minority patients to receive potentially beneficial treatments such as angiography or percutaneous coronary intervention. This paper looks at the data surrounding the increased rate of heart disease in racial and ethnic minorities, where the risk is related to the prevalence of comorbidities with hypertension or diabetes mellitus, which, in combination with environmental factors, may largely explain CHF disparity. The conclusion is that it is essential that healthcare providers understand these various communities, including nuances in disease presentation, risk factors, and treatment among different racial and ethnic groups. Awareness of these communities' attributes, as well as differences in incidence, risk factor burdens, prognosis and treatment are necessary to mitigate racial and ethnic disparities in heart disease.



Keywords: Acute coronary, syndrome heart disease, health disparities, hypertension,

INTRODUCTION

A large body of literature has come together to form a vision of a different future for cardiovascular risk in the U.S. Ongoing shifts in population demographics, combined with growing, well-established health disparities have changed the dynamics of population-level cardiovascular risk in the U.S. In the next 35 years, it is predicted that non-Hispanic whites will no longer comprise the majority of the U.S. population, due to increased numbers of Hispanics and Asians [1]. There are well-established disparities in cardiovascular health outcomes between minority and non-minority group across the U.S. Understanding varied risk factor profiles, and how to treat a changing population, are critical to achieving continued improvements in care. Such efforts will be key to eliminating racial and ethnic disparities in health – and essential to improving population-level cardiovascular care. For researchers and clinicians undertaking such improvements in care, this review may help to focus efforts on areas in which disparities in risk are greatest or most urgent. Additionally, this review may provide policymakers with an entry point for investigating more impactful approaches to addressing population-level disparities through better informed policy and funding decisions.

UNDERSTANDING HEALTH DISPARITIES IN CARDIOVASCULAR CARE

The Institute of Medicine defines health disparities as “differences in the quality of health care that are not due to access-related factors or clinical needs, preferences, and appropriateness of interventions [2]”. Health disparities in the U.S. exist by ethnicity, race, geography and socioeconomic status. The overall cost of these disparities in the U.S. has been estimated at around 1.24 Trillion U.S. Dollars (Table 1). The U.S. Office of Management and Budget has classified minority groups in the U.S. as African American, Asian American and Pacific Islander, Native American, White, and Hispanic. Patient, provider and system-related factors all contribute to racial and ethnic health disparities. At the patient level, individual behaviors (including diet and exercise) and potentially genetic factors may contribute to health disparities. At the provider level, factors can include unintentional bias, and varying sensitivity to the needs and differences of patients from various backgrounds. At the health systems level specific factors can include access to care, insurance coverage, cultural competency and the kinds of infrastructure required to address the needs of diverse patients. It has been noted that some of these health systems disparities persist after controlling for both socioeconomic and clinical variables [3].

Unfortunately, there may not be adequate recognition of the issue among doctors: a large majority of physicians are unlikely to recognize disparities in their own hospital setting

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Table 1. Economic burden of health disparities in the United States.

	Impact
Combined costs of health inequalities and premature death	\$1.24 trillion (USD)
Potential reduction in the indirect costs associated with illness and premature death if minority health inequalities were eliminated	\$1 trillion (USD)
Potential reduction in direct medical care expenditures if minority health disparities were eliminated	\$229.4 billion (USD)
Percent excess direct medical care expenditures for African Americans, Asians, and Hispanics that were due to health inequalities	30.6%

Source: LaViest T, Gaskin D, and Richard P; *The Economic Burden of Health Inequalities in the United States*, 2009. Findings of a Commissioned Report from the Joint Center for Political and Economic Studies.

or within their own practices [4]. Physicians are more likely to attribute disparity to patient-level or system-level deficiencies than to problems at the provider level. Awareness of potential disparities among clinicians is particularly important because there is a clustering of risk factors that is apparent in minority populations with coronary artery disease [5-7]. Systematically identifying and treating modifiable CVD risk factors is critical to patients in these populations (Table 2). As noted by Kurian and Cardarelli, “Better understanding and awareness of the disparities of CVD risk factors by race and ethnicity may help clinicians and public health professionals develop culturally sensitive interventions, prevention programs, and services specifically targeted toward risk burdens in each of these populations [8]”. This review will look at identifying the varied cardiovascular risk profile among African Americans, Hispanic and Asian Americans in the U.S. By identifying these differences they may be better identified and treated and lead to the reduction of health disparities.

CARDIOVASCULAR DISEASE RISK IN AFRICAN AMERICAN COMMUNITIES

Disproportionate rates of cardiovascular disease (CVD) are seen in the U.S. African American population. African American subgroups have a greater burden of myocardial infarction, heart failure, stroke, and other cardiovascular events [9]. On a population level there is a higher overall prevalence of risk factors that are unrecognized and therefore not treated, which places these individuals at a greater likelihood of experiencing adverse outcomes and therefore potentially higher morbidity and mortality [8, 10]. Among the various minority population groups, African American men have the highest overall death rate from cardiovascular disease [10-12]. This extends to African American females, whose death rates from CVD are higher than those of white females [11]. Equally as concerning is the fact that deaths also occur much earlier in African Americans compared to whites [12].

African American adults have among the highest rates of hypertension in the world [8, 10, 13]. They and Mexican Americans tend to have higher blood pressure and exhibit lower levels of blood pressure control than whites in the U.S., even after consideration of modifiable health behaviors, suggesting that other racial/ethnic differences underlie these disparities [14].

Studies assessing unique characteristics of high blood pressure in African Americans have found that aldosterone correlates significantly with several CVD risk factors associated with obesity-related high blood pressure in this population [15]. Aside from being an independent marker for heart disease morbidity and mortality [16], N-terminal prohormone brain-type natriuretic peptide (NT-proBNP) has been shown to be an independent biomarker for predicting events related to heart disease, including heart failure and overall mortality, in African Americans with kidney disease and high blood pressure [17]. BNP is not just a predictor of heart failure: of patients admitted to the hospital with heart failure, African American patients have higher BNP levels compared with whites and Hispanics [18]. The pathologic developments accompanying risk factor aggregation contributes to a higher burden of disease among African American men and women. Unfortunately, despite having a higher risk burden, African American men and women are less likely to receive adequate treatment or achieve adequate control of these risk factors, including obesity or hypertension [6].

African American patients are more likely to have symptoms and functional impairment from ACS [19]. A significantly higher prevalence of CHD has been identified in elderly African American women [20]. Presentation of symptoms can vary as well. In a study of women with CHD, nearly all minority participants reported a higher sense of fatigue and sleep disturbance as prodromal symptoms; yet fewer than 50% reported prodromal chest pain or discomfort [21]. The most commonly identified acute symptom was shortness of breath, with minority women reporting significantly more acute symptoms than white women. In another study of women, African Americans demonstrated the highest risk burden, whereas Hispanic and Alaska Native participants showed the least CVD [22]. Individual and community characteristics explained some racial/ethnic disparities, but other disparities persisted even after controlling for these factors [22]. Differences exist between the sexes in minority populations, too: men are more likely to be hospitalized for heart disease and acute MI, while women are more likely to be admitted for congestive heart failure and stroke [10].

The death rate from ACS is 30% higher among African Americans than in non-Hispanic whites [5]. Patients from racial/ethnic minority groups are generally younger, have another comorbidity (e.g., hypertension, diabetes, obesity),

Table 2. Disease risk and risk factors for different ethnic and racial groups.

	Black/African American	Asian American/Pacific Islander	Non-White Hispanic
Disease Impact	<ul style="list-style-type: none"> • 30% more likely to die from heart disease • Twice as likely to have a stroke • Higher rate of MI • Higher rate of heart failure • Higher functional impairment from ACS • Higher death rate from ACS 	<ul style="list-style-type: none"> • Coronary artery disease occurs earlier in life and in a higher percentage of the population in Asian Indians than in other ethnic groups 	<ul style="list-style-type: none"> • Lower rates of overall CVD • Puerto Rican Americans have the highest HTN related death rates of all Hispanic subgroups. • Rate of heart failure for Hispanics is lower than for African Americans, but higher than for non-Hispanic whites
Risk Factors	<ul style="list-style-type: none"> • 40% more likely to have high blood pressure • 10% less likely than their white counterparts to have their blood pressure under control. • Twice as likely to be diagnosed with Diabetes • Higher rate of PVD • Higher rate of Obesity 	<ul style="list-style-type: none"> • Lipoprotein levels are higher in Indians than any other ethnic group • South Asians have more nontraditional CVD risk factors, including differences in inflammatory markers as well as insulin resistance • South Asians were less likely to undergo systematic screening than white males • Korean Americans, Vietnamese Americans and Filipino American males have some of the highest smoking rates 	<ul style="list-style-type: none"> • Awareness that heart disease is the leading cause of death was lowest for Latino women • Mexican Americans have a higher prevalence of HTN • Higher BMI and waist circumference among Mexican Americans • Mexican Americans and Puerto Ricans have twice the rate of DM compared to non-Hispanic whites • Higher rate of triglycerides • Lower rates of CAC • Mexican Americans have the highest rate of age-adjusted prevalence of metabolic syndrome compared to other race/ethnic groups
What to Do	<ul style="list-style-type: none"> • Improved awareness and better HTN control • Increased awareness of stroke symptoms • Improved access to appropriate intervention. • Tailored drug treatment for heart failure 	<ul style="list-style-type: none"> • Earlier screening for heart disease • Emerging factors such as genetic polymorphism and dysfunctional high-density lipoprotein (HDL) in assessing risk factors 	<ul style="list-style-type: none"> • Increased awareness around risk factors • Improved targeted strategies around diabetes control

and are more likely to be women [5, 7, 23]. Minority patients with ACS are at greater risk of myocardial infarction (MI), rehospitalization as well as death from ACS and are less likely to receive potentially beneficial treatments such as angiography or percutaneous coronary intervention than non-minority patients [9]. Population-level data showed that among African American, Hispanic and Asian patients who underwent percutaneous coronary intervention, only African Americans had a significant reduction in event-free survival 2-years post-procedure [24]. It is also noted that African Americans with acute MI are younger and are less likely to receive evidenced-based treatments [9]. The decreased likelihood of undergoing appropriate treatment, compounded by decreased access to care, may exacerbate disparities in acute MI care [25].

African Americans are at a significantly higher risk of suffering from heart failure compared with other ethnic groups [26]. Among CHF patients, African Americans were least affected by interim MI, while Hispanic and white participants were most affected by left ventricular mass increase [26] Risk was related to the prevalence of comorbidities with hypertension or diabetes mellitus, which, in combination with environmental factors may largely explain CHF dispar-

ity. Adjustment for interim infarction accentuates ethnic differences in the incidence of CHF between African Americans and whites. Differential use of coronary revascularization may contribute to the poorer functional outcomes observed among African American patients with documented coronary disease and heart failure [19].

In one study of largely African Americans with heart failure or left ventricular hypertrophy, those with heart failure shared many abnormalities of systolic, diastolic, and vascular functions with non-failing left ventricular hypertrophy patients, but had accentuated left ventricular hypertrophy and left atrial dilation or failure. The emergence of data from studies such as A-HeFT indicates that differences in pharmacology may require tailored drug treatment strategies for people with heart failure of different racial/ethnic backgrounds [27]. Drugs like isosorbide dinitrate and hydralazine hydrochloride (FDC I/H) significantly decreased the risk of all-cause death and first hospitalization for heart failure, and improved quality of life leading to the approval of the first drug tailored for specific racial/ethnic populations [28]. African American patients with heart failure who were taking FDC I/H and neurohormonal blockers showed significantly reduced mortality and improvement in event-free survival

and hospitalization [28]. These factors may help to clarify pathophysiology and better define the African American heart failure population [29].

African Americans have the highest incidence of stroke among groups in the U.S.; their strokes tend to be more severe with a higher morbidity and resulting in higher mortality [30]. Similar to ACS, African Americans tend to be younger at the time of the first stroke event. Although the overall incidence of stroke in the U.S. appeared to go down in 2010, the change was the result of a decrease in ischemic stroke in whites only; African Americans remained unchanged [31].

The high risk factor burden has been implicated as a factor in the higher stroke incidence, particularly the presence of hypertension or diabetes, and especially for African Americans [9, 31]. In one study, African Americans had a higher prevalence of five risk factors independently associated with stroke (treated diabetes, hypertension, peripheral vascular disease, higher C-reactive protein, and inactivity) whereas whites had a higher prevalence of three risk factors (older age, prior MI, and lower high-density lipoprotein cholesterol) [32].

Awareness of stroke symptoms is suboptimal among minority women, even though they are at higher risk than non-minority women [33]. One study noted that African Americans with hypertension may have been more aware of their disease status compared to whites, but were less likely to be adequately treated and subsequently have their disease under control [34]. This may contribute significantly to the higher incidence of stroke in African Americans, and should represent a treatment priority in terms of population management.

CARDIOVASCULAR DISEASE RISK IN HISPANIC COMMUNITIES

Unique among minority groups are Hispanic subpopulations, which are linked not just by geographic origin but also by common linguistics, with ancestry related to Spanish-speaking nations from Europe, Central, South America and the Caribbean. Hence subgroup analysis, such as comparing Mexican American with Puerto-Rican American, may be particularly valid for understanding health outcomes. Hispanics have been reported to have higher rates of CVD risk factors, yet demonstrate lower rates of CHD and total CVD [10, 35, 36]. A difference in risk factors and either prevalence of CVD or subclinical disease have also been seen in Mexican Americans, though their risk profiles were unique compared to individuals of other Hispanic backgrounds, indicating that it is important to delineate Hispanic subgroups [37].

Elevated Body Mass Index (BMI), ranging from obesity to being overweight, has a negative impact on all ages, racial and ethnic groups, and sexes [8, 11]. Diet and exercise, as evidenced by caloric management through proper nutrition as well as the recommended physical activity, also appears to be universally important to health. BMI and waist circumference are inversely associated with fitness, with low fitness most significant in African Americans and Mexican Americans [8, 38]. For more clearly defined population-level risk factors, the data around obesity remains among the most

compelling, with very high rates seen in the U.S., particularly among Hispanic American subgroups, including Mexican Americans. Up to 75 percent of Mexican American men and 72 percent of Mexican American women are obese or overweight.

When looking at risk factors such as diabetes, the prevalence of diagnosed diabetes in subgroups such as Mexican-Americans and Puerto Ricans was over twice that of non-Hispanic whites [39]. Outside of the environmental impact of lifestyle and behavior on the incidence and prevalence of diabetes in U.S. Hispanics, data from 42 extended Mexican American families in San Antonio, Texas, showed that genes accounted for 30% to 45% of the phenotypic prevalence of diabetes. In fact, genes accounted for 15% to 30% of the phenotypic variation in measures of glucose, high blood pressure and adiposity [2]. Part of this was due to the unique admixture of U.S. Hispanic populations where a higher degree of Native American admixture served as a significant ingredient in the higher rates of type 2 diabetes, with a partial contribution of Spanish admixture to diabetes susceptibility among Mexico-originating populations.

Tremendous geographic variation in diabetes manifestation is seen between these populations in the Southeastern and Southwestern U.S., respectively. Yet no differences among racial/ethnic minority populations were consistently found for many traditional risk factors [8]. Certain patterns in dyslipidemia have been noted among Hispanic populations, with Hispanics overall having higher triglyceride levels and lower levels of high-density lipoprotein (HDL) [37]. There are subgroup differences, with Mexican Americans displaying dyslipidemia patterns seen in diabetics with more elevated small, dense low-density lipoprotein particles [40]. In looking at other non-traditional risk factors, some data suggest that coronary artery calcium is present in lesser amounts in Hispanics compared to Whites [41, 42]. The exact impact of this difference in coronary calcium is not well known.

In looking at high blood pressure, subgroups such as Mexican Americans continue to have a higher prevalence of hypertension and pre-hypertension than non-Hispanic whites. Puerto Rican Americans had the highest hypertension-related death rates compared to the other Hispanic subgroups, while those of Cuban heritage had the lowest overall hypertension-related death rates. An increase in CVD risk factors, specifically hypertension, between first- and second-generation Mexican Americans suggests that acculturation in terms of diet and lifestyle changes are negatively affecting CVD health in this population [43]. In a study of hospitalized hypertension patients with diabetes, Hispanics had higher odds of rehospitalization than whites and other ethnic groups 1 year (but not 30 days) following admission, and this effect was not explained by the type of antihypertensive medication prescribed [44].

There is a lack of data in terms of large studies on heart failure as it relates to U.S. Hispanic populations. Still, it is believed that the rate of heart failure for Hispanics is lower than for African Americans, but higher than for non-Hispanic whites [35, 45]. Interestingly, Hispanic heart failure patients with preserved ejection fraction had better

in-hospital survival than non-Hispanic whites with preserved ejection fraction, yet inpatient mortality was similar between groups with reduced ejection fraction [46]. The etiology of heart failure is related not just to hypertension and coronary artery disease: there is also data to show that metabolic syndrome and insulin resistance play a more significant role in the pathogenesis of heart failure in U.S. Hispanics. Mexican Americans have the highest rate of age-adjusted prevalence of metabolic syndrome compared to other race/ethnic groups [47]. Metabolic syndrome has been linked to higher left ventricular mass and dysfunction, independent of blood pressure or underlying coronary artery disease [48]. This may in part explain the differential prevalence and presentation of heart failure among Hispanics.

Looking at population-level data, Hispanics in the U.S. undergoing coronary artery bypass graft surgery are generally younger, more likely to be women, and maintaining a lower BMI [23, 49]. Among Hispanics with acute MI who were enrolled in the American Heart Association's *Get With The Guidelines-CAD* program, males were predominant in all regions, and Midwestern Hispanics were more likely to be younger. Northeastern Hispanics were more often insured by Medicaid. All regional subgroups showed high rates of hypertension, dyslipidemia, diabetes, and smoking, with the highest rates observed in the northeast region [50]. One study concludes that some easily measured characteristics can be used to make decisions about allocating resources to case management of Hispanics with heart disease [51]. Such case management strategies might emphasize patient education, provider education, decision support, self-management and in-person care management. These strategies should be considered to reduce disparities in ACS this population.

CVD RISK IN ASIAN AMERICAN COMMUNITIES

There is limited data available on CVD risk factors for Asian American subgroups, but traditional CVD risk factors in Asian Americans have similarities to whites in some instances [52, 53]. Judging by available data, the prevalence of CVD risk factors appears to vary greatly across the Asian subgroups, which could affect risk assessment [53]. For example, it's been noted that South Asians may exhibit more nontraditional CVD risk factors, including differences in inflammatory markers as well as insulin resistance [54]. This is noted as well in other populations where markers such as levels of C-reactive protein (CRP) vary among racial and ethnic groups. However, despite the ongoing discussions regarding the clinical impact of CRP, the meaning behind these differences and how to manage them remain ill defined [48, 55].

Across all minority populations there have been differences in access to screening programs for heart disease; for example, women and South Asians were less likely to undergo systematic screening than white males [56]. It has been challenging to appropriately estimate risk in a variety of Asian American subgroups due to the lack of data and systematic studies. Unfortunately, traditional risk-assessment tools may not be entirely effective: for example, Framingham Risk has been demonstrated to systematically overestimate the risk of coronary artery disease in subgroups like Japanese Americans [57]. By contrast, one study of

4497 South Asians has suggested adding 10 years to the age of South Asian people was the simplest way of calculating coronary heart disease risk using paper-based methods [58]. Given the overall challenges with traditional risk factors and risk factor tools in appropriately estimating risk, there may be a role for emerging factors such as genetic polymorphism and dysfunctional high-density lipoprotein (HDL) in assessing risk factors.

One traditional risk factor is particularly high in some Asian subgroups: Smoking. Data from the California Health Interview Survey (CHIS) has provided the most complete picture of smoking prevalence estimates for Asian Americans and Asian-American subgroups [59]. Korean Americans, Vietnamese Americans and Filipino American males have some of the highest smoking rates, indicating the importance of having targeted interventions to address this cardiovascular risk factor for these subpopulations.

ACS affects a considerably larger proportion of South Asians than individuals from other Asian backgrounds [60]. Significant differences have been noted in the overall risk factor dynamic of South Asians compared to non-South Asians who have suffered from acute MI compared to other races/ethnicities. Yet, despite this higher incidence of ACS in the South Asian population, the in-hospital case-fatality rate from actual myocardial infarctions is not significantly different across groups [60]. It is also very important to look for non-traditional symptoms in certain Asian populations – including Chinese, South Asian, and Southeast Asian patients – who have been shown to be less likely to exhibit classic symptoms of acute MI [61]. Southeast Asians also suffer from significant delays in recognizing symptoms and appropriate treatment: 30% of this minority group waited longer than 12 hours to seek treatment, whereas non-minorities were more likely to undergo treatment within 3 hours of onset [61]. After receipt of revascularization South Asians have been shown to be less likely to experience long-term improvements in angina compared to whites [62].

UNDERSTANDING COMMUNITIES

Overall, minorities have an elevated risk of morbidity and mortality due to coronary artery disease [63], and have not benefited to the same extent from the general decline in deaths caused by heart disease in the U.S. over the last few decades. Population-level efforts to improve lifestyle interventions should be an important part of primary and secondary prevention strategies. Although the common wisdom may suggest that such interventions be universally applied, it must be noted that risk assessment is still a challenge in certain populations. For example, current guidelines used to identify metabolic syndrome underestimate the risk in South Asian individuals [64]. Risk algorithms at the population level will need to be continually adjusted to account for these findings so they may more effectively assist in mitigating these disparities.

It is essential that healthcare providers understand the nuances in disease presentation, risk factors, and treatment in different racial and ethnic groups and communities. One strategy will be essential: Cultural competency, which has been defined as the ability “to provide care to patients with diverse values, beliefs, and behaviors including tailoring

delivery of care to meet patients' social, cultural, and linguistic needs" [65]. Disparities are best addressed when all aspects of genetics and environment are considered.

Additional research and research strategies in minority communities can provide an opportunity to improve health disparities in cardiovascular disease. Community-based participatory research, as well as intervention strategies that are community-generated, provide a powerful means for developing capacity at the local level. Such research can effectively evaluate not just whether a particular strategy worked, but for whom it worked and in what way. Collaborative interdisciplinary research offers a lens to see the complex interaction of the multi-faceted issues related to health disparities (e.g., personal, provider and systems level). This demands input, coordination and cooperation at a variety of levels (from communities to academia), to identify and implement successful solutions.

BEYOND THE UNITED STATES

The challenges faced by minority and other underserved communities is not unique just to the United States. In 2011 the European Society of Hypertension established a Working Group on 'Hypertension and Cardiovascular risk in low resource settings'. The Working Group looked at amongst other things the noted fact that 80% of all CVD related deaths occur in underserved communities and in these communities hypertension is the leading risk factor [66]. The stroke rate in African urban communities is 5 times higher than in England [67]. Similar to the risk factor profile seen in African American, Hispanic and other minority communities in the US, diet and exercise as well as other community related factors are known to increase the overall risk factor profile in these communities.

The solutions from the Work Group in tackling this problem on the global level are similar to what is recommended in the US. The Work Group recommended policy initiatives to improve data collection, to adapt organization of health systems to cultures, and to provide information to these communities on health problems and services. On a system level, recommendations included the identification of individuals with high-risk CVD in low and middle income communities to make cost-effective the allocation of available resources.

CONCLUSION

Decreasing health disparities must be a significant goal at the patient, provider, and system's levels [4]. Although additional research is needed to fully understand the differences in CVD risk, prevention, and treatment to improve outcomes throughout our increasingly diversified population, greater awareness on the parts of practicing physicians is essential. Better understanding of the disparities of CVD risk factors may help clinicians and public health professionals develop culturally sensitive interventions, prevention programs and services specifically targeted at risk burdens in each of these impacted populations [8]. Burgeoning populations such as Hispanics and Asians should be incorporated into future research to help us better understand their CVD presentation and optimal interventions.

Eliminating disparities will require aggressive efforts focused on risk assessment, guideline adherence, and risk-factor control in at-risk populations [6]. As Lurie and colleagues noted, "improving quality of care through the use of practice guidelines can play an important role in addressing racial and ethnic disparities the combination of increasing awareness, improving quality, and increasing patient demand for and participation in high-quality care will likely contribute to addressing this important societal health issue" [4].

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

- [1] Bureau USC. An Older and More Diverse Nation by Midcentury. 2009; <http://web.archive.org/web/20080822044429/http://www.census.gov/Press-Release/www/releases/archives/population/012496.html>. [Accessed July 18, 2011].
- [2] Mayberry R, Boone L. *Racial/Ethnic Differences in Cardiac Care: The Weight of the Evidence*. Henry J. Kaiser Family Foundation; October 2002.
- [3] Vivo RP, Krim SR, Liang L, *et al*. Short- and long-term rehospitalization and mortality for heart failure in 4 racial/ethnic populations. *J Am Heart Assoc* 2014; 3(5): e001134.
- [4] Lurie N, Fremont A, Jain AK, *et al*. Racial and ethnic disparities in care: the perspectives of cardiologists. *Circulation* 2005; 111(10): 1264-9.
- [5] Nasir K, Shaw LJ, Liu ST, *et al*. Ethnic differences in the prognostic value of coronary artery calcification for all-cause mortality. *J Am Coll Cardiol* 2007; 50(10): 953-60.
- [6] Watkins LO. Epidemiology and burden of cardiovascular disease. *Clin Cardiol* 2004; 27(6 Suppl 3): 1112-6.
- [7] Yeo K, Li Z, Amsterdam EA. Abstract 3117: Clinical Characteristics and Operative Mortality Among Whites, Hispanics, Asians and Blacks in the 2003 California Coronary Artery Bypass Graft Surgery Outcomes Reporting Program. *Circulation* 2006; 114: 11-658.
- [8] Kurian AK, Cardarelli KM. Racial and ethnic differences in cardiovascular disease risk factors: a systematic review. *Ethn Dis* 2007; 17(1): 143-52.
- [9] Bonow RO, Grant AO, Jacobs AK. The cardiovascular state of the union: confronting healthcare disparities. *Circulation* 2005; 111(10): 1205-7.
- [10] Mensah GA, Mokdad AH, Ford ES, Greenlund KJ, Croft JB. State of disparities in cardiovascular health in the United States. *Circulation* 2005; 111(10): 1233-41.
- [11] Roger VL, Go AS, Lloyd-Jones DM, *et al*. Executive Summary: Heart Disease and Stroke Statistics 2011 Update: A Report from the American Heart Association. *Circulation* 2011; 123: 459-63.
- [12] Wyatt SB, Williams DR, Calvin R, Henderson FC, Walker ER, Winters K. Racism and cardiovascular disease in African Americans. *Am J Med Sci* 2003; 325(6): 315-31.
- [13] Ong KL, Cheung BM, Man YB, Lau CP, Lam KS. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999-2004. *Hypertension* 2007; 49(1): 69-75.
- [14] Redmond N, Baer HJ, Hicks LS. Health behaviors and racial disparity in blood pressure control in the national health and nutrition examination survey. *Hypertension* 2011; 57(3): 383-9.
- [15] Kidambi S, Kotchen JM, Grim CE, *et al*. Association of adrenal steroids with hypertension and the metabolic syndrome in blacks. *Hypertension* 2007; 49(3): 704-11.
- [16] Bibbins-Domingo K, Gupta R, Na B, Wu AH, Schiller NB, Whooley MA. N-terminal fragment of the prohormone brain-type natriuretic peptide (NT-proBNP), cardiovascular events, and

- mortality in patients with stable coronary heart disease. *JAMA* 2007; 297(2): 169-76.
- [17] Astor BC, Yi S, Hiremath L, *et al.* N-terminal prohormone brain natriuretic peptide as a predictor of cardiovascular disease and mortality in blacks with hypertensive kidney disease: the African American Study of Kidney Disease and Hypertension (AASK). *Circulation* 2008; 117(13): 1685-92.
- [18] Krim SR, Vivo RP, Krim NR, *et al.* Racial/Ethnic differences in B-type natriuretic peptide levels and their association with care and outcomes among patients hospitalized with heart failure: findings from Get With The Guidelines-Heart Failure. *JACC Heart Fail* 2013; 1(4): 345-52.
- [19] Kaul P, Lytle BL, Spertus JA, DeLong ER, Peterson ED. Influence of racial disparities in procedure use on functional status outcomes among patients with coronary artery disease. *Circulation* 2005; 111(10): 1284-90.
- [20] Shaw LJ, Shaw RE, Merz CN, *et al.* Impact of ethnicity and gender differences on angiographic coronary artery disease prevalence and in-hospital mortality in the American College of Cardiology-National Cardiovascular Data Registry. *Circulation* 2008; 117(14): 1787-801.
- [21] McSweeney JC, O'Sullivan P, Cody M, *et al.* Abstract 3306: Black, Hispanic, and White Women's Symptoms of Coronary Heart Disease. *Circulation* 2006; 114: 11-702.
- [22] Finkelstein EA, Khavjou OA, Mobley LR, Haney DM, Will JC. Racial/ethnic disparities in coronary heart disease risk factors among WISEWOMAN enrollees. *J Womens Health (Larchmt)* 2004; 13(5): 503-18.
- [23] van Ryn M, Burgess D, Malat J, Griffin J. Physicians' perceptions of patients' social and behavioral characteristics and race disparities in treatment recommendations for men with coronary artery disease. *Am J Public Health* 2006; 96(2): 351-7.
- [24] Slater J, Selzer F, Dorbala S, *et al.* Ethnic differences in the presentation, treatment strategy, and outcomes of percutaneous coronary intervention (a report from the National Heart, Lung, and Blood Institute Dynamic Registry). *Am J Cardiol* 2003; 92(7): 773-8.
- [25] Popescu I, Cram P, Vaughan-Sarrazin MS. Differences in admitting hospital characteristics for black and white medicare beneficiaries with acute myocardial infarction. *Circulation* 2011; 123(23): 2710-6.
- [26] Bahrami H, Kronmal R, Bluemke DA, *et al.* Differences in the incidence of congestive heart failure by ethnicity: the multi-ethnic study of atherosclerosis. *Arch Intern Med* 2008; 168(19): 2138-45.
- [27] Franciosa JA, Taylor AL, Cohn JN, *et al.* African-American Heart Failure Trial (A-HeFT): rationale, design, and methodology. *J Card Fail* 2002; 8(3): 128-35.
- [28] Taylor AL, Ziesche S, Yancy CW, *et al.* Early and sustained benefit on event-free survival and heart failure hospitalization from fixed-dose combination of isosorbide dinitrate/hydralazine: consistency across subgroups in the African-American Heart Failure Trial. *Circulation* 2007; 115(13): 1747-53.
- [29] Melenovsky V, Borlaug BA, Rosen B, *et al.* Cardiovascular features of heart failure with preserved ejection fraction versus nonfailing hypertensive left ventricular hypertrophy in the urban Baltimore community: the role of atrial remodeling/dysfunction. *J Am Coll Cardiol* 2007; 49(2): 198-207.
- [30] Gillum R. Stroke in blacks. *Stroke* 1988; 19: 1-9.
- [31] Kleindorfer DO, Khoury J, Moomaw CJ, *et al.* Stroke incidence is decreasing in whites but not in blacks: a population-based estimate of temporal trends in stroke incidence from the Greater Cincinnati/Northern Kentucky Stroke Study. *Stroke* 2010; 41(7): 1326-31.
- [32] Bravata DM, Wells CK, Gulanski B, *et al.* Racial disparities in stroke risk factors: the impact of socioeconomic status. *Stroke* 2005; 36(7): 1507-11.
- [33] Ferris A, Robertson RM, Fabunmi R, Mosca L. American Heart Association and American Stroke Association national survey of stroke risk awareness among women. *Circulation* 2005; 111(10): 1321-6.
- [34] Howard G, Prineas R, Moy C, *et al.* Racial and geographic differences in awareness, treatment, and control of hypertension: the REasons for Geographic And Racial Differences in Stroke study. *Stroke* 2006; 37(5): 1171-8.
- [35] Mitchell BD, Stern MP, Haffner SM, Hazuda HP, Patterson JK. Risk factors for cardiovascular mortality in Mexican Americans and non-Hispanic whites. San Antonio Heart Study. *Am J Epidemiol* 1990; 131(3): 423-33.
- [36] Liao Y, Cooper RS, Cao G, Kaufman JS, Long AE, McGee DL. Mortality from coronary heart disease and cardiovascular disease among adult U.S. Hispanics: findings from the National Health Interview Survey (1986 to 1994). *J Am Coll Cardiol* 1997; 30(5): 1200-5.
- [37] Allison MA, Budoff MJ, Wong ND, Blumenthal RS, Schreiner PJ, Criqui MH. Prevalence of and risk factors for subclinical cardiovascular disease in selected US Hispanic ethnic groups: the Multi-Ethnic Study of Atherosclerosis. *Am J Epidemiol* 2008; 167(8): 962-9.
- [38] Carnethon MR, Gulati M, Greenland P. Prevalence and cardiovascular disease correlates of low cardiorespiratory fitness in adolescents and adults. *JAMA* 2005; 294(23): 2981-8.
- [39] Swenson CJ, Trepka MJ, Rewers MJ, Scarbro S, Hiatt WR, Hamman RF. Cardiovascular disease mortality in Hispanics and non-Hispanic whites. *Am J Epidemiol* 2002; 156(10): 919-28.
- [40] Haffner SM, Stern MP, Hazuda HP, Rosenthal M, Knapp JA. The role of behavioral variables and fat patterning in explaining ethnic differences in serum lipids and lipoproteins. *Am J Epidemiol* 1986; 123(5): 830-9.
- [41] Bild DE, Detrano R, Peterson D, *et al.* Ethnic differences in coronary calcification: the Multi-Ethnic Study of Atherosclerosis (MESA). *Circulation* 2005; 111(10): 1313-20.
- [42] Reaven PD, Thurmond D, Domb A, Gerkin R, Budoff MJ, Goldman S. Comparison of frequency of coronary artery calcium in healthy Hispanic versus non-Hispanic white men by electron beam computed tomography. *Am J Cardiol* 2003; 92(10): 1198-1200.
- [43] Morales LS, Leng M, Escarce JJ. Risk of cardiovascular disease in first and second generation Mexican-Americans. *J Immigr Minor Health* 2011; 13(1): 61-8.
- [44] Mochari-Greenberger H, Mosca L. Racial/Ethnic Differences in Medication Uptake and Clinical Outcomes Among Hospitalized Cardiovascular Patients With Hypertension and Diabetes. *Am J Hypertens* 2014; pii: hpu101.
- [45] Vivo RP, Krim SR, Cevik C, Witteles RM. Heart failure in Hispanics. *J Am Coll Cardiol* 2009; 53(14): 1167-75.
- [46] Vivo RP, Krim SR, Krim NR, *et al.* Care and outcomes of Hispanic patients admitted with heart failure with preserved or reduced ejection fraction: findings from get with the guidelines-heart failure. *Circ Heart Fail* 2012; 5(2): 167-75.
- [47] Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. *JAMA* 2002; 287(3): 356-9.
- [48] Ingelsson E, Arnlov J, Lind L, Sundstrom J. Metabolic syndrome and risk for heart failure in middle-aged men. *Heart* 2006; 92(10): 1409-13.
- [49] Parikh SV, Enriquez JR, Selzer F, *et al.* Abstract 916: Association of a Unique Cardiovascular Risk Profile with Outcomes in Hispanic Patients Referred for PCI: Results from the NHLBI Dynamic Registry. *Circulation* 2008; 118: S_632.
- [50] Krim SR, Vivo RP, Krim NR, *et al.* Regional differences in clinical profile, quality of care, and outcomes among Hispanic patients hospitalized with acute myocardial infarction in the Get with Guidelines-Coronary Artery Disease (GWTG-CAD) registry. *Am Heart J* 2011; 162(6): 988-995 e984.
- [51] Riegel B, Carlson B, Romero T. Abstract 2508: Designing Disease Management Programs for Hispanics with Heart Failure. *Circulation* 2006; 114: II_517-II_518.
- [52] Ueshima H, Sekikawa A, Miura K, *et al.* Cardiovascular disease and risk factors in Asia: a selected review. *Circulation* 2008; 118(25): 2702-9.
- [53] Palaniappan LP, Araneta MR, Assimes TL, *et al.* Call to action: cardiovascular disease in Asian Americans: a science advisory from the American Heart Association. *Circulation* 2010; 122(12): 1242-52.
- [54] Ajjan R, Carter AM, Somani R, Kain K, Grant PJ. Ethnic differences in cardiovascular risk factors in healthy Caucasian and South Asian individuals with the metabolic syndrome. *J Thromb Haemost* 2007; 5(4): 754-60.
- [55] Heald AH, Anderson SG, Ivison F, Laing I, Gibson JM, Cruickshank K. C-reactive protein and the insulin-like growth factor (IGF)-system in relation to risk of cardiovascular disease in different ethnic groups. *Atherosclerosis* 2003; 170(1): 79-86.

- [56] Bartys S, Baker D, Lewis P, Middleton E. Inequity in recording of risk in a local population-based screening programme for cardiovascular disease. *Eur J Cardiovasc Prev Rehabil* 2005; 12(1): 63-7.
- [57] D'Agostino RB, Sr., Grundy S, Sullivan LM, Wilson P, Group CHDRP. Validation of the Framingham coronary heart disease prediction scores: results of a multiple ethnic groups investigation. *JAMA* 2001; 286(2): 180-7.
- [58] Aarabi M, Jackson PR. Predicting coronary risk in UK South Asians: an adjustment method for Framingham-based tools. *Eur J Cardiovasc Prev Rehabil* 2005; 12(1): 46-51.
- [59] Tang H, Shimizu R, Chen MS, Jr. English language proficiency and smoking prevalence among California's Asian Americans. *Cancer* 2005; 104(12 Suppl): 2982-8.
- [60] Gupta M, Doobay AV, Singh N, *et al.* Risk factors, hospital management and outcomes after acute myocardial infarction in South Asian Canadians and matched control subjects. *CMAJ* 2002; 166(6): 717-22.
- [61] King KM, Khan NA, Quan H. Ethnic variation in acute myocardial infarction presentation and access to care. *Am J Cardiol* 2009; 103(10): 1368-73.
- [62] Zaman MJ, Crook AM, Junghans C, *et al.* Ethnic differences in long-term improvement of angina following revascularization or medical management: a comparison between south Asians and white Europeans. *J Public Health (Oxf)* 2009; 31(1): 168-74.
- [63] Chaturvedi N. Ethnic differences in cardiovascular disease. *Heart* 2003; 89(6): 681-6.
- [64] Eapen D, Kalra GL, Merchant N, Arora A, Khan BV. Metabolic syndrome and cardiovascular disease in South Asians. *Vasc Health Risk Manag* 2009; 5: 731-43.
- [65] Yancy CW, Wang TY, Ventura HO, *et al.* The coalition to reduce racial and ethnic disparities in cardiovascular disease outcomes (credo): why credo matters to cardiologists. *J Am Coll Cardiol* 2011; 57(3): 245-52.
- [66] Modesti PA, Agostoni P, Agyemang C, *et al.* Cardiovascular risk assessment in low-resource settings: a consensus document of the European Society of Hypertension Working Group on Hypertension and Cardiovascular Risk in Low Resource Settings. *J Hypertens* 2014; 32(5): 951-60.
- [67] Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; 380: 2095-128.

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