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Diabetes and Cardiovascular Disease Risk Factors as Influenced by Race and Ethnic Background

Miriam Padilla · Anne L. Peters

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Abstract Cardiovascular disease (CVD) is the leading cause of death in the USA accounting for 32 % of all deaths (Prev Chron Dis 11:1302507, 2014). Those with diabetes (DM) are two times more likely to experience a CVD event and have a two to fourfold greater mortality rate from a CVD event as compared to those without DM (Diabetes Care 35, 2012). Ethnic minorities have higher incidence of DM; whereas only 7.1 % of non-Hispanic Whites (NHW) have diabetes mellitus type 2 (DM2), it is present in 8.4 % of Asian Americans, 11.8 % of Hispanics, and 12.6 % of non-Hispanic Blacks (NHB) (Cardiorenal Med 4:1–11, 2014). African Americans (NHB) are twice as likely to develop DM2 as compared to NHW and have higher rates of retinopathy, hypertension (HTN) and renal disease (PLoS ONE 7(3):e32840, 2012). American Indian (AI) adults are three times more likely to have diabetes than the general adult US population and have higher rates of hypertension, lower leg amputations, cerebrovascular disease, obesity, and mortality from diabetes than do NHW (Diabetes Care 33(7), 2010). Mexican Americans (MA) have an odds ratio of developing diabetes that is 2.33 times higher than NHW (Diabetes Care 35, 2012). Latinos have higher rates of retinopathy, renal disease, coronary heart disease, and poorly controlled diabetes as compared to NHW (Diabetes Care 35, 2012). Asians have either greater or lower rates of CVD risk factors compared to NHW depending of the subgroup of Asian background; however, Asians develop DM at a lower BMI than many other ethnicities (Cardiorenal Med 4:1–11, 2014). Education, income, health insurance status, and length of residence in host country also influence DM prevalence and CVD risk factors.

Keywords Racial disparities · Immigrant health · Diabetes · Cardiovascular disease

Introduction

Cardiovascular disease is the leading cause of death in the USA accounting for 32 % of all deaths [7]. Cardiovascular disease (CVD) progression and mortality is influenced by many factors including obesity, hypertension, diabetes, dyslipidemia, chronic kidney disease (CKD), smoking, unhealthy eating habits, age, race, family history, and lack of exercise [3•]. Alarmingly, those with diabetes are two times more likely to experience a CVD event in comparison to those without diabetes (DM) [2]. If a person with DM does experience a CVD event, they also have a two to fourfold greater mortality rate from the event than a person without diabetes [2]. As obesity rates rise in the USA, there is a corresponding increase in the numbers of individuals with DM. In the USA, 35.7 % of adults were obese in 2010 and the prevalence of diabetes increased from 5.5 million cases in 1980 to 20.7 million cases in 2010 [3•]. In 2006, 13 % of the US adult population had diabetes mellitus type 2 (DM2) [14]. More specifically, when examining the prevalence of DM2 in the USA by race from 2007 to 2009, only 7.1 % of non-Hispanic Whites (NHW) had DM2 compared to 8.4 % of Asian Americans, 11.8 % of Hispanics, and 12.6 % in non-Hispanic Blacks (NHB) [3•]. Not only do ethnic minorities have increased prevalence of diabetes but they also have increased morbidity from CVD events as compared to NHW. Tillin et. all found that DM was predictive of stroke

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M. Padilla · A. L. Peters (✉)
Division of Endocrinology, Keck School of Medicine of the University of Southern California, Los Angeles, CA, USA
e-mail: momofmax@mac.com

in all ethnic groups residing in Canada [16]. Europeans with diabetes had a 1.3-fold increase in age-adjusted incidence of stroke compared to Europeans without diabetes [16]. African Caribbeans, however, were three times more likely to have a stroke when compared to NHW without diabetes [16]. South Asians with DM also had higher rates of stroke, presenting with a 2.5-fold increased incidence of stroke compared to NHW without DM [16]. In order to address disparities, it is important first to understand to scope of the situation.

The foreign-born population in the USA has increased by 57 % from 1990 to 2000 [15]. Initially numbering 19.8 million foreign-born residents living in the USA, in 1990, their population increased to 31.1 million in 2000 [15]. This is a significant increase in foreign-born individuals when compared to the US native-born population which only increased by 9.5 % in the same time period [15]. Out of the foreign-born individuals who move to the USA, Mexicans comprise 29.5 % of immigrants, persons from China account for 4.9 %, and Filipino-born immigrants make up another 4.4 % [15]. It is imperative to be cognizant of this dynamic flux in demographics since foreign-born individuals are less likely to know they have obesity, hypertension, and hyperlipidemia [5]. A study of 12,124 participants by Langellier et al. found that 36 % of foreign-born non-English speakers were unaware that they had hypertension compared to 24.9 % unawareness in US-born participants [5]. Also, 48 % of foreign-born non-English speakers did not realize they had hypercholesterolemia as compared to 30.5 % of US-born participants who did not know the same [5]. It is estimated that improved screening and education of immigrant communities and racial minority groups could save the USA $6.7 billion yearly by preventing as many as 110,000 preventable hospitalizations in Hispanics and 430,000 preventable hospitalizations in Blacks [3•].

DM and CVD Risk Factors in NHB Americans

Preventable all-condition hospitalizations for NHB occur at twice the rate of NHW and cost up to $3.4 billion USD a year [3•]. Many of these preventable hospitalizations are influenced by the increased prevalence of diabetes in NHB. NHB are twice as likely to develop DM2 as NHW, even after taking into account the socioeconomic status (SES), BMI, and behavioral risk factors [14]. Once they are diagnosed with DM, NHB are also 50 % more likely than NHW to have poor glycemic control, described as an HbA1C >7 % [2]. Although it has been noted that NHB do have a higher HgA1C level at any given glycemic level compared to NHW, NHB also develop retinopathy at lower HbA1C levels than NHW [3•]. NHB in the USA have double the rates of retinopathy as do NHW and four times the rate of early and end-stage renal disease as do NHW [8]. Furthermore, NHB also have the highest incidence of hypertension in the USA [7]. When HTN is defined as systolic blood pressure (SBP) >140 mmHg or diastolic blood pressure (DBP) >90 mmHg, 44 % of NHB in the USA have HTN whereas only 29 % of NHW are diagnosed with the same [7]. Disturbingly, the National Health and Nutrition Examination Survey (NHANES) described that rates of HTN have been increasing in NHB from 39.7 % in 1988–1994 to 44.3 % in 1999–2004 [4]. In that same time period, rates of obesity in NHB increased from 32 to 42.4 % and DM increased in NHB from 11.5 to 13 % [4]. One positive finding from NHANES was that the prevalence of smoking decreased in NHB from 34.7 % in 1988–2004 to 27.3 % in 1999–2004 [4]. Still, the percentage of cigarette use is much higher in NHB compared to the national median. In 2009, the national median for cigarette use was 19.6 % in men and 16.8 % in women [11]. During the same time period, 28 % of NHB men and 19.9 % of NHB women were smoking cigarettes [11].

DM and CVD Risk Factors in Native Americans

American Indians (AI) also have higher rates of cigarette use when compared to the national average. Surveys from 2009 evaluated by the Racial and Ethnic Approaches to Community Health Across the US (REACH U.S.) found that 36 % of AI men and 36 % of AI women smoked cigarettes [11]. This can compound health risks in AI especially when smoking is combined with substantial prevalence of obesity. Alarmingly, obesity was described in 46.2 % of AI men and 45.5 % of AI women in 2009 when the national median for obesity was 28.6 % in men and 26 % in women [11]. The REACH U.S. survey also found that 43.9 % of AI men reported they had HTN, whereas only 29.8 % of men nationally stated they had HTN [11]. If the AI individual had DM, he or she also had greater chance of being diagnosed with HTN. A study of patients treated through the Indian Health Service in Phoenix, Arizona, from 2004 to 2005 showed that 61.2 % of all AI adults with diabetes had hypertension, in comparison to the age-adjusted prevalence rate for HTN in US adults with diabetes which was 31.5 % [10]. The same study by O'Conell et al. also found that AI adults with DM were >10 times more likely to undergo lower extremity amputations and 2 times more likely to have mental health disorders than other US adults with diabetes [10]. Cerebrovascular disease was also more prominent in AI adults with DM; 6.9 % of AI adults were diagnosed with cerebrovascular disease whereas only 5.5 % of US adults with diabetes had the same [10]. Along with this, AI have been found to have the highest prevalence of coronary artery disease (CAD) nationally, having CAD present in 11.6 % of their population [7]. All of these comorbidities have led to the realization that AI and Alaskan Natives (AN) have the highest rate of premature deaths from heart disease of all races at nearly 2.5 times the rate for NHW [10]. Out of all of the deaths from heart disease that occur in AI/AN

persons, 36 % of them are classified as being premature [10]. Strikingly, AI/AN persons are 4 times more likely to die from diabetes than the general population in the USA [10]. These statistics are particularly alarming when one takes into account that AI adults are 3 times more likely to have diabetes than those in the general adult US population [10]. Therefore, not only to AI/AN have greater prevalence of DM but they also have greater morbidity and mortality from DM in relation to NHW.

DM and CVD Risk Factors in Latinos

Slightly lower than the rate for AI, Mexican Americans (MA) have an age- and sex- adjusted odds ratio of developing diabetes that is 2.33 times higher than NHW [6]. If they are diagnosed with DM, Mexican Americans are 50 % more likely to have poor glycemic control in comparison to NHW when poor glycemic control is defined by a HgA1C >7 % [2]. Part of the reason for not meeting glycemic goals may be that only 64.1 % of Hispanics with DM reported having their HbA1C checked in the last year. This is much lower than the national statistics which showed that nationally, 79.9 % of people with diabetes had their HgA1C levels evaluated in the last year [11]. Additional disparities are also shown when reviewing the extent of cholesterol monitoring. Nationally, 74.4 % of men stated that they had their cholesterol checked in the last 5 years, whereas only 60.5 % of Hispanic men did [11]. Lack of access to health care may play a role in poor glycemic control. In the USA, 21.8 % of Hispanic men and 25.6 % of Hispanic women acknowledged that they could not see a doctor because of the cost [11]. When documenting those with median household income of <$25,000, 21.3 % of men nationally fell under this classification whereas 45.4 % of Hispanic men were described as having such low income [11]. The low-income status of many Latinos makes obtaining health insurance to be more difficult. Although nationally 16.5 % of men and 12.4 % of women lack healthcare coverage, as many as 29.2 % of Hispanic men and 26.7 % of Hispanic women are uninsured [11]. Lack of proper preventative care may attribute to retinopathy rates that are 3 times greater and early- and end-stage kidney disease rates that are 2.5 times higher in Hispanics as compared to NHW [8]. Interestingly, rates of CHD in Hispanics are significantly elevated in those who have resided in the USA for 10 years or more and in those who prefer to speak English as compared to those who have resided less than 10 years in the USA and those who prefer to speak Spanish [19]. Acculturation into the western diet and lifestyle may be detrimental to the CVD mortality in immigrants.

The Hispanic Community health Study/Study of Latinos (HCHS/SOL) found that CVD risk factors varied substantially by background. Among Latinos in the USA from 2009 to 2011, prevalence of diabetes in men ranged from 10.1 % in South Americans (SA), 13.2 % in Cubans, 16.2 % in Puerto Ricans (PR), 16.3 % in Central Americans (CA), 18.2 % in Dominicans, and 19.3 % in MA [19]. Incidence of DM in women was similar, with the exception of PR women having 19.4 % prevalence and Mexican women having a prevalence of 18.5 % [19]. Obesity was highest among PR participants with 40.9 % of PR men being obese and 51.4 % of PR women having a BMI>30 kg/m^2 [19]. SA men had the lowest rates of obesity with only 26.8 % of them being obese and 30.8 % of SA women being obese [19]. Smoking rates were the highest among PR participants; 34.7 % of PR men and 31.7 % of PR women smoked cigarettes [19]. However, NHANES noted that MA had a lower odds ratio for smoking, or 0.66, compared to NHW [2]. In the HCHS/SOL study, the overall rate of hypercholesterolemia (defined as a total cholesterol≥240 mg/dl, HDL<40 mg/dl, LDL>160 mg/dl, or receiving treatment) was 52 % among men and 37 % in women [19]. CA men had the highest incidence of hypercholesterolemia (54.9 %), and out of the women, PR women had the highest rate of hypercholesterolemia (41 %) [19]. Hypertension also varied by country of origin. In the Latino community, 25 % of men and 24 % of women have been diagnosed with hypertension [19]. However, HTN rates are the highest among Dominican men (32.6 %) and lowest among SA women (15.9 %) [19]. Furthermore, prevalence of CHD was highest at 5 % among Puerto Rican men and women, Cuban men, and Dominican men. Dominican men also had the highest rates of self-reported stroke at 4 % whereas PR women had the highest rates of self-reported strokes in Latina women at 2 % [19].

DM and CVD Risk Factors in Asian American/Pacific Islanders

Significant variations in CVD risk were also documented when examining the backgrounds of Asian/Pacific Islanders (API) in the USA. A study by Karter et al. reviewed information on 2,123,548 patients from Kaiser Permanente in Northern California [13]. They found that ethnic minorities had a much higher rate of DM as compared to NHW [13]. The breakdown by ethnicity is seen in Table 1. Other studies have found that Native Hawaiian elderly have double the rates of diabetes than do NHW age 65 years or older or 25.4 % compared to 13.1 % accordingly [1]. DM has also been noted to affect as many as 18 % of Arab Americans aged 20–75 years old and 29 % of Asian Indian Americans [3•]. Evaluating differences between Asian subgroups is valuable since previously, it was thought that Asians had a higher rate of DM than NHW but lower than Latinos and Blacks [13]. This theory was actually a misinterpretation of the data since most surveys before 2000 classified Asians under "other" and did not take into account their vast differences [13]. A study by Holland et all of 94,423 Asian and NHW patients in Northern California showed that there was significant heterogeneity of

Table 1 Prevalence of DM by race in a Northern California Kaiser population

Ethnicity	Percentage
Pacific islanders	18.3
Filipinos	16.1
South Asians	15.9
Latinos	14.0
Non-Hispanic Blacks	13.7
American Indians	13.4
Multiracial	12.8
Southeast Asians	10.5
Japanese	10.3
Vietnamese	9.9
Koreans	9.9
Chinese	8.2
Non-Hispanic Whites	7.3

coronary heart disease (CHD), stroke (CVA), and peripheral vascular disease (PVD) across Asian subgroups [20]. For instance, the odds ratio (OR) of CHD risk for Asian women as a whole was 0.92 when compared to NHW, but when divided by subgroup, Koreans had an OR of 0.34, Chinese women OR of 0.72, and Filipino women OR of 1.66, and Vietnamese women had an OR of 1.78 [20]. Compared to NHW, Asian Indian men had an odds ratio for CHD that was 1.77 whereas Chinese men had an OR of 0.78 [20]. CVA risk also varies substantially by subgroups. Korean men had an OR of 0.51 for CVA compared to NHW whereas Vietnamese men had an OR of 2.09 [20]. In women, although the OR for CVA in all Asian women was 1.03, this ranged from Filipino women having an OR of 2.02 to Korean women having an odds ratio of 0.80 [20]. These differences may continue to impact how health professionals reach out to the Asian community since Asian Americans are the fastest growing racial/ethnic group in the USA, going from 10.2 million in 2000 to 14.7 million inhabitants in 2010, an increase of 43 % [12•].

Just as the length of residence in the USA seemed to impact CVD risk of Latino immigrants, the same was also found in Asian immigrants. One study of Asians in Canada found that Chinese immigrants were more likely to consume convenience foods, desserts/candy, soft drinks, and red meat and have larger portions the longer they resided in Canada [12•]. Such changes in behavioral patterns will increase the impact of DM in the Asian community since Asian subgroups have a higher incidence of DM at comparable BMI compared to NHW [13]. Out of 15,357 new cases of DM that were studied by Karter et al. in 2010, Chinese, Japanese, Filipino, and South Asians had the lowest BMI at time of DM diagnosis compared to NHW, NHB, Latinos, and AI [13]. While AI averaged a BMI of 36.2 kg/m^2 at time of DM diagnosis, Chinese individuals had a BMI of 27.2 kg/m^2 when they were first diagnosed with DM [13]. Pacific Islanders had 19.9 new cases of DM per 1000 person years, South Asians had 17.2 new cases per 1000 person years, Filipinos had 14.7 cases, AI had 12 cases, Latinos and NHB had 11.2 cases, Japanese had 7.5 cases, Chinese had 6.5 cases, and NHW had 6.3 cases per 1000 person years [13]. These finding have led the World Health Organization to suggest that a BMI of 23–27.5 kg/m^2 in Asians be considered overweight and a BMI≥27.5 kg/m^2 be considered obesity in Asians, since Asians have a less favorable lipid, glucose, insulin, and CRP profile as compared to NHW at the same BMI [3•].

Education and Social Impact on DM and CVD Risk Factors

Education and socioeconomic status also affects CVD risk and DM incidence. The NHANES study showed that the prevalence of DM was 7.4 % in patients with less than a high school education from 1988 to 1994 [2]. This rate increased to 10.7 % from 1999 to 2008 in patients with less than a high school education [2]. Out of those with DM with less than a high school education, only 12 % of respondents said their doctors recommended they maintain a HgA1C<7 % compared to 44 % of individuals with DM with more than high school education who reported the same [2]. As a result, individuals with postsecondary education had better DM control and had an odds ratio of 0.65 of having poor glycemic control as compared to those without postsecondary education [2]. Those with postsecondary education were also less likely to smoke with an odds ratio of 0.63 compared to those without postsecondary education [2]. Numbers of those who have less than a high school education can vary substantially by race and ethnicity, anywhere from 6.3 % of API men in 2009 to 29.5 % in Latino men [11]. Women of racial minorities are more likely to have less than a high school education ranging from 9.3 % of API females to 31.5 % of Latino women in 2009 [11]. This is quite substantial when taking into account that the national median of men with less than a high school education is 8.5 and 7.5 % for women [11]. Completion of high school education also varies by geographic location. For instance, less than 2 % of API men and women living in Los Angeles and Orange Counties had less than a high school education but as many as 21.3 % of API men and 27.1 % of API women in New York City had less than a high school education [11]. Lack of education means that many ethnic minorities may not understand the signs and symptoms associated with CVD or CVA. While 14.7 % of women nationally knew the symptoms of a heart attack, only 13.5 % of AI women and 4.7 % of Latina women knew the symptoms [11]. Similarly, only 7 % of Latina women and 15.4 % of AI women knew the symptoms of a stroke compared to 21 % of women nationally knowing the signs and symptoms of a CVA [11].

Limitations to Evaluating DM and CVD Risk by Race

Realizing that socio-economic differences do attribute to DM and CVD risk makes one question if many of the racial disparities documented are truly due to genetic differences versus due more to socio-economic status (SES) or lifestyle practices [8]. It may be more relevant to compare an ethnicity to their matched counterpart in the same geographic location with more similar lifestyle practices. For example, Alaskan Natives were previously documented as having lower rates of heart disease mortality as compared to all races in the USA, but when they were compared to the very low-risk population of NHW living in Alaska, their relative risk of having heart disease as the underlying cause of death was actually 1.27 times higher [17•]. Place of residence and even the process of immigrating to another country can itself bias the information. The migration selection hypothesis states that immigrants that come to the USA are healthier than those who stay in their home country and those who become elder or sick are more likely to migrate back to their home country [18]. In support of this is, the finding that Mexican migrants interviewed in the USA had lower rates of hypertension as compared to Mexicans living in Mexico [18]. The "healthy immigrant effect" seems to deteriorate with length of residence in the new country as the minority groups adopt the nutritional practices of their host country [12•]. Increased acculturation into the US society is associated with lower consumption of fruits and vegetables, higher BMI, more rates of smoking, and greater amount of alcohol use [18]. Therefore, research methods may be more precise if they focus not only on race but also on length of residence in the host country and compare outcomes of similar race individuals in their country of origin.

However, defining race and ethnicity is an inexact classification [8]. Veazie et all found that up to 30 % of American Indians/Alaskan Natives were misclassified or underreported on death certificates and significantly overestimated the AI/AN populations of Hispanic origin [17•]. Inaccuracies might arise in trying to match cases and controls to self-reported ancestry when many individuals are no longer completely aware of their precise ancestry [9]. Individuals may think of themselves as one race when their genetic profile may show otherwise. A study by Lai et. all found that the ancestral genetic composition of 1129 Puerto Ricans was 57.2 % European, 27.4 % African, and 15.4 % Native American ancestry [9]. Within these individuals, those with DM2 had significantly higher percentage of European ancestry, those with CVD had higher Native American ancestry, and those with HTN had higher African ancestry [9]. In the future, it may be more accurate to do genetic testing on individuals and calculate the CVD and DM risk based on genetic ancestry instead of self-reported racial constructs. This is particularly relevant when most surveys have only a few races to choose from, mainly White, Asian, Black, and Hispanic. "White" however can reflect origins that are European, Middle Eastern, or North African, and "Asian" can include cultures varying from Native Hawaiians to Cambodians, Hmong, Tongas, Chinese, Koreans, or Filipinos. Varying geographical locations for the same race means that within one "race" patients may have more cultural and genetic variability than between ethnicities [3•].

Conclusion

In conclusion, CVD is a leading cause of morbidity and mortality in the USA and patients with DM are more likely to die of CVD. Ethnic minorities have higher burden of DM in their communities and concurrent higher rates of HTN, obesity, stroke, and CAD as compared to NHW. With ever increasing numbers of migrant populations, health care providers have the difficult task of reaching ethnic minorities so as to help ameliorate these racial health care disparities. Health care providers should provide culturally competent medicine while at the same time realizing that each patient is an individual with an array of factors, both social and genetic, influencing their final well-being.

Compliance with Ethics Guidelines

Conflict of Interest Anne Peters reports consulting fees from Amgen, Abbott Diabetes Care, Becton Dickinson, Biodel, Bristol Myers Squibb/Astra-Zeneca, Janssen, Lexicon, Lilly, Medtronic Minimed, Novo Nordisk, OptumRx, sanofi, Takeda, Thermalin, and speaking fees from Bristol Myers Squibb/Astra-Zeneca, Novo Nordisk, Janssen, a research grant from Janssen, and editorial fees from Medscape, outside the submitted work. Miriam Padilla has no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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