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Disaggregation of Cause-Specific Cardiovascular Disease Mortality Among Hispanic Subgroups

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Abstract

IMPORTANCE—Hispanics are the largest minority group in the United States and face a disproportionate burden of risk factors for cardiovascular disease (CVD) and low socioeconomic position. However, Hispanics paradoxically experience lower all-cause mortality rates compared with their non-Hispanic white (NHW) counterparts. This phenomenon has been largely observed in Mexicans, and whether this holds true for other Hispanic subgroups or whether these favorable trends persist over time remains unknown.

OBJECTIVE—To disaggregate a decade of national CVD mortality data for the 3 largest US Hispanic subgroups.

DESIGN, SETTING, AND PARTICIPANTS—Deaths from CVD for the 3 largest US Hispanic subgroups—Mexicans, Puerto Ricans, and Cubans—compared with NHWs were extracted from

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the US National Center for Health Statistics mortality records using the underlying cause of death based on coding from the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (I00-II69). Mortality data were evaluated from January 1, 2003, to December 31, 2012. Population estimates were calculated using linear interpolation from the 2000 and 2010 US Census reports. Data were analyzed from November 2015 to July 2016.

MAIN OUTCOMES AND MEASURES—Mortality due to CVD.

RESULTS—Participants included 688 074 Mexican, 163 335 Puerto Rican, 130 397 Cuban, and 19 357 160 NHW individuals (49.0 % men and 51.0% women; mean [SD] age, 75 [15] years). At the time of CVD death, Mexicans (age, 67 [18] years) and Puerto Ricans (age, 68 [17] years) were younger compared with NHWs (age, 76 [15] years). Mortality rates due to CVD decreased from a mean of 414.2 per 100 000 in 2003 to 303.3 per 100 000 in 2012. Estimated decreases in mortality rate for CVD from 2003 to 2012 ranged from 85 per 100 000 for all Hispanic women to 144 per 100 000 for Cuban men, but rate differences between groups vary substantially, with Puerto Ricans exhibiting similar mortality patterns to NHWs, and Mexicans experiencing lower mortality. Puerto Ricans experienced higher mortality rates for ischemic and hypertensive heart disease compared with other subgroups, whereas Mexicans experienced higher rates of cerebrovascular disease deaths.

CONCLUSIONS AND RELEVANCE—Significant differences in CVD mortality rates and changes over time were found among the 3 largest Hispanic subgroups in the United States. Findings suggest that the current aggregate classification of Hispanics masks heterogeneity in CVD mortality reporting, leading to an incomplete understanding of health risks and outcomes in this population.

By 2060, 1 in 3 individuals in the United States will be of Hispanic origin.¹ Despite this phenomenal projected growth, relatively little is known about this diverse group. Studies by the Institute of Medicine and others^{2–6} have highlighted the lack of health data for Hispanics, especially in the area of cardiovascular disease (CVD), which is the leading cause of death among Hispanics in the United States.⁶ Differences in CVD mortality across the 3 largest Hispanic subgroups in the United States (Mexicans, Puerto Ricans, and Cubans) are particularly intriguing because these distinct groups vary widely in immigration histories, socioeconomic status, culture, lifestyles, and risk factors. Within each of these ethnic subgroups, even more heterogeneity exists given the diversity in racial background, with varying Native American, European, and African ancestry. The current aggregation of these diverse Hispanic subgroups in mortality reporting has led to an incomplete understanding of specific health risks and outcomes in each unique subgroup.⁷

Recent reports from the Hispanic Community Health Study/Study of Latinos, a prospective cohort study that examines risk factor data in Mexicans, Puerto Ricans, Cubans, and other Hispanic subgroups in urban settings (Bronx, New York; Chicago, Illinois; Miami, Florida; and San Diego, California), demonstrate significant variation in the prevalence of CVD risk factors.⁸ In particular, Mexicans had the highest rate of type 2 diabetes, whereas Puerto Ricans had the highest prevalence of smoking and obesity. In addition to this heterogeneity in risk factors, the Hispanic mortality paradox also remains incompletely understood. The paradox refers to the epidemiologic finding that Hispanics often fare better than their non-

Hispanic white (NHW) counterparts on mortality outcomes despite lower levels of income, education, and health care access.⁹ Other studies contend that this mortality paradox among Hispanics is spurious, resulting from ethnic misclassification and underascertainment of deaths.^{10,11} However, studies that have attempted to account for selective migration of healthier individuals and statistical immortality among Cuban and Puerto Ricans continue to demonstrate a mortality advantage among Hispanics.^{12,13} Whether the Hispanic mortality paradox still exists and, if so, whether this paradox is true in all Hispanic subgroups is a matter of controversy.^{9,12}

To our knowledge, no studies at the national level have yet examined CVD mortality outcomes by specific Hispanic subgroups. Therefore, the goal of our study is to accurately characterize CVD mortality among the 3 largest Hispanic subgroups in the United States (Mexicans, Puerto Ricans, and Cubans). We hypothesize that significant differences in CVD mortality rates and specific causes of CVD mortality exist between Hispanic subgroups, potentially unmasking heterogeneity that is not characterized by aggregate Hispanic classification schemes.

Methods

Study Population

The study population consisted of Hispanic and NHW adults 25 years or older in the entire US population from January 1, 2003, to December 31, 2012. Race/ethnicity was recorded on death certificates by the funeral director using state guidelines. Hispanic ethnic groups are classified as 1 of the following categories on US mortality records from 2003 to 2012: Mexican, Puerto Rican, Cuban, or other. Analyses were restricted to the 3 largest Hispanic subgroups to ensure the highest accuracy of findings and to avoid the aggregation of various Hispanic subgroups in the “other” category (ie, South vs Central Americans). In addition, these 3 groups are consistently documented on the national death certificates throughout our study period. The institutional review board of Stanford University approved this study and provided a waiver for use of these publicly available mortality and US Census data.

The numerator data were calculated using the multiple cause of death mortality records (deidentified at the county level) database obtained with special permission from the National Center for Health Statistics. For this study’s cause-specific analyses, the underlying cause of death was identified on mortality records using the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* recode of 358 selected causes of death for Mexicans, Puerto Ricans, and Cubans, with all Hispanics and NHWs as comparison groups. We used total CVD (*ICD-10* codes I00-I69) and the subcategories of ischemic heart disease (*ICD-10* codes I20-I25), hypertensive heart disease (*ICD-10* codes I11 and I13), heart failure (*ICD-10* code I50), and cerebrovascular disease (*ICD-10* codes I60-I69).

The denominator data were calculated by linear interpolation for 2003 to 2009, US Census data for 2010, and extrapolation for 2011 to 2012 using the full population count data by racial and/or ethnic subgroup available during the study period from the 2000 and 2010 US Census reports.¹⁴ Methods on linear interpolation have been previously described.¹⁵ In

short, the midstudy year (2007) denominator population counts are estimated by fitting a line over time using the 2000 and 2010 census counts as observed end points and obtaining best-fitting estimates along the line as population estimates for the 2003 to 2012 study period.

Statistical Analysis

Data were analyzed from November 2015 to July 2016. Age-adjusted, cause-specific death rates were calculated per 100000 population by year and 5-year age groups using direct standardization for age adjustment to the 2000 US standard population. All analyses are stratified by sex and racial and/or ethnic subgroups as all Hispanics, Mexicans, Puerto Ricans, Cubans, and NHWs. Levels of CVD mortality were age-adjusted by selected racial and/or ethnic subgroups, cause of death, and sex from 2003 to 2012. All analyses were run in R (version 3.1.1).¹⁶ We used Poisson regression models to estimate mean annual percentage change statistics with 95 % CIs, which were used to characterize the magnitude and direction of trends and the statistical significance of trends.^{15,17}

Given the differences in ischemic heart disease and cerebrovascular mortality levels by subgroups, we created smoothed curves for proportional mortality rate ratios (PMRR) for these specific CVD causes of death by age group using Loess (local polynomial regression) curves.¹⁸ These curves indicate how the proportions of deaths due to ischemic heart disease and cerebrovascular disease in Hispanic subgroups compare with those for the NHW group by age. The PMRR is calculated as the proportion of observed deaths due to a specified cause in each Hispanic subgroup divided by the proportion of deaths in the observed reference group (NHW), as previously demonstrated in a separate analysis.¹⁹ In the Loess smoothing, the PMRR at each age was weighted by the total number of all-cause deaths at that age in the relevant Hispanic subgroup. Loess curves were created using deaths at ages 40 to 105 years but shown at ages 45 to 100 years because of the low numbers of deaths for individuals younger than 45 years or older than 100 years. All statistical testing was 2-sided at the 5 % significance level ($P < .05$).

Results

The Table shows the study characteristics of Cuban, Mexican, and Puerto Rican adults older than 25 years who died during the period from 2003 to 2012 compared with all Hispanics and NHWs in the United States. The study sample consisted of 1 247 178 deaths for all Hispanics, 130 397 deaths for Cubans, 688 074 deaths for Mexicans, 163 335 deaths for Puerto Ricans, and 19 357 160 deaths for NHWs (49.0% men and 51.0% women; mean [SD] age, 75 [15] years). Mexicans and Puerto Ricans were 1 decade younger (mean [SD] ages, 67 [18] and 68 [17] years, respectively) than Cubans and NHWs (mean [SD] ages, 77 [14] and 76 [15] years, respectively) at the time of death. At the time of death, 19.1 % of Mexicans and 16.4 % of Puerto Ricans were 25 to 49 years of age compared with just 5.3 % of Cubans and 6.6 % of NHWs. Among the study sample, 95.8 % of Cubans, 79.7 % of Puerto Ricans, and 44.8 % of Mexican decedents were foreign born. Mexican decedents had the lowest levels of educational attainment, with 61.6 % having less than a high school education.

The population estimates and frequency of CVD deaths by the major subgroups (ischemic heart disease, hypertensive heart disease, heart failure, and cerebrovascular disease) are shown in eTable 1 in the Supplement. Overall, CVD was the most common cause of death for all subgroups, with a higher proportion of deaths attributed to CVD for Cubans (37.6 %) compared with other Hispanic subgroups. Ischemic heart disease represented the leading cause of CVD death among all Hispanic subgroups.

Figure 1 demonstrates the Loess smooth curves representing PMRRs for CVD-specific deaths by age for Hispanic subgroups compared with NHWs for ischemic heart disease and cerebrovascular disease. Ischemic heart disease accounts for a lower proportion of deaths for all Hispanic subgroups aged 45 to 65 years, but then increases after 65 years of age for Hispanics relative to NHWs. Cubans and Puerto Ricans had the highest PMRRs for ischemic heart disease compared with other Hispanic subgroups and NHWs across the age spectrum. Cerebrovascular disease accounted for a higher proportion of deaths for younger Hispanics compared with NHWs, but the difference narrowed after 75 years of age. Mexican men and women experienced higher PMRRs for cerebrovascular disease relative to other Hispanic subgroups and NHWs.

Age-adjusted mortality rates per 100000 population are displayed in eTable 2 in the Supplement. Estimated decreases in mortality rate for CVD from 2003 to 2012 ranged from 85 per 100000 for all Hispanic women to 144 per 100000 for Cuban men. All Hispanics, Cubans, Mexicans, and Puerto Ricans were compared with NHWs as the referent group. The NHW group (1372.9 deaths per 100000 men; 983.3 deaths per 100000 women) had the highest rates of all-cause mortality, followed by the Puerto Ricans (1285.4 deaths per 100000 men; 844.1 deaths per 100000 women), Cubans (1127.6 deaths per 100000 men; 718.1 deaths per 100000 women), and Mexicans (1059.0 deaths per 100000 men; 763.5 deaths per 100000 women) groups. All Hispanics, in aggregate, had the lowest mortality rates compared with other Hispanic subgroups and the NHWs but were close in comparison with Mexicans (1035.8 deaths per 100000 men; 713.9 deaths per 100000 women).

The same patterns hold true for total CVD mortality rates. Ischemic heart disease mortality was highest among Puerto Ricans (265.7 deaths per 100000 men; 171.8 deaths per 100000 women) and NHWs (263.5 deaths per 100000 men; 148.2 deaths per 100000 women) and lowest in Mexicans (196.9 deaths per 100000 men; 124.2 deaths per 100000 women). Conversely, Mexicans experienced the highest rates of cerebrovascular disease deaths compared with NHWs and other Hispanic subgroups (63.4 deaths per 100000 men; 57.5 deaths per 100000 women) (eTable 2 in the Supplement).

Figure 2 shows trends of age-adjusted mortality rates (per 100000) by year, sex, and race and/or ethnicity. The mean annual percentage changes with 95 % CIs are presented in eTable 3 in the Supplement. In general, mean annual percentage changes indicate that decreases in all-cause mortality (−0.92 % to −1.94 % change per year in mortality rates), total CVD mortality (−2.54 % to −4.17 % change per year in mortality rates), cerebrovascular disease mortality (−2.94 % to −4.20 % change per year in mortality rates), and ischemic heart disease mortality (−3.67 % to −6.48 % change per year in mortality rates) were significant ($P < .05$). Decreased mortality during the study period occurred in similar magnitudes across

racial and/or ethnic groups and sex. Mortality rates due to CVD decreased from a mean of 414.2 per 100000 in 2003 to 303.3 per 100000 in 2012. Overall, CVD death rates declined for all groups, and Puerto Ricans experienced age-adjusted CVD mortality rates comparable to those of NHWs. Similar patterns are shown for ischemic heart disease (Figure 3), although Puerto Rican and Cuban women experienced higher death rates compared with all Hispanics, Mexicans, and NHWs. Finally, Mexicans experienced higher rates of cerebrovascular disease deaths compared with other Hispanic subgroups (Figure 4) but were comparable to those of NHWs. Cubans experienced the lowest rates of cerebrovascular disease mortality compared with other Hispanics and NHWs.

Discussion

Using a decade of national data, we found marked heterogeneity in CVD mortality patterns among the 3 largest Hispanic subgroups. Puerto Ricans and Mexicans were younger at the time of CVD death than Cubans and NHWs. After adjustment for age, Puerto Ricans and Cubans experienced CVD mortality rates comparable to those of NHWs but had overall higher rates of ischemic and hypertensive heart disease. Mexicans experienced higher cerebrovascular disease mortality rates compared with other Hispanic subgroups but still lower rates compared with NHWs. Therefore, studying Hispanics as an aggregate group masks potentially meaningful heterogeneity in CVD risks among Hispanic subgroups.

Eliminating disparities in CVD outcomes for this growing US demographic group has been recognized as a national priority,^{5,6} with recent reports and policy statements continuing to discuss the lack of data on CVD health in Hispanics.^{4-7,20} Hispanics have also been traditionally reported as an aggregate group in the literature but are known to be a widely heterogeneous group with origins from more than 20 countries. A few studies have shown differences in CVD prevalence by Hispanic subgroups,^{9,21,22} but most research has been limited to Mexican Americans,²³⁻²⁶ few subgroups,^{27,28} or small samples,^{29,30} prompting the American Heart Association⁷ to issue a recommendation for research of disaggregated subgroups. As shown in our study, CVD mortality varies among Hispanic subgroups, with overall higher mortality rates among Puerto Ricans and lower rates among Mexicans for ischemic and hypertensive CVD. Focusing only on 1 particular subgroup (ie, Mexicans, as found in most US studies) fails to capture the full burden of disease among Hispanics and may have largely underestimated select causes of CVD risk in other Hispanic subgroups.

In addition, minority health research in Hispanics is fraught with discussion of the Hispanic paradox, in which some studies,³¹⁻³³ but not all,^{10,11} have reported lower mortality rates in Hispanics than in NHWs. Explanations for the Hispanic paradox remain inconclusive, and whether this paradox is observed in all Hispanic subgroups remains uncertain. In our study, we found that, overall, Puerto Ricans have CVD mortality rates comparable to those of NHWs. When we further disaggregate by cause-specific CVD mortality, we found that some Hispanic subgroups experience higher rates of age-adjusted mortality compared with their NHW counterparts, placing in question the Hispanic paradox for disaggregated groups. In addition, Mexicans and Puerto Ricans were younger at the time of CVD deaths compared with Cubans and NHWs, with nearly 20 % of CVD deaths occurring before 50 years of age, a fact that has received little attention in the public health and epidemiologic literature.

Given the wide range of CVD risk factors among Hispanic subgroups, we should disaggregate cause-specific CVD mortality to inform appropriate preventive strategies and offer personalized treatment for these diverse groups. In our study, we disaggregated all-cause CVD mortality into ischemic CVD, hypertensive CVD, heart failure, and cerebrovascular disease. We found important differences in cause-specific death by Hispanic subgroups, with Puerto Ricans experiencing higher rates of ischemic and hypertensive heart disease and Mexicans experiencing higher rates of cerebrovascular disease deaths compared with other Hispanic subgroups. Data from the Brain Attack Surveillance in Corpus Christi Project³⁴ demonstrated greater than a 2-fold increased incidence of stroke among Mexican Americans aged 45 to 49 years compared with NHWs, which supports our findings of an excess burden of stroke mortality among younger Mexicans. Genetic differences in susceptibility to stroke among the 3 subgroups may explain some of the marked disparity. Our findings are also likely explained by differences in CVD risk factors by subgroups, as documented by other studies,^{8,20} which can in turn be targeted toward prevention efforts. For example, data from the Hispanic Community Health Study/Study of Latinos showed that Puerto Ricans have the highest prevalence of current cigarette smoking among Hispanic subgroups, with 35 % of men and 32 % of women identifying as current smokers.³⁵ This prevalence may account for the observed differences in ischemic heart disease mortality. Alternatively, differences in awareness and control of risk factors (eg, blood pressure, glucose levels) among Hispanic subgroups^{35–37} may account for the observed findings. In data from the National Health and Nutrition Examination Survey and the National Health Interview Survey,²⁰ Mexicans with hypertension had an overall prevalence of uncontrolled hypertension of 72 % (almost 80 % among men), likely accounting for the differences in cerebrovascular disease mortality, particularly among younger individuals.

Studies in other racial and ethnic groups have shown the value of studying cause-specific CVD mortality. The Ni-Hon-San study,³⁸ for example, demonstrated an inverse relationship in Japanese Americans between acculturation and stroke and a positive relationship between acculturation and coronary heart disease. Work examining mortality disparities among Asian American subgroups confirms differential outcomes in cause of death by Asian American subgroups (Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese), a group traditionally considered a model minority when evaluated in aggregate.¹⁵ Similarly, Jose and colleagues¹⁹ showed that mortality rates for ischemic heart disease were higher among Asian Indian populations and that all Asian subgroups had greater cerebrovascular disease mortality compared with NHWs. The study also documented that younger Filipino and Asian Indians experienced higher CVD mortality compared with NHWs.

Limitations

Several limitations of this study warrant mention. Misclassification of race and ethnicity data on mortality records may have led to underreporting of mortality rates³⁹; however, recent studies have ascertained that Hispanic classification on death records is reasonably accurate, with a net ascertainment of Hispanic classification just 3 % higher on survey records compared with death certificates.¹³ With a potential 3 % misclassification of Hispanic race and/or ethnicity on the death records, rates may be slightly underestimated, and this relatively small misclassification rate varies across subgroups.¹³ Misclassification of the

underlying cause of CVD death is also possible although likely to be nondifferential among subgroups. Our study focused on CVD deaths, but variability in competing mortality risks among subgroups (ie, cancer)⁴⁰ may affect our findings.

Cultural differences may also explain misclassification of cause of death; for example, Hispanic populations are less often willing to withdraw care during catastrophic hospitalizations.^{41–43} Statistical immortality conferred by reverse migration (ie, individuals may migrate to their country of origin to die) may result in an underestimation of deaths. However, this explanation is unlikely for Puerto Ricans because they are captured in national US death surveillance data, and Cubans are not readily able to return home. In addition, differential migration patterns (ie, for Cubans to the United States) may account for differences in age distributions among the 3 Hispanic subgroups. However, all mortality comparisons are age adjusted, allowing for comparisons across populations with different mean age distributions.

The comparison group of all Hispanics includes a heterogeneous population of Spaniards, Dominicans, South and Central Americans, and Latin Americans, which could not be further disaggregated owing to inconsistencies in data collection. We acknowledge that the other Hispanic subgroups listed account for 20 % of this group and collectively contribute to the overall lower mortality rates for this category compared with our 3 subgroups of interest. This group also includes Hispanics who did not provide a country of origin when responding to the Hispanic question in the US Census, estimated to represent about 16 % of the sample.¹³ We chose these 3 subgroups because they are specifically enumerated on the US Census.⁴⁴ Each of the subgroups that we studied have a different history of racial admixture (ie, Native American, European, and African), and this factor may have led to the differences we observed.⁷

Last, we were unable to measure differences in individual characteristics such as socioeconomic status, area of residence, acculturation metrics, health behaviors, and variation in risk factor prevalence, which may partly account for our findings because these variables likely drive the observed differences among groups. Future studies will seek to link mortality, clinical, and socioeconomic data to further explore potential explanations for our observations.

Conclusions

Through this national study of 10 years of mortality data, we found marked heterogeneity in cause-specific CVD mortality among the 3 largest Hispanic subgroups in the United States. Findings from this study suggest that aggregation of Hispanics as a single group fails to capture important differences in CVD outcomes for this increasingly important and growing segment of the population. Public health efforts should be geared toward culturally appropriate interventions to reduce the burden of CVD risk factors in this diverse population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

Question

What are the differences in mortality rates due to cardiovascular disease among Hispanic subgroups compared with non-Hispanic whites in the United States?

Findings

This examination of US mortality data from 2003 to 2012 for the 3 largest Hispanic subgroups found an overall decrease in mortality levels due to cardiovascular disease. However, Mexicans and Puerto Ricans were younger at the time of death compared with non-Hispanic white participants, Mexicans experienced lower total and cardiovascular disease mortality than Puerto Ricans or Cubans, Puerto Ricans experienced higher rates of ischemic heart disease deaths, and Mexicans had higher rates of cerebrovascular disease deaths.

Meaning

The current aggregate classification of Hispanics masks heterogeneity in the reporting of mortality due to cardiovascular disease, leading to an incomplete understanding of health risks and outcomes among Hispanic subgroups.

Figure 1. Proportional Mortality Rate Ratios

Rate ratios are stratified by age and sex for ischemic heart disease and cerebrovascular disease by race and/or ethnicity.

Figure 2. Cardiovascular Disease Mortality

Data are stratified by race and/or ethnicity and sex from National Center for Health Statistics mortality data (2003–2012).

Figure 3. Ischemic Heart Disease Mortality

Data are stratified by race and/or ethnicity and sex from National Center for Health Statistics mortality data (2003–2012).

Figure 4. Cerebrovascular Disease Mortality

Data are stratified race and/or ethnicity and sex from National Center for Health Statistics mortality data (2003–2012).

Table

Demographic Characteristics of Deaths Among Adults by Race and/or Ethnicity, 2003–2012^a

Characteristic	Ethnicity, % of Population Group				
	All Hispanics	Cuban	Mexican	Puerto Rican	NHW
No. of population					
Total	249 494 170	11 588 813	146 421 918	23 498 113	1 381 195 228
Deaths	1 247 178	130 397	688 074	163 335	19 357 160
CVD deaths	387 656	49 013	207 487	51 912	6 623 593
Age, mean (SD), y	68 (18)	77 (14)	67 (18)	68 (17)	76 (15)
Female	45.6	48.7	44.0	45.9	51.3
Foreign born	56.8	95.8	44.8	79.7	5.1
Age category, y					
25–49	17.1	5.3	19.1	16.4	6.6
50–64	20.9	11.5	21.9	23.8	15.2
65–79	29.2	30.6	28.9	30.6	29.0
80	32.9	52.6	30.0	29.1	49.3
Educational level					
Less than high school	52.0	39.9	61.1	42.9	23.3
High school but not bachelor's degree	38.1	41.3	32.0	48.1	58.2
Bachelor's degree or more	6.4	15.3	3.6	5.4	14.6

Abbreviations: CVD, cardiovascular disease; NHW, non-Hispanic white.

^aBased on census data for adults 25 years or older during the study period.