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Cardiovascular Disease in Hispanics/Latinos in the United States

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Abstract

Cardiovascular diseases (CVD) are the leading cause of mortality in the United States and Western world for all groups with one exception: CVDs are the number 2 cause of death for Hispanics/ Latinos behind cancer with overall cancer rates lower for Latinos relative to non-Hispanic Whites (NHWs). Despite a significantly worse risk factor profile marked by higher rates of traditional and non-traditional determinants, some CVD prevalence and mortality rates are significantly lower among Latinos relative NHWs. These findings support a need for greater understanding of CVDs specifically among Latinos in order to better document prevalence, appropriately model risk and resilience, and improve targeting of intervention efforts. The current aim is to provide a state-of-the-science review of CVDs amongst Latinos including a review of the epidemiological evidence, risk factor prevalence, and evaluation of the breadth and quality of the data. Questions concerning the generalizability of current risk models, the Hispanic paradox as it relates to CVDs, contributing psychosocial and sociocultural factors, and future directions are discussed.

Keywords

Hispanic/Latino; Cardiovascular disease; cardiovascular risk factors; Race/Ethnicity; Disparities

Introduction

Cardiovascular disease (CVD) accounts for 23.5% of all deaths in the United States (US) making it the nation's leading cause of mortality, a designation it has held for over a century

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with the exception of the 1918 influenza pandemic (Mozaffarian et al., 2015). Although CVD is the leading cause of death among Hispanic adults, overall rates of coronary heart disease (CHD) and overall cardiac mortality are lower compared to non-Hispanics. This increasingly robust observation combined with the significant growth of the Latino population fuels a need for greater understanding of CVD specifically among Latinos in order to appropriately model risk, identify resilience, and improve targeting of intervention efforts with broader economic and health implications for the nation as a whole.

The American Heart Association (AHA) recently issued a scientific statement highlighting the public health burden of CVD in Hispanics and calling for the development of culturally tailored interventions and the prioritizing of Latinos in the nation's heart health improvement goals (Rodriguez, Allison et al., 2014). An underlying issue in this call is the acknowledgement of an insufficient understanding of Hispanic heart health in general and specifically with respect to differences by Hispanic background. Indeed, the majority of the associated literature omits description of backgrounds of the Latino samples. Failure to disaggregate by background will likely impede progress given the heterogeneity of Hispanics, particularly in terms of demographic characteristics, sociocultural factors, diet, and health behaviors. In recognition of these issues recent large scale studies such as the Hispanic Communities Health Study-Study of Latinos (HCHS/SOL) have been initiated to examine this heterogeneity among the Hispanic/Latino population with respect to heart disease risk disease (Daviglus et al., 2012).

The current aim is to provide a concise state-of-the-science review of CVD amongst Latinos including a review of the epidemiological evidence, risk factor prevalence, and evaluation of the breadth and quality of the data. Questions concerning the generalizability of current risk models, the Hispanic paradox as it relates to CVD, contributing psychosocial and sociocultural factors, and future directions are discussed. We emphasize that the goal of reducing the disease burden necessitates complementary efforts of a variety of disciplines including medicine, psychology, public health, nursing, social work, nutrition, and others. Psychology will be particularly important with regards to understanding psychosocial, sociocultural, and behavioral factors and in developing and implementing culturally tailored interventions.

Cardiovascular Diseases among Latinos

Cardiovascular disease is an umbrella term referring to the cluster of conditions affecting the heart and circulatory system. The diseases are differentiated largely by their etiology including but not limited to arrhythmias (problems with maintaining a normal orchestrated heart rhythm) to problems of obstructed coronary arteries, to inefficient pumping or ejection of blood into the circulatory system. Cardiovascular diseases are multiply determined by genetics, behavior, and psychosocial factors as well as the presence of other diseases, early detection, and adherence to management strategies (medical, behavioral). The risk of most conditions increases with age and is greater in men. Clinically meaningful endpoints are characterized by insufficient blood flow leading to tissue death, particularly in the heart (e.g., myocardial infarction or "heart attack") and brain (stroke).

A Note on Data

Epidemiological data on CVDs largely comes from large, community cohort and population-based studies often sponsored by the National Institutes of Health (NIH) and in particular, the National Heart Lung and Blood Institute (NHLBI). A list of these studies can be found at https://www.nhlbi.nih.gov/research/resources/obesity/population/. The most renowned of these is the Framingham Heart Study which began in 1948 and has informed much of our knowledge on the prevalence, course, and outcomes of heart disease.

Of the 9 major population-based studies, only 2 directly target Hispanics. Initiated in 1999, the Multi-Ethnic Study of Atherosclerosis (MESA: Bild et al., 2002) is a multi-site investigation looking at the prevalence and progression of atherosclerosis in an ethnically diverse sample of 6,800 men and women. The initial sampling included 22% Hispanic (n=1496) as well as 28% non-Hispanic black (NHB), 12% Chinese, and 39% NHW. The second study is the Hispanic Community Health Study/Study of Latinos (HCHS/SOL: Daviglus et al., 2012), casually referred to as the Latino Framingham given its landmark status and focus exclusively on Hispanics. Initially funded in 2006 and again in 2013 to allow for a follow up exam, this multisite epidemiological study examines CVD prevalence among 16,400 Hispanics representing 7 Hispanic origin groupings: Central American, Cubans, Dominicans, Mexicans, Puerto Ricans, and South Americans. The HCHS/SOL study has the potential to speak to heterogeneity in CVD risk, course, and outcomes between Hispanics of different backgrounds. More information and a list of publications stemming from this investigation can be found at https://www2.cscc.unc.edu/hchs/. Although the MESA Hispanic sample is relatively small and the HCHS/SOL study is quite new with limited publication impact at this time, both studies will likely have a significant impact on our knowledge of CVD in Latinos in the future.

Given the relative limitations in the population-based studies, much of the current knowledge of Latinos and CVD comes from smaller cohort studies. Examples include several longitudinal investigations including the San Antonio Heart Study (Stern, Pugh, Gaskill, & Hazuda, 1982) comparing Mexican-Americans and NHWs, the Northern Manhattan Study (NOMAS: Sacco et al., 2001) which includes a sample of Caribbean Hispanics (i.e., Cuban, Puerto Rican, Dominican), the Study of Women Across the Nation (SWAN: Sowers et al., 2000) which includes multiple ethnic groups along with Central American, Mexican, and Caribbean Hispanics. These and other studies have been valuable in providing basic prevalence evidence in the context of more focused investigations. In the next section we review the epidemiological data for the major CVDs with an emphasis on Latinos.

Overall CVD Prevalence

Much of the data regarding the statistical tabulations for CVDs comes from the annual Heart Disease and Stroke Statistics updates published by the American Heart Association in the journal *Circulation.* The 2015 report indicates that approximately 85.6 million or greater than 1 in 3 adults in the US have at least 1 type of CVD (Mozaffarian et al., 2015). The age-adjusted overall CVD prevalence is lower for Hispanics (8.3%) than either NHWs or NHBs (11.1% and 10.3%, respectively). These trends documenting lower prevalence among

Hispanics have been consistently reported and contribute to an overall paradox between observed risk and prevalence which will be addressed later. Next we will describe Hispanic trends in specific forms of CVD.

Coronary Heart Disease

Coronary heart disease (CHD) is the most common form of CVD, accounting for over 370,000 deaths annually (Mozaffarian et al., 2015). Coronary heart disease is sometimes referred to as coronary artery disease (CAD) or ischemic heart disease (IHD) each of which are unique conditions but which share significant overlap in risk, etiology, and outcomes. These conditions generally inflammatory in nature and are characterized by the progressive accumulation of plaque or atherosclerosis in the walls of the coronary arteries which supply oxygen-rich blood to the heart tissue (myocardium). As the disease progresses, these arteries become increasingly narrowed, compromising the system's ability to meet the heart tissue's metabolic demands. When coronary blood flow becomes sufficiently compromised either through progressive narrowing or sudden obstruction due to an acute blood clot, the affected person will first experience myocardial ischemia (i.e., chest pain or angina due to insufficient oxygen to the tissue) followed by myocardial infarction (MI, heart attack) or tissue death if blood flow is not restored in time.

Estimates from the National Health and Nutrition Examination Survey (NHANES) are that 6.2% or 15.5 million US adults over the age of 20 years have CHD (Mozaffarian et al., 2015). Risk increases with age and varies by sex with the overall prevalence rate higher for men relative to women (7.6% vs. 5.0%, respectively). Most germane to this review is evidence documenting variations by race/ethnicity particularly for Hispanics/Latinos. Among men, the prevalence rate of CHD is lower for Hispanics/Latinos than for both NHBs (6.7% vs. 7.2%) and NHWs (7.8%). In contrast, NHW women have the lowest overall prevalence rate amongst these groups at 4.6% followed by Latinas at 5.9% and NHB women having the highest relative prevalence at 7.0%.

Scant evidence speaks to variations in prevalence by Hispanic background. For example, data from the HCHS/SOL showed that the overall prevalence of self-reported CHD was 4% for Hispanic men and 2% for Hispanic women. Prevalence was noted to be higher (around 5%) in Cuban and Dominican men, along with Puerto Rican men and women (Daviglus et al., 2012). Similarly, NHANES 2009–2010 data estimated the CHD prevalence among Mexican American men and women to be 7% and 5%, respectively (Mozaffarian et al., 2015).

Surveys conducted by the AHA showed that in 2012, Hispanic women were less likely to be aware of heart disease as the leading cause of death compared to NHW women (Mosca, Ferris, Fabunmi, & Robertson, 2004). According to the data from BRFSS in 2005, Hispanics (14%) were also less likely to be aware of the warning signs of a MI or heart attack when compared to NHWs (30%) and NHBs (16%) (CDC, 2008). A prospective study inclusive of Mexican Americans age 65 years revealed that the rates for hospitalization for MI among men and women were 427.4 and 606.1 per 100,000 people, respectively (Nichaman, Wear, Goff, & Labarthe, 1993). These rates were significantly higher when compared to NHW males and females (276.9 and 502.6 per 100,000, respectively).

With respect to CHD outcomes, there is an overall paucity of data on Hispanics as exemplified in the AHA statistical report (Mozaffarian et al., 2015). A few studies have investigated outcomes in limited geographic areas. For example, the age-specific prevalence of MI for Hispanic men and women in the San Antonio Heart Study was 4.0% and 2.5%, respectively, compared to 5.5% and 1.4%, respectively, for NHWs (Mitchell, Hazuda, Haffner, Patterson, & Stern, 1991). A cross-sectional study across five Southwestern states estimated the prevalence of heart attacks to be 8% for Hispanics aged 65 to 74 years and 11% for those 75 years of age (Otiniano, Du, Maldonado, Ray, & Markides, 2005). The rates for Hispanic men were 12% compared to 8% for Hispanic women (Otiniano et al., 2005). The prevalence of premature CAD (<40 years old) was lower in Hispanics (20%), compared to NHBs (30%), and NHWs (50%: Amin et al., 2009). These studies likely include predominantly Mexican-American samples and may not generalize to other Hispanic groups.

Overall, prevalence rates for CHD and risk for MI are lower for Hispanics compared to NHBs and lower for Hispanic men compared to NHW men. Among women, Latinas showed advantages over NHB women but a relative disparity in disease prevalence and MI incidence compared to NHW women. However, data also show that Hispanics are more likely to be hospitalized for MI relative to non-Hispanic whites. It is critical to note the lack of data on Hispanics with regard to evidence of disease progression and incidence of disease-specific events such as MI, chest pain (angina), and CHD-specific mortality. In addition, there is a critical lack of data on Hispanics of different backgrounds.

Heart Failure

Heart failure (HF), sometimes referred to as congestive heart failure, is a chronic and progressive condition where the heart loses its ability to sufficiently pump oxygen-rich blood into the body. Over time, this oxygen deficit leads to a broad array of symptoms including fatigue, weakness, irregular pulse including palpitations, shortness of breath regardless of activity level, cough, swelling, compromised organs due to insufficient oxygen, and death. Heart failure can result from a number of causes including but not limited to high blood pressure, MI, heart valve disease and infection of the heart tissue.

HF is the most common cause of hospitalization in persons over the age of 65 years due to its prevalence, association with age, and progressive nature (Farmakis, Stafylas, Giamouzis, Maniadakis, & Parissis, 2015). It is estimated that 5.7 million adults over age 20 have HF and that the incidence exceeds 870,000 new cases annually. Like CHD, there are significant differences in prevalence by race/ethnicity with the risk consistently greater for blacks than whites. Limited data comes from the MESA study which documented a higher HF incidence for Hispanics compared to NHW 3.5 vs. 2.4 per 1000 person-years, respectively: Bahrami et al., 2008; Vivo, Krim, Cevik, & Witteles, 2009). However, HF rates were significantly lower for Hispanics compared to NHBs (4.6 per 1000 person-years). In contrast, national statistics suggest that the prevalence of HF is lowest in in Mexican Americans, followed by non-Hispanic whites (Mozaffarian et al., 2015). More generalizable data is needed to clarify rates and guide intervention efforts.

Very limited data speak to comparative hospitalization rates for Hispanics with HF. One study of black, white, Hispanic, and Asian persons with HF living in California found a that Hispanics had a slightly lower HF hospitalization rate compared to whites and significantly lower rate than blacks (Alexander, Grumbach, Remy, Rowell, & Massie, 1999). In addition, this study found that there was no difference in adjusted rehospitalization rates between whites and Hispanics. However, Hispanics with HF had a significantly lower age-adjusted risk of death compared to whites (RR = 0.78; 95% CI: 0.75, 0.81). A similar study using Medicare provider records between 1990 and 2000 found somewhat higher HF hospitalization rates for Hispanics relative to non-Hispanic whites but relatively lower HF in-hospital mortality (Brown, Haldeman, Croft, Giles, & Mensah, 2005).

These findings should be interpreted with caution as the data is very limited, over 20 years old, largely based on estimations, does not account for factors related to access to care and omits important Hispanic demographic factors including nativity status and country of origin/background. However, they suggest that the prevalence and outcome trends for Hispanics are different from blacks and whites. Given the public health challenges HF poses and in light of the rapid increase in the US Hispanic population, more data is needed to document epidemiological trends among Hispanics and to inform targeted intervention strategies.

Peripheral Vascular Disease

The vascular system transports blood from the heart to the tissue (via arteries) and back to the heart (via veins). Peripheral artery disease or peripheral vascular disease (PAD/PVD) refers to narrowing of the arteries outside of the brain and heart, usually in the lower extremities. The pathophysiology is similar to CHD in that the underlying condition involves the progressive buildup of fatty material or atherosclerosis in the walls of the arteries which along with thrombosis leads to compromised blood flow to the tissue. Outcomes range from leg pain to and tissue death necessitating amputation. Importantly, PVD is strongly associated with CHD and is considered a significant risk factor for cardiac events including MI and mortality (Grenon et al., 2013).

Peripheral vascular disease affects approximately 8.5 million adults over age 40 years. Black-white disparities in prevalence and mortality are well documented. However, data on Hispanics is limited with much of the epidemiological data coming from the MESA study. For example, in the MESA cohort, the prevalence of an ankle-brachial index <0.9 (used to define significant PVD) was substantially lower in Hispanics (2.4%) when compared to NHBs (7.2%) and NHWs (3.6%: Allison et al., 2006). Further analysis showed that Hispanics had 51% lower odds of having PVD than NHWs after adjustment for multiple risk factors, including DM, smoking, and low SES. A second reported the prevalence of PVD to be 13.7% among Mexicans, similar to NHWs (13.5%) and less than NHBs (22.8%) in a sample of primary care clinic patients (Collins, Petersen, Suarez-Almazor, & Ashton, 2003).

With respect to treatment, evidence suggests that intervention rates are lower for Hispanics compared to NHWs. For example, a review of hospital records in New York and Florida found that although Hispanics were more likely to be admitted to the hospital with PVD they were less likely to receive surgical intervention (4 vs. 6 per 10,000 person-years,

respectively (Morrissey et al., 2007). A follow-up study in this sample found that the uninsured and Medicaid patients presented to the hospital with more severe disease and yet, were less likely to receive surgical intervention.

Although it appears that Hispanics may have lower rates of PVD and intervention, the findings should be viewed with much caution. First, the data are very limited, second, they may reflect a degree of treatment seeking delay, at least in Hispanics with PVD, and third, they may reflect differences in healthcare access which clouds utilization data such as these. More data is needed to disentangle this ambiguity in order to properly identify those at risk and address mediating factors.

Stroke

Stroke is a clinical outcome analogous to a heart attack or MI except occurring in the brain as opposed to the heart. Like PVD, stroke is a form of CVD given the shared circulatory system and associated disease pathophysiology. At a basic level, stroke is the outcome of fatty buildup or atherosclerosis in the arteries feeding oxygen-rich blood to the brain. Atherosclerosis in this region is referred to as cerebrovascular disease is a common pathogenesis of stroke. It should be noted that there are two basic categories of stroke: 1) Ischemic strokes which account for 85% of all strokes and are the result of compromised blood flow to the brain due to atherosclerosis and/or sudden blockage related to thrombosis, and 2) hemorrhagic stroke which occurs when an artery in the brain become weakened or enlarged and subsequently bursts. There are also separate disease entities so-called mini strokes or transient ischemic attacks (TIAs) which are characterized by temporary compromises in blood flow due to narrowed arteries or blockage.

An estimated 2.6% or 6.6 million US adults have a history of stroke according to the American Heart Association (Mozaffarian et al., 2015). The incidence is roughly equal by sex but significant differences by race are well documented with the risk significantly greater for blacks compared to whites. The data for Hispanics and relative stroke risk are mixed. For example, survey data from the Center for Disease Control's 2013 Behavioral Risk Factor Surveillance System (BRFSS) indicates that stroke prevalence for Hispanics is approximately 2.3% compared to 2.5% for NHWs and 4.0% for NHBs (Mozaffarian et al., 2015). However, these data rely on self-report and may be biased in light of evidence that Hispanics are less aware of stroke warning signs compared to NHWs and NHBs (Mozaffarian et al., 2015).

In contrast studies using more objective measures find a slightly elevated risk of stroke for Hispanics. For example, The Brain Attach Surveillance in Corpus Christi (BASIC) project, a community based study in Texas, showed an increased 3-year incidence of stroke among Mexican Americans compared to NHWs (16.8 vs. 13.6 per 1000) with a notably higher risk at younger (45–59, 60–74 years) but not older (75 and over) ages (Morgenstern et al., 2004). Data from NOMAS also documents elevated incidence among Dominican, Cuban, and Puerto Rican Hispanics compared to NHWs (White et al., 2005). Finally, new data from the HCHS/SOL showed that among Hispanics of different backgrounds, self-reported stroke prevalence is highest in Dominican men and Puerto Rican women (Daviglus et al., 2012).

Despite the mixed findings regarding incidence, national vital statistics data consistently show that the age-adjusted mortality due to stroke is lower for Hispanics compared to both NHWs and NHBs. For example, the most recent CDC report at the time of this paper reports that between 2010 and 2013 the age-adjusted stroke mortality rate for adult men aged 45-years and over was 91.9 per 100,000 deaths for Hispanics which is comparable to NH Asian (92.8) and lower than the rate for both NHW and NHB men (100.7 and 154.8, respectively; Ingram & Montresor-Lopez, 2015). Likewise, the rate for Latinas (81.6 per 100,000 deaths) was also comparable to NH Asian women (83.0) and lower than the rate for both NHW and NHB women (101.1 and 131.4, respectively). Moreover, the distribution of stroke deaths varies not only by race/ethnicity but by age as well. For example, approximately 77% of stroke deaths occur in persons above the age of 65 among whites but only 60% among Hispanics.

Together these findings suggest that the relative risk of stroke among Hispanics is similar or greater than for NHWs but lower than for NHBs, particularly with respect to stroke mortality. The reason for this discrepancy may be due to differences in stroke pathophysiology, age of onset, and/or care, broadly defined, during or after the event.

Overall Mortality: The Hispanic Paradox

Despite the distressingly worse CV risk profile, Hispanics experience lower all-cause and cardiovascular-specific mortality compared to NHWs. This epidemiological phenomenon first identified in the Southwest borderlands is commonly referred to as the Hispanic or Latino Mortality Paradox (Markides & Coreil, 1986). The paradox is evident in national vital statistics reports past and present (Heron, 2015; Hoyert, Kung, & Smith, 2005) which show that Hispanics have longer life expectancies than NHWs or NHBs along with lower heart disease mortality (Askim-Lovseth & Aldana, 2007; CDC, 2002). These findings are typically based upon an estimation methodology whereby the number of death certificates are divided by census counts to derive a death statistic for a particular group. In a recent investigation using this approach, Arias and colleagues (2010) found that the all-cause mortality rate for Hispanics is approximately 20% lower than that of non-Hispanics. Although various concerns regarding data accuracy have been raised, these issues don't appear to be specific to Hispanics (Arias et al., 2010) or to affect the outcomes (Abraido-Lanza et al., 1999).

In contrast to estimation approaches, longitudinal studies which assess participant ethnicity at baseline and follow the individual longitudinally to study end are less vulnerable to data fidelity concerns. Numerous longitudinal investigations involving Hispanics have produced mixed findings with regards to relative all-cause and cardiovascular-specific mortality differences. To determine an overall effect, Ruiz and colleagues (2013) conducted a systematic review and meta-analysis of the longitudinal literature yielding 58 unique studies involving 4.6 million participants of various race/ethnicities where mortality was a reported outcome (Ruiz, Steffen, & Smith, 2013). After accounting for standard covariates, the omnibus test revealed that Hispanics were 17.5% more likely to be alive at the conclusion of the longitudinal investigations compared to non-Hispanics. These findings complement the

vital statistics and estimation method findings and contribute to validating the all-cause mortality advantage.

Recent meta-analyses extend the findings of the Hispanic mortality paradox to CVD. The Ruiz et al (2013) meta-analysis included an analysis of the 11 identified longitudinal studies reporting mortality outcomes among cardiac samples. The observed odds ratio for these studies was 0.75 or a 25% mortality advantage in the context of CVD. In addition, Cortes-Bergoderi and colleagues (2013) examined the literature assessing incidence of CVD mortality in Hispanics and NHWs. Their analysis revealed a statistically significant association between Hispanic ethnicity and lower CV and all-cause mortality despite having a higher CV risk profile when compared to NHWs.

Together, these data provide compelling support for Hispanic advantages in all-cause mortality and in general cardiovascular mortality. However, there are significant knowledge gaps for specific cardiac conditions and differences by Hispanic background as well as a host of other known and potential moderators including but not limited to SES, acculturation, urban vs. rural settings, neighborhood environment, and region of the country. Prospective data from HCHS/SOL may inform many of these issues in time.

Summary

Caution must be stressed in how these findings are translated to clinical care of the Hispanic population. First, advantageous prevalence data and outcomes should not deter screening or treatment. Although the findings support a relative mortality advantage, significant proportions of Hispanics are at risk and must be identified and properly managed. Second, the mortality paradox is a broad epidemiologic phenomena with the associated data currently insufficient to conclude whether it pertains to all Hispanic groups or all types of cardiovascular disease (stroke, heart failure, coronary heart disease) equally. These points have not yet been investigated fully and limitations must be acknowledged. Third, relative advantages in prevalence and mortality are not analogous to a disease course advantages at the individual level for those affected. Again, screening, risk factor reduction, and efforts to optimize management should be the goals for Hispanics as they are for all populations.

In the next section we examine the risk factor evidence and discuss possible reasons for the seemingly paradoxical relationship between risk and disease incidence and outcomes.

Traditional CVD Risk Factors in Hispanics

Cardiovascular disease risk is multiply determined by a cluster of non-modifiable and modifiable risk factors. Identification of these factors largely comes from the Framingham Heart Study (Wilson et al., 1998). Risk factors can be divided into non-modifiable factors including Age, sex, and family history as well as modifiable factors. Modifiable factors are so named as they can be altered through behavior including behavior change (e.g., smoking, diet, exercise) or behavioral adherence to medical treatment (e.g., taking medication as prescribed, attending medical appointments). Key modifiable risk factors are total cholesterol and HDL cholesterol, body mass index (BMI), management of high blood pressure and diabetes and smoking status. Health behaviors and health promotion among Latinos is discussed elsewhere in this special issue (see Arellano et al., 2016). Therefore we

will only briefly review these factors and focus our attention on cholesterol, disease management, and smoking.

Body Mass and Physical Activity

Body mass index (BMI) is a key metric for determining both obesity and CVD risk (McGee, 2005). Briefly, BMI is an estimation of body fat based on height and weight. Recent data from NHANES 2007–2010 estimated that 81.3% and 78.2% of adult Mexican American men and women respectively, were either overweight or obese. These prevalence rates were higher for Mexican American men and women than NHWs and NHBs, except for NHB women whose obesity rates were generally comparable to Mexican American women (CDC, 2010). Similar results were demonstrated from the HCHS/SOL data where the overall percentage of being overweight but not obese (defined as a BMI 25–30 kg/m2) was 41% in men and 34% in women (Kaplan, Aviles-Santa et al., 2014). The overall percentage of participants who were obese (BMI >30 kg/m2) was 37% in men and 43% in women. With respect to Hispanic subgroups, obesity prevalence was highest in both Puerto Rican men and women at 41% and 51%, respectively. Both South American men and women had the lowest prevalence of obesity at 27% and 31%, respectively (Daviglus et al., 2012).

Physical activity along with diet are key determinants of BMI. National physical activity guidelines for adults designated that adults should engage in at least 150 minutes of physical activity per week (Mozaffarian et al., 2015). Data from the NHIS showed that in 2012, only 15.7% of Hispanics adults age 18 years met the national guidelines for physical activity and Hispanic adults (39.8%) were more likely to be physically inactive that NHW adults (26.2%). Self-reported physical activity in the NHIS did vary among the Hispanic subgroups. For example, Cubans and Dominicans report less leisure-time physical activity than do Mexicans and Central/South Americans (Neighbors, Marquez, & Marcus, 2008).

Importantly, these prior studies did not account for the physical activity that occurs during normal working hours or for transportation-related physical activity. Occupational physical activity may be more important among Hispanics since many more work in blue-collar versus white-collar jobs, which tend to be more physically demanding (CDC, 2011). More work needs to be done in this area to ascertain a better estimate of broad physical activity as opposed to leisure time exercise exclusively.

Smoking

Hispanics smoking rates are strikingly low. The CDC (2012) reports that the national average prevalence of smoking in 2012 was 19.0% for adults 18 years and older with similar rates for both NHW and blacks (20.6% and 19.4%, respectively). In contrast, smoking prevalence among Hispanics was 12.9% with prevalence highest among Puerto Rican and Cuban men (35% and 31%) and women (33% and 22%); lowest among Dominican men (11%) and women (12%: Daviglus et al., 2012; Kaplan, Bangdiwala et al., 2014).

There are critical racial/ethnic differences among smokers with Hispanics smoking fewer days per week, smoking fewer cigarettes per day, and having lower levels of continine (a nicotine biomarker) when number of cigarettes are held constant suggesting a difference in nicotine absorption perhaps from differences in inhalation (Caraballo et al., 1998;

SAMHSA, 2006; Trinidad et al., 2009). Finally, the estimated lung-cancer risk per cigarette is lowest for Hispanics relative to other racial/ethnic groups (Haiman et al., 2006). These stark differences in a key behavioral risk factor have led to significant interest in its role in the observed paradoxical disease risk.

Although these rates are relatively positive, two notes of caution should be considered. First, higher acculturation to US culture as well as being born in the US are associated with higher smoking prevalence after adjustment for demographics, SES and health insurance status (Kaplan, Bangdiwala et al., 2014). Second, Hispanic smokers are half as likely as NHW smokers to be advised on or offered assistance with smoking cessation (National Alliance for Hispanic Health, 2003). These findings remind us that not only does risk remain but that disparities exist within advantageous findings.

Cholesterol

Hypercholesterolemia or "high cholesterol" is a well-known risk factor for CVD (Mozaffarian et al., 2015). Current recommendations are for a total cholesterol level of <200mg/dL, high-density lipoprotein (HDL), sometimes referred to as "good cholesterol" of >50mg/dL, and low-density liproprotein (LDL) cholesterol 130 mg/dL denote CV risk. In age-adjusted National Health and Nutrition Examination Survey (NHANES) data from 2007–2010, Mexican American men were more likely to have higher levels of total and LDL cholesterol than NHW and NHB men. Both Mexican American men and women had a higher prevalence of low HDL cholesterol levels (<50mg/dL) when compared to NHW and NHB counterparts. In NHANES, the average LDL cholesterol levels among men and women in the US were 141.7 and 119.1 mg/dL respectively, whereas among Mexican American men and women the average LDL cholesterol levels were significantly higher at 161.4 and 134.1 mg/dL respectively (Rodriguez, Allison et al., 2014).

In HCHS/SOL, over half of Hispanic men and over a third of Hispanic women had evidence of hypercholesterolemia and/or dyslipidemia (i.e. an abnormal lipid profile: (Daviglus et al., 2012). Among Hispanic/Latino subgroups in this cohort, the prevalence of having any abnormal cholesterol component (defined as either high total cholesterol, high LDL, high triglycerides, or low HDL) was highest among Central Americans and Cubans, and lowest among Dominicans (Rodriguez et al., 2014). Specifically, elevated LDL cholesterol levels were highest among Cubans, while high triglycerides were highest among Central Americans. Low HDL levels were highest among Puerto Ricans. According to HCHS/SOL, less than half of Hispanics with high cholesterol were aware of their condition; less than a third of Hispanics with high cholesterol were being treated; and among those receiving treatment, less than two-thirds had cholesterol concentrations that were adequately controlled. Younger Hispanic adults, women, those with lower income, those uninsured, and more recent immigrants were particularly less likely to have controlled cholesterol levels (Rodriguez et al., 2015).

Diabetes

Diabetes mellitus (DM) has reached epidemic proportions in the US and places affected individuals at two-to four- fold risk of developing CVD (CDC, 2014). The 2009–2012

overall prevalence of diagnosed DM in US adults > 20 years and older was 7.6% for NHW, 9.0% for Asian Americans, 12.8% for Hispanics, and 15.9% for NHBs (Mozaffarian et al., 2015). Compared to NHWs, the risk of diagnosed DM is 66% higher for Hispanics.

Data from the HCHS/SOL showed an overall prevalence for diabetes of 17% in men and women (Daviglus et al., 2012). In addition, higher rates of DM were demonstrated among Central Americans, Dominicans, Puerto Ricans, and Mexicans compared to the other Hispanic subgroups even after adjustment for age, sex, BMI, field center, and years lived in the US (Schneiderman et al., 2014). Further analysis demonstrated that only 59% of participants with objectively defined DM were aware of their condition, whereas only 48% with diagnosed DM exhibited adequate control. Participants that were aware of their diagnosis of DM demonstrated greater glycemic control compared to those who were unaware after adjustment for the same variables as above (Schneiderman et al., 2014).

We should note that in addition to DM, there are several related metabolic conditions that disproportionally affect Hispanics including prediabetes, insulin resistance, and metabolic syndrome that are relevant but beyond the scope of this review.

Hypertension

High blood pressure or hypertension (HTN) is defined as systolic blood pressure   140 mmHg or diastolic blood pressure   90 mmHg. The estimated prevalence of age-adjusted HTN in adults 20 years and older based on NHANES data from 2009–2012 was 32.6% meaning that approximately one third of the US adult population is believed to have the condition. These data document lower prevalence for Hispanic men and women (29.6% and 29.9%, respectively) compared to both NHW men and women (32.9% and 30.1%, respectively). Non-Hispanic blacks had the highest prevalence at 44.9% for men and 46.1% for women.

Although Hispanics as a group have lower HTN prevalence, there are three important disparities to be aware of. First, there is very little published data regarding HTN among Hispanics of different backgrounds. Sorlie et al. report that the overall age-adjusted prevalence of HTN for Hispanic men and women was 26 and 25%, respectively, with prevalence rates higher in Dominican, Puerto Rican, and Cuban adults. Mexican Americans had significantly lower prevalence of HTN compared to all other Hispanic subgroups except South Americans (p<0.01) (Sorlie, 2014). NHIS data from 1997–2005 demonstrated that Hispanic blacks had higher prevalence of HTN than Hispanic whites, noted even for Hispanic blacks with higher income and education levels when compared to Hispanic whites of lower socioeconomic status. Second, Hispanic adults were least likely to be aware of their HTN compared to NHW (78% vs. 81%) and NHB adults (87%: Nwankwo, Yoon, Burt, & Gu, 2013). Third, even when diagnosed, Hispanic adults are less likely to be on treatment (70%) compared to NHW and NHB adults (77% and 80%, respectively). Fourth, Hispanic adults with HTN (41%) were also least likely to achieve HTN control compared to NHB (48%) and NHW adults (56%). Together, these findings suggest significant screening and treatment disparities that must be addressed to reduce risk in this population.

CVD Risk Factor Profiles – Prevalence and Appropriateness

Data from the 1999–2002 NHANES report on combined CVD risk profiles (blood pressure, metabolic and inflammatory risk) and found that while foreign-born Mexicans and NHWs had similar combined risk profiles, US-born Mexicans were at higher risk (Crimmins, Kim, Alley, Karlamangla, & Seeman, 2007). In NHANES, the prevalence of three or more major CVD risk factors was higher for Hispanic men (21.3%) and women (17.4%) than among NHWs. Among Hispanic subgroups, both Puerto Rican men (24.9%) and women (25.0%) had the highest prevalence of having three or more major CVD risk factors. Similar disparities for Puerto Ricans was observed in HCHS/SOL which also found that lower SES and higher acculturation to US were associated with greater risk (Daviglus et al., 2012).

An alternative way of looking at risk is to examine prevalence of markers of ideal cardiovascular health. The focus on ideal cardiovascular health is relatively new and represents the AHAs 2020 goals for improving the nation's cardiovascular health. Seven metrics are proposed including not smoking, sufficient physical activity, a healthy diet, normal body weight, and optimal total cholesterol, BP, and fasting glucose. Longitudinal data from NHANES found that those achieving 6–7 of these markers had half the risk of mortality compared to those with none (Mozaffarian et al., 2015). Although data is very limited, it appears that NHBs and Hispanics have fewer ideal markers than NHWs (Rodriguez, 2012).

Before leaving this topic we are compelled to ask whether Framingham-derived risk factors by which CVD risk are predicted appropriate for Hispanics. This question stems from the observation that Framingham prediction models tend to overestimate risk in Hispanics. For example, in an analysis of 6 prospective cohort studies involving over 23,000 participants, D'Agostino and colleagues (2001) found that while the models accurately predicted risk in NHWs and NHBs, they systematically overestimated risk in Hispanics, Japanese Americans and Native Americans. Similarly, in a review of 3 databases involving 1,655 abstracts, Cortes-Berhoderi and colleagues (2012) found that Framingham scores were "modest at best" in predicting outcomes for Hispanics and in many cases overestimated risk.

One explanation for this lack of fit is that the weighted impact of a given risk factor on CVD may vary by race/ethnicity. Indeed, a handful of investigations suggest that low HDL or "good cholesterol" and diabetes, may not be as strongly predictive of CVD in Hispanics compared to non-Hispanics (Swenson et al., 2002; Willey et al., 2011). If true, the effect would be a degree of risk overestimation. Importantly, these data are quite limited and should be approached with caution, particularly in regards to their clinical application. For example, it is clear that diabetes portends an increased risk of CVD morbidity and mortality among Hispanics compared to not having diabetes. However, if the weighted impact does vary, it could have the effect of overestimating risk. Moreover they remind us about the importance of validating assessment tools for use in different populations and adjusting to optimize utility.

Note that the Framingham risk factors were derived from the original Framingham cohort which did not include Hispanics. From a psychometric perspective, this is analogous to deriving a measure on one population but then failing to standardize it on a second

population before applying it. Thus, one potential solution to improving risk modeling is to standardize the current models through weighted estimation for use with Hispanics. A second and perhaps better option would be to use future longitudinal data from the HCHS/SOL to derive a risk factor model specific to Hispanics and for each of the included subgroups. This approach is contingent on accruing events.

Psychosocial Factors Affecting CVD Risks and Health Behaviors

In addition to traditional biological and behavioral determinants, a robust literature supports the role of psychosocial factors as causal determinants of CVD risk and outcomes (Smith & Ruiz, 2002). For example, results from the prospective INTERHEART Study, a global investigation of determinants of CVD outcomes spanning 52 countries over 7 continents, found that psychosocial stress was the third most powerful predictor of MI after genetics and comparable in impact to smoking status (Yusuf et al., 2004). Several psychosocial factors appear uniquely important to Hispanic CVD risk. These include but are not limited to discrimination, acculturation, and social integration and support networks.

Perceived Discrimination

Perceived discrimination which can be conceptualized as a form of social stress, is associated with a range of negative mental and physical health outcomes including increase risk of CVD and mortality (Pascoe & Richman, 2009). Recent studies have found that Hispanics generally report less perceived discrimination than NHWs and NHBs. Among Hispanics data from the HCHS/SOL study suggests overall prevalence rates of discrimination experiences ranged from 64.9% to 98% (Arellano-Morales et al., 2015). Differences in prevalence were found to be due to region as opposed to Hispanic background (e.g., Mexicans living in Chicago reporting more discrimination than Mexicans living in San Diego, no difference between backgrounds within a given region).

There's little reason to suspect that the basic relationship between higher perceived discrimination and greater CVD risk would be any different than it is for NHBs and NHWs. However, there is some indication that these risks may be offset by resilience factors such as marriage, social networks, or other cultural factors. For example, in one study, perceived everyday discrimination was detrimental to the physical health of Puerto Ricans and Mexicans, but the stress buffering effects of marriage attenuated the harmful associations among Mexicans (Lee & Ferraro, 2009). More research is needed to understand potential moderating or buffering factors as well as to validate measurement instruments (mostly developed for NHBs) for use in Hispanic samples.

A Sociocultural Hypothesis

A leading hypothesis to explain the Hispanic mortality paradox is that Hispanic cultural values engender larger and stronger social networks which buffer risk particularly in the context of health challenges (Gallo, Penedo, Espinosa de los Monteros, & Arguelles, 2009; Ruiz, Campos, Garcia, & Gallo, 2016). This sociocultural hypothesis leverages two critical findings. First, social support and particularly measures of social integration are well-established moderators of health and mortality (c.f., Holt-Lunstad, Smith & Layton, 2010).

Second, Hispanic cultural values for collectivism, familismo, and simpatia emphasize building and strengthening these social bonds.

As noted in the introduction by Ruiz and colleagues (2016), there is a paucity of direct data testing this hypothesis. However, various proxies lend support to the idea. For example, lower acculturation and foreign-born nativity – both proxies for stronger cultural values – are associated with lower CVD prevalence and cause mortality in a variety of contexts (Abraido-Lanza et al., 1999). Second, ethnically dense neighborhoods or barrios – again, contexts in which values are assumed to be stronger) are associated with lower disease incidence and mortality (Eschbach Ostir, Patel, Markides, & Goodwin, 2004). These data do not yet address direct associations with health and have not yet been examined with respect to CVD. However, they offer a promising path for investigating resilience that may contribute to the somewhat puzzling epidemiological trends.

Conclusion

Hispanics experience lower CVD prevalence and mortality than non-Hispanics. There are variations in risk, prevalence, and outcomes by Hispanic background. However, knowledge of many basic epidemiologic trends are limited due to the lack of data, omissions in reporting backgrounds of samples, and inappropriate application of risk models to the study of Hispanics. The Hispanic mortality paradox and perhaps a broader health paradox, if true, may provide opportunities to further explore factors mediating this protective CV effect in Hispanics and extend these benefits to all Americans. However, further careful and cautious study is needed. The reduction of CVD in Hispanics is a critically important goal to public health initiatives such as Health People 2020. Further longitudinal studies are needed to examine the CV risk profile and morbidity and mortality of all Hispanic subgroups with regard to all aspects of CVD (stroke, heart failure, sudden cardiac death, coronary heart disease). As Hispanics/Latinos are the largest ethnic minority in the US, further focus and progress regarding CVD/cardiovascular health in Hispanics/Latinos will lead to important improvements in the overall US CV public health burden.

Acknowledgments

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