2019

Biological Risk Profiles Among Latino Subgroups in the Health and Retirement Study

Catherine García

Jennifer A. Ailshire

Innovation in Aging
cite as: *Innovation in Aging*, 2019, Vol. 3, No. 2, 1–14
doi:10.1093/geroni/igz017
Advance Access publication June 29, 2019

Special Section: Latino Aging and Health: Original Research Article

Biological Risk Profiles Among Latino Subgroups in the Health and Retirement Study

Catherine García, MS* and Jennifer A. Ailshire, PhD

Leonard Davis School of Gerontology, University of Southern California, Los Angeles, California.

*Address correspondence to: Catherine García, MS, Leonard Davis School of Gerontology, University of Southern California, 3715 McClintock Avenue, Room 215, Los Angeles, CA 90089–0191. E-mail: perezcat@usc.edu

Received: December 1, 2018; Editorial Decision Date: May 23, 2019

Decision Editor: Steven Albert, PhD

Abstract

Background and Objectives: Latinos residing in the United States exhibit an increased risk for cardiovascular and metabolic diseases compared to non-Latino whites. This elevated risk contributes to a significantly higher prevalence of diabetes and hypertension among Latino adults. Examining biological risk profiles of older Latinos as a "pan-ethnic group" and by Latino subpopulations may help to explain the increased burden of disease in later life among this population. The objective of this study is to document biological risk profiles among a nationally representative sample of older U.S. Latinos by nativity and country of origin.

Research Design and Methods: We use the 2006–2012 Health and Retirement Study to compare cardiovascular, metabolic, inflammatory and cumulative biological risk among U.S.-born Mexicans, foreign-born Mexicans, U.S.-born Puerto Ricans, island-born Puerto Ricans, U.S.-born "other" Latinos, foreign-born "other" Latinos, and non-Latino whites.

Results: Older Latinos exhibit heterogeneous biological risk profiles. U.S.-born Mexicans, foreign-born Mexicans, U.S.-born "other" Latinos, and foreign-born "other" Latinos exhibited a higher rate of cardiovascular risk relative to non-Latino whites. In addition, U.S.-born Mexicans, foreign-born Mexicans, island-born Puerto Ricans, and foreign-born "other" Latinos had a higher rate of metabolic risk than non-Latino whites. Island-born Puerto Ricans were the only group to exhibit higher inflammation than non-Latino whites. The observed differences were largely attenuated by socioeconomic status, indicating that high levels of risk among older Latino subpopulations compared to non-Latino whites are associated with lower socioeconomic status.

Discussion and Implications: Older U.S. Latinos are a demographically diverse population with unique sociocultural characteristics which may contribute to differences in biological risk across the life course that influence disease progression. Examining Latinos by nativity and country of origin may help identify risks specific to individual subpopulations that can lead to culturally appropriate interventions which help prevent and reduce the burden of cardiovascular and metabolic diseases.

Translational Significance: Higher cardiovascular, metabolic, and inflammation risk varies among Latinos by nativity and country of origin. Differences in risk compared to U.S. born non-Latino whites, and among Latinos, are largely explained by differences in socioeconomic status.

Keywords: Biological processes, Country of origin, Latinos, Nativity, Physiological dysregulation

Prior research indicates older Latinos residing in the United States have comparable health and mortality outcomes to non-Latino whites (hereafter, whites) despite their lower socioeconomic status (Elo, Turra, Kestenbaum, & Ferguson, 2004; Markides & Eschbach, 2005). Most studies on trends and health patterns in the Latino population have relied on self-reported health indicators. Although self-reported health provides important information on population health, these measures assume that an individual has interacted with the health care system for a doctor/physician to diagnose them with a health condition. Such an assumption has implications for how we understand overall health patterns in any given population. In particular, evaluating disease burden among Latinos based solely on self-reports may result in an inaccurate depiction of overall health patterns due to low rates of health insurance coverage, reduced health care access, differences in utilization/source of care, and cultural and language barriers, which may preclude them from obtaining a medical diagnosis from a healthcare professional (Morales, Lara, Kington, Valdez, & Escarce, 2002; Tienda & Mitchell, 2006; White, Haas, & Williams, 2012). This is of particular importance as mounting evidence indicates older Latinos have longer life expectancies and lower mortality than whites (Arias, Heron, & Xu, 2017; Fenelon, Chinn, & Anderson, 2017). Moreover, Latinos have been found to spend a larger proportion of their late-life with morbidity, disability, and cognitive impairment (Cantu, Hayward, Hummer, & Chiu, 2013; Garcia et al., 2019; Garcia, Garcia, Chiu, Raji, & Markides, 2018; Hayward, Hummer, Chiu, González-González, & Wong, 2014), which draws into question the quality of life in old age among this rapidly aging population.

Biological risk factors used to assess health such as blood pressure, blood glucose, and cholesterol provide objective indicators of health status that are measured consistently across individuals, and are not reliant on knowledge or interaction with the health care system (Goldman, Glei, Lin, & Weinstein, 2009; Weinstein, Vaupel, & Wachter, 2007). The collection of biological data in large population-based surveys, such as the Health and Retirement Study, provide a novel opportunity to expand our understanding of Latino health by examining the underlying mechanisms leading to disease, disability, cognitive impairment, and death among a demographically diverse population. Research shows biomarkers predict a variety of health outcomes, and the use of these measures has the potential benefit of improving the health of older adults by screening for early stage illnesses that may ameliorate negative health outcomes across the life-course (Crimmins, Vasunilashorn, Kim, & Alley, 2008).

Prior studies have examined racial/ethnic, and nativity differences in biological risk profiles among the adult population in the United States. In general, these studies document that foreign-born Latinos and individuals of Mexican descent have comparable risk profiles as whites, whereas U.S.-born Mexicans exhibit higher-risk profiles, independent of socioeconomic status, health behaviors, and acculturation factors (Crimmins, Kim, Alley, Karlamangla, & Seeman, 2007; Peek et al., 2010). However, less research has examined biological risk profiles among a nationally representative population of older Latino subgroups. Latinos residing in the United States are comprised of individuals from demographically diverse backgrounds that include more than 20 distinct countries of origin (Lopez, Gonzalez-Barrera, & Cuddington, 2013). Recent evidence suggests heterogeneous patterns in morbidity, mortality, and longevity among older Latinos are due in part to sociocultural differences by nativity and country of origin (Fenelon et al., 2017; Garcia, Garcia, & Ailshire, 2018; Garcia et al., 2018), indicating that the demographic diversity within this population needs to be taken into account if we are to address the underlying mechanisms that lead to differential health outcomes. Thus, using biological indicators to examine the risk profiles of older Latinos may help elucidate whether differences in sociocultural factors among Latino subgroups contribute to variations in health across the life-course.

The present study builds on prior research by investigating racial/ethnic, nativity, and country of origin differences in biological risk profiles among adults ages 50 and older in the United States. We used measured indicators of physiological status that include cardiovascular, metabolic, and inflammation markers to examine differentials in risk profiles among older Latino subgroups relative to whites. Examining differences in biological risk profiles across racial/ethnic, nativity, and country of origin groups may lead to a better understanding of the mechanisms and pathways that create and sustain health disparities observed in late-life disease.

Background

Latinos residing in the United States have been found to be at an increased risk for cardiovascular and metabolic diseases compared to whites (Roger et al., 2012). This elevated risk contributes to a significantly higher prevalence of diabetes and hypertension among Latino adults. For instance, the age-adjusted prevalence of diabetes and hypertension is 12.1% and 27.8% among Latinos aged 18 years and older compared to 7.4% and 27.8% for whites (Center for Disease Control and Prevention, 2017; Fryar, Ostchega, Hales, Zhang, & Kruszon-Moran, 2017). However, prevalence estimates based on self-reports may be underreporting the total disease burden and disease risk among this population as Latinos are more likely to have undiagnosed diabetes and hypertension relative to whites (Center for Disease Control and Prevention, 2017). In addition, Latinos have also been found to have a higher prevalence of prediabetes (Center for Disease Control and Prevention, 2017; Cowie et al., 2009) and prehypertension (Okosun, Boltri, Anochie, & Chandra, 2004) than whites. Overall, these findings suggest that without preventive

measures, undiagnosed and prestages of illness increase the risk for progression to overt chronic disease. Since Latinos are less likely to receive preventive care compared to whites, getting a diagnosis often occurs later in the course of the disease (Chatterji, Joo, & Lahiri, 2010; Davidson et al., 2007), where the risk for complications increase with duration of the disease. Thus, the examination of biological indicators that can help prevent late-life health disparities is warranted.

Measures of cumulative biological risk incorporate multiple markers of functioning across physiological systems to determine overall health risk. Cumulative biological risk captures how chronic adversity accelerates biological aging due to the "wear and tear" of biological systems that are related to subsequent onset of disease, disability, cognitive decline and mortality (Crimmins & Seeman, 2004; McEwen & Seeman, 1999). Evidence on cumulative biological risk shows Latinos have a higher average biological risk score than whites (Crimmins et al., 2007), which makes them particularly vulnerable to cardiovascular and metabolic diseases. Yet, it remains unclear how differences in sociocultural and demographic characteristics combined with exposure to adverse circumstances (i.e., discrimination and low socioeconomic status) lead to physiological disparities within the Latino population.

Studies examining biological risk profiles among Latinos are scarce; however, emerging evidence indicates there are heterogeneous risk patterns among Latino subgroups by nativity and country of origin. For example, using a nationally representative sample of adults ages 40 years and older from the National Health and Nutrition Examination Surveys (NHANES), Crimmins and colleagues (2007) showed Latinos as a pan-ethnic group and individuals of Mexican-origin exhibited higher levels of biological risk compared to whites. Moreover, this study documented a higher level of biological risk for U.S.-born Mexican Americans relative to their foreign-born counterparts, independent of socioeconomic status, health related behaviors, and health care access. The authors attributed these findings to immigrant selection among the foreign-born, and minority status among the U.S.-born (Crimmins et al., 2007). Similarly, research using data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) found that U.S.-born Latinos ages 18–74 years had a higher biological risk than their foreign-born counterparts, though the foreign-born health advantage declined with advancing age (55 years and older) and increased duration in the United States (Salazar et al., 2016). Additionally, this study documented differences in biological risk by country of origin with Puerto Ricans exhibiting higher average biological risk scores and South Americans exhibiting lower biological risk scores compared to Mexicans, Cubans, Dominicans, and Central Americans (Salazar et al., 2016).

Additional research on inflammation burden among Mexican-origin adults aged 60 years and older shows the importance of immigration status. Using data from the Sacramento Area Latino Study on Aging (SALSA), Martin, Haan, Fernandez-Rhodes, Lee, and Aiello, 2018) found that second- and third-generation Mexican Americans had higher levels of inflammation than Mexican immigrants. This study further documented that higher inflammation among immigrants was associated with increased duration in the United States (Martin et al., 2018). Overall, these findings indicate that biological risk profiles among Latinos vary by nativity status and country of origin suggesting there may be significant heterogeneity in the total burden of disease risk within the Latino population. However, a limitation of these studies is that they primarily focus on the Mexican-origin population, regional samples, and Latinos at younger ages, leaving a dearth of knowledge regarding within-Latino subgroups differences by nativity and country of origin among the broader population of older U.S. Latinos.

Latinos are a demographically diverse population and we would expect that biological risk profiles across Latino subgroups will vary as there are documented differences in the social, economic, political, and immigration experiences of these groups. Differences in sociocultural characteristics based on nativity and country of origin may influence exposures to stressors (e.g., early-life adversity, residential segregation, poor socioeconomic status) over the life-course that accelerate biological aging by promoting physiological dysregulation, which contributes to variation in late-life diseases (Crimmins, Kim, & Vasunilashorn, 2010). In addition, each major U.S. Latino subgroup has a distinct socio-political history and cultural orientation, which may lead to variations in socioeconomic incorporation that result in diverging life trajectories and cumulative exposure to stress.

For instance, older island-born Puerto Ricans and foreign-born Cubans are differentiated by distinct sociopolitical circumstances that have characterized their life experiences in the United States. The experience of Puerto Ricans is largely influenced by their status as U.S. citizens that allow them to more easily migrate to and from the U.S. mainland than other foreign-born Latino subgroups (Duany, 2002). The dire economic circumstances of the island contribute to substantial out migration of Puerto Ricans to the mainland in search of educational and economic opportunities. However, once on the mainland, Puerto Ricans experience increased levels of discrimination, and are more likely to be socially and residentially isolated (Aranda & Rivera, 2016; Santiago & Galster, 1995; Velez & Burgos, 2010). In contrast, early waves of Cuban immigrants received refugee status and resettlement assistance from the government, which facilitated their economic incorporation into U.S. society (Cislo, Spence, & Gayman, 2010). Furthermore, foreign-born Cubans are more likely to live in ethnic enclaves that provide social and economic resources and are less likely to perceive discrimination than other Latino subgroups (Pérez, Fortuna, & Alegría, 2008). Conversely, Mexicans experience a cumulative exposure to

a combination of discrimination and general stress associated with low socioeconomic status related to their minority and immigration status in the United States (Flores et al., 2008). These heterogeneous experiences of Latinos in chronic adversity may impose "wear and tear" on biological systems, which increases risk for morbidity over the life-course and contributes to Latino health disparities in late life (Garcia et al., 2018; McEwen & Seeman, 1999).

The objective of this study is to document biological risk profiles among a demographically diverse, nationally representative sample of older Latino subgroups by nativity and country of origin. Given differences in social and economic conditions related to physiological dysregulation, we expect that biological risk profiles will differ across Latino subgroups. We use measures of cardiovascular, metabolic, and inflammation risk as these biomarkers are associated with physiological processes that contribute to the pathophysiology and risk for cardiovascular and metabolic diseases. Examining physiological systems individually in addition to a cumulative measure may be more informative for assessing Latino subgroup risk profiles. It is possible that individual risk factors among Latino subgroups may be more concentrated in some physiological systems than in others.

Method

Data

The data come from the 2006–2012 Health and Retirement Study (HRS), an ongoing nationally representative survey of adults over age 50 in the contiguous United States. The HRS, which began in 1992, conducts interviews with surviving respondents approximately every 2 years. In addition, a new cohort of older adults is added to the sample every 6 years (e.g., 1998, 2004, 2010). The HRS is a multistage area probability sample of U.S. households, with oversamples of African Americans, Latinos, and Floridians. Details on sample design and measurement validation have been published elsewhere (Hauser & Willis, 2004; Juster & Suzman, 1995). In 2006, a random one-half of the sample was selected to participate in an enhanced face-to-face (EFTF) interview, which included the collection of anthropometric measurements and blood samples in the homes of community-dwelling respondents (Crimmins, et al., 2013; Crimmins, Guyer, Ofstedal, Wallace, & Weir, 2008). Biomarkers were collected from the other half of the HRS sample in 2008. In 2010, there was a refresher sample where a random one-half of the new sample was selected to participate in an EFTF, with the other half receiving an EFTF in 2012. Overall completion rates for biomarker assessments ranged from 81 to 87% across the four waves.

Sample Selection

The 2006–2012 HRS has information on 13,442 Latino and white respondents aged 50 years and older who have a biomarker weight. We omitted 347 (2.6%) individuals who were missing information on the following variables: biomarkers, education, smoking status, exercise, and health insurance. An analysis of missing data (results available upon request) showed that white males and whites aged 80 years and older were more likely to have missing information. Ancillary analyses (results available upon request) including a missing indicator did not significantly change the results reported with listwise deletion. Since the data missing constitutes less than 3% of the total sample, omitting these individuals is inconsequential and do not bias the results (Bennett, 2001; Schafer, 1999). After excluding individuals with missing data, the final analytical sample includes 13,095 respondents: 578 U.S.-born Mexicans, 620 foreign-born Mexicans, 62 U.S.-born Puerto Ricans, 138 island-born Puerto Ricans, 113 foreign-born Cubans, 112 U.S.-born "other" Latinos, 186 foreign-born "other" Latinos, and 11,286 U.S.-born non-Latino whites.

Measures

Biological risk factors

We created risk scores for cardiovascular functioning, metabolic functioning, inflammation, and cumulative biological risk (Table 2) by summing the number of biological risk factors that met clinical or research defined high-risk criteria for each biomarker. Cardiovascular functioning included three indicators: systolic blood pressure, diastolic blood pressure, and pulse rate. Guidelines for high-risk were defined as ≥140 mmHg for systolic blood pressure, ≥90 mmHg for diastolic blood pressure, and ≥90 for pulse rate (Cook, Togni, Schaub, Wenaweser, & Hess, 2006; National High Blood Pressure Education Program, 2004). Metabolic functioning included five indicators: total cholesterol, high-density lipoprotein (HDL) cholesterol, glycated hemoglobin, cystatin-C, and obesity. Guidelines for high-risk were defined as ≥240 mg/dL for total cholesterol, <40 mg/dL for HDL cholesterol, ≥6.5% for glycated hemoglobin, ≥1.55 mg/dL for cystatin-C, and obesity is a dichotomous indicator of individuals with a body mass index of 30 kg/m^2 (Brown, Zhang, Mitchell, & Ailshire, 2018; Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001; Kumar et al., 2010). Inflammation included one indicator: C-reactive protein (CRP), a measure of systemic inflammation. Guidelines for high-risk were defined as ≥3.0 mg/L for CRP (Ridker, 2003). Following previous research, we created a summary measure (range 0–9) that indicated the number of elevated risk factors present across the three systems.

Sociodemographics and health behaviors

Covariates included in the models are: race/ethnicity, nativity, age, sex, education, poverty status, smoking status, exercise, and health insurance. Respondents were classified based on self-reported race/ethnicity, birthplace information, and country of origin, which include: U.S.-born

Mexicans, foreign-born Mexicans, U.S.-born Puerto Ricans, island-born Puerto Ricans, foreign-born Cubans, U.S.-born "other" Latinos, foreign-born "other" Latinos, and U.S.-born non-Latino whites. Respondents were categorized as being U.S.-born if they were born in one of the 50 states in the United States, and foreign-born if born outside the United States, including its territories (i.e., Puerto Rico). Latinos whose country of origin could not be ascertained are grouped into an "other" Latino category. U.S.-born Cubans are omitted due to small sample size. Age is a categorical variable that includes respondents aged 50–59, 60–69, 70–79, and 80+. Sex is a dichotomous variable that includes females and males.

We examined two aspects of socioeconomic status that may account for race/ethnic, nativity, and country of origin differences in biological risk profiles: educational attainment distinguishes respondents with less than a high school education, high school education, and more than a high school education. Poverty status is determined by the ratio of total household income to the official poverty thresholds established by the U.S. Census Bureau, which varies by family composition and year. Ratios less than 1.00 (or 100%) reflect living below poverty, whereas values greater than 1.00 reflect income farther away from poverty.

To better account for sources of racial/ethnic, nativity, and country of origin differences in biological risk, we also controlled for health behaviors and availability of medical care. Smoking status distinguishes respondents who never-smoked, former smokers, and current smokers. We included an indicator for lack of physical activity (i.e., no vigorous or moderate activity in the last month, and individuals who cannot exercise due to physical limitations). We also controlled for current health insurance availability based on respondent reports of whether they had any health insurance (e.g., government or private), which we used as a proxy for access to health care.

Analytic Strategy

First, we examined demographic, socioeconomic, behavioral, and biomarker characteristics by race/ethnicity, nativity, and country of origin. We compare differences between groups using chi-squared tests. Next, we examined differences in biological risk profiles between Latinos as a pan-ethnic group and whites, and then by Latino subgroups to highlight within-Latino differences. The term Latino will be used to denote Latinos as a pan-ethnic group that includes Mexicans, Puerto Ricans, Cubans, and "other" Latinos. Negative binomial regression models were used to estimate the rate ratios of cumulative biological risk (range 0–9), cardiovascular risk (range 0–3), and metabolic risk (range 0–5). Logistic regression was used to determine the relative likelihood of having inflammation (range 0–1). In Model 1, we controlled for age and sex as biological risk varies across these population groups. In Model 2, we additionally controlled for socioeconomic status (SES) to examine how differences in biological risk profiles by race/ethnicity, nativity, and country of origin would change. Finally, in Model 3, we added controls for health behaviors and access to care to determine whether race/ethnicity, nativity, and country of origin differences were independent of these factors. All models controlled for year of interview to account for differences in reporting year. We account for the complex survey design of HRS by using Stata's *svy* commands, which adjusts for differential sampling probabilities and nonresponse, population stratification, and sample weights. Analyses were conducted using Stata version 14.

Results

Descriptive Statistics

Table 1 shows sample characteristics by race/ethnicity, nativity, and country of origin. Among Latinos, foreign-born Mexicans are the largest subgroup (34.3%), followed by U.S.-born Mexicans (31.9%), foreign-born "other" Latinos (10.3%), island-born Puerto Ricans (7.6%), foreign-born Cubans (6.3%), U.S.-born "other" Latinos (6.2%), and U.S.-born Puerto Ricans (3.4%). U.S.-born Puerto Ricans and foreign-born Mexicans were the youngest groups in the sample, whereas foreign-born Cubans and U.S.-born "other" Latinos were the oldest. Across all groups, females comprised the majority of the sample (ranging from 50.0 to 63.1%). All Latino subgroups reported less education and greater poverty than whites. However, education and poverty levels varied significantly by nativity and country of origin among older Latinos. For instance, foreign-born Mexicans reported the lowest levels of educational attainment and highest proportion of poverty among Latino subgroups, whereas U.S.-born "other" Latinos and foreign-born Cubans exhibited the highest level of educational attainment and lowest proportion of poverty among Latino subgroups.

All Latino subgroups, except for U.S.-born Puerto Ricans and island-born Puerto Ricans, reported lower rates of smoking than whites. While most respondents reported not engaging in physical activity, island-born Puerto Ricans and foreign-born Cubans had the highest proportion of respondents that did not engage in any physical activity. Most respondents reported having health insurance coverage, though foreign-born Mexicans reported lower rates of insurance coverage compared to other subgroups.

High-Risk Categorization of Biomarkers

Table 2 shows the distribution of high-risk biological risk factors by race/ethnicity, nativity, and country of origin. Measured high systolic and diastolic blood pressure was more prevalent across Latino subgroups than whites, except for foreign-born Cubans in systolic blood pressure. High pulse rate, total cholesterol, and HDL cholesterol did

Table 1. Demographic, Socioeconomic, and Health Behavior Characteristics by Race/Ethnicity, Nativity, and Country of Origin Presented as Weighted Percentages, HRS 2006–2012

	U.S.-born Mexican	Foreign-born Mexican	U.S.-born Puerto Rican	Island-born Puerto Rican	Foreign-born Cuban	U.S.-born "other" Latino	Foreign-born "other" Latino	U.S.-born white
Age[a]								
50–59	49.1	56.8	76.3	44.7	20.1	29.5	35.3	42.8
60–69	33.6	27.6	17.3	37.8	31.8	34.9	37.4	28.9
70–79	13.0	11.8	4.9	11.1	33.4	23.0	16.8	17.7
80+	4.3	3.8	1.5	6.4	14.8	12.6	10.6	10.6
Female[a]	54.6	50.0	55.7	50.8	55.8	55.0	63.1	53.0
Education[a]								
<HS	44.1	78.1	17.0	51.3	40.6	34.0	53.0	11.9
HS	28.3	10.8	45.4	19.7	27.1	26.2	19.3	33.6
>HS	27.6	11.1	37.7	29.0	32.3	39.7	27.7	54.5
Poverty Status[a]								
0–99%	20.5	32.2	18.3	29.7	19.8	15.6	20.3	5.3
100–299%	37.4	46.7	45.0	43.8	42.7	34.7	44.3	29.2
300% and above	42.0	21.1	36.7	26.6	37.5	49.8	35.4	65.5
Smoking Status[a]								
Current smoker	15.9	13.5	27.9	16.1	12.1	14.9	7.7	15.6
Former smoker	43.9	34.6	39.1	42.4	31.2	42.7	36.9	41.5
Nonsmoker	40.2	51.9	32.9	41.5	56.7	42.4	55.3	42.9
No Physical Activity[a]	60.9	55.1	46.6	82.8	77.6	56.0	60.2	54.9
Health Insurance[a]	79.2	56.3	90.8	85.9	96.1	91.5	77.5	90.7
N	578	620	62	138	113	112	186	11,286

Note: HRS = Health and Retirement Study; HS = High school.

[a]Significant race/ethnic, nativity, and country of origin differences at $p < .05$.

Table 2. Percent High-Risk on Individual Biomarkers by Race/Ethnicity, Nativity, and Country of Origin, HRS 2006–2012

		Race/Ethnicity/Nativity							
Biological risk indicators	High-risk cut points	U.S.-born Mexican	FB Mexican	U.S.-born Puerto Rican	IB Puerto Rican	FB Cuban	U.S.-born "other" Hispanic	FB "other" Hispanic	U.S. white
Cardiovascular Risk Factors									
Systolic Blood Pressure[a]	≥140 mm Hg	37.3	37.6	35.2	42.4	31.6	46.6	44.3	33.5
Diastolic Blood Pressure[a]	≥90 mm Hg	23.9	22.9	21.6	24.5	26.5	28.9	30.7	21.3
Pulse Rate	≥90 bpm	6.9	8.6	13.4	6.5	4.4	6.5	7.6	6.9
Metabolic Risk Factors									
Total Cholesterol	≥240 mg/dL	21.0	19.6	21.3	19.2	11.8	26.3	23.5	21.7
High-density lipoprotein Cholesterol	<40 mg/dL	29.0	24.5	12.3	29.1	32.3	20.4	32.7	24.5
Glycated Hemoglobin[a]	≥6.5%	29.4	27.5	11.6	20.9	20.3	23.0	23.4	13.0
Cystatin-C[a]	≥1.55 mg/dL	11.6	8.8	7.0	12.7	19.5	16.2	10.1	12.5
Obesity[a]	≥30 kg/m^2	45.0	41.8	35.9	48.0	35.6	29.5	36.3	32.4
Inflammation Risk Factor									
C-Reactive Protein	≥3.0 mg/L	42.8	37.8	35.9	48.9	46.7	47.7	42.1	39.8

Note: HRS = Health and Retirement Study; FB = foreign-born; IB = island-born.
[a]Significant race/ethnic, nativity, and country of origin differences at $p < .05$.

not differ across race/ethnicity, nativity, and country of origin groups. High glycated hemoglobin was more prevalent among all Latino subgroups (apart from U.S.-born Puerto Ricans) than whites, with U.S.-born Mexicans exhibiting the highest levels of elevated glycated hemoglobin. Elevated levels of cystatin-C were observed among island-born Puerto Ricans, foreign-born Cubans, and U.S.-born "other" Latinos. All Latino subgroups (apart from U.S.-born Latino subgroups) were more likely to be obese than whites. Finally, there were no significant racial/ethnic, nativity, and country of origin differences observed in inflammation.

Cumulative Biological Risk

Table 3 shows incidence rate ratios (IRR) and 95% confidence intervals (CI) for total biological risk across cardiovascular, metabolic, and inflammation systems by race/ethnicity, nativity, and country of origin. IRRs between zero and one indicate lower rates for biological risk, and IRRs greater than one indicate higher rates for biological risk. First, we present the results for cumulative biological risk between Latinos as a pan-ethnic group and whites. Overall, Latinos had a greater rate of biological risk than whites (IRR = 1.24, 95% CI: 1.17, 1.30), independent of age and sex (Model 1). When we included SES (Model 2), the rate of biological risk was reduced substantially but remained significant, such that Latinos still had a greater rate of biological risk compared to whites (IRR = 1.08, 95% CI: 1.03, 1.13). Accounting for health behaviors and access to care do not further explain differences in biological risk among Latinos.

Examining the demographic diversity among Latino subgroups highlights significant heterogeneity in biological risk by race/ethnicity, nativity, and country of origin. U.S.-born Mexicans (IRR = 1.24, 95% CI: 1.16, 1.33), foreign-born Mexicans (IRR = 1.21, 95% CI: 1.12, 1.30), island-born Puerto Ricans (IRR = 1.26, 95% CI: 1.09, 1.45), and foreign-born "other" Latinos (IRR = 1.17, 95% CI: 1.05, 1.27) had a higher biological risk than whites, independent of age and sex (Model 1). Controlling for SES (Model 2) attenuates the differences observed among each Latino subgroup, except for U.S.-born Mexicans. U.S.-born Mexicans continued to exhibit higher rates of biological risk independent of educational attainment and poverty status (IRR = 1.13, 95% CI: 1.05, 1.21). Further accounting for health behaviors and access to care (Model 3) did not explain greater biological risk among U.S.-born Mexicans.

Cardiovascular Risk

Table 4 shows IRR and 95% CI for cardiovascular risk by race/ethnicity, nativity, and country of origin. Examining cardiovascular risk between Latinos as a pan-ethnic group and whites shows that Latinos had a higher rate of cardiovascular risk compared to whites (IRR = 1.23, 95% CI: 1.14, 1.33), controlling for age and sex (Model 1). After we controlled for SES (Model 2), cardiovascular risk was reduced for Latinos, but they still had a higher rate of cardiovascular risk than whites (IRR = 1.13, 95% CI: 1.03, 1.23), which indicated that Latinos had a higher risk for poor cardiovascular health independent of their SES. Including health behaviors and access to health care (Model 3) did not change the results in the previous model, suggesting that health behaviors and access to care do not explain differences in cardiovascular risk among Latinos.

When analyzing cardiovascular risk by Latino subgroups, we find heterogeneous patterns in risk such that that U.S.-born Mexicans (IRR = 1.18, 95% CI: 1.03,

Table 3. IRRs and 95% CI of Cumulative Biological Risk by Race/Ethnicity, Nativity, and Country of Origin, HRS 2006–2012

	M1[a]		M2[b]		M3[c]	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Panel A: All Latinos						
U.S.-born white (ref)						
Latinos	1.21***	(1.16, 1.26)	1.08**	(1.03, 1.13)	1.09***	(1.04, 1.14)
Panel B: Latino Subgroups						
U.S.-born white (ref)						
U.S.-born Mexican	1.24***	(1.16, 1.33)	1.13***	(1.05, 1.21)	1.13***	(1.06, 1.21)
Foreign-born Mexican	1.21***	(1.12, 1.30)	1.03	(0.95, 1.11)	1.05	(0.97, 1.14)
U.S.-born Puerto Rican	1.11	(0.92, 1.34)	1.03	(0.86, 1.25)	1.05	(0.87, 1.25)
Island-born Puerto Rican	1.26**	(1.09, 1.45)	1.11	(0.94, 1.30)	1.07	(0.91, 1.26)
Foreign-born Cuban	1.11	(0.94, 1.30)	1.02	(0.87, 1.20)	1.01	(0.86, 1.18)
U.S.-born "other" Latino	1.14	(0.99, 1.32)	1.08	(0.94, 1.24)	1.10	(0.96, 1.26)
Foreign-born "other" Latino	1.1**	(1.05, 1.27)	1.06	(0.94, 1.16)	1.06	(0.96, 1.18)

Note: CI = Confidence interval; HRS = Health and Retirement Study; IRR = Incidence rate ratio.

[a]Model 1 controls for age, sex, and year of interview. [b]Model 2 additionally controls for education and poverty status. [c]Model 3 additionally controls for smoking, physical activity, and health insurance.

*$p < .05$, **$p < .01$, ***$p < .001$.

1.35), foreign-born Mexicans (IRR = 1.27, 95% CI: 1.11, 1.46), U.S.-born "other" Latinos (IRR = 1.25, 95% CI: 1.00, 1.57), and foreign-born "other" Latinos (IRR = 1.29, 95% CI: 1.06, 1.58) had a higher rate of cardiovascular risk than whites, controlling for age and sex (Model 1). After we controlled for SES (Model 2), we found no significant differences in the rate of cardiovascular risk between Latino subgroups and whites, indicating that the race/ethnicity, nativity, and country of origin differences in cardiovascular risk were a result of SES disparities experienced by these Latino subgroups. Health behaviors and access to care (Model 3) did not change the results.

Metabolic Risk

Table 5 shows the IRR and 95% CI for metabolic risk by race/ethnicity, nativity, and country of origin. In Model 1, controlling for age and sex, shows that Latinos as a pan-ethnic group had a higher rate of metabolic risk than whites (IRR = 1.24, 95% CI: 1.17, 1.30). After we controlled for SES (Model 2), metabolic risk was reduced for Latinos, though they continued to exhibit a higher rate of metabolic risk than whites (IRR = 1.11, 95% CI: 1.04, 1.17). Health behaviors and access to care did not explain greater metabolic risk among older Latinos.

Table 4. IRRs and 95% CI of Cardiovascular Risk by Race/Ethnicity, Nativity, and Country of Origin, HRS 2006–2012

	M1[a]		M2[b]		M3[c]	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Panel A: All Latinos						
U.S.-born white (ref)	—	—	—	—	—	—
Latinos	1.23***	(1.14, 1.33)	1.13**	(1.03, 1.23)	1.13**	(1.04, 1.24)
Panel B: Latino Subgroups						
U.S.-born white (ref)						
U.S.-born Mexican	1.18*	(1.03, 1.35)	1.09	(0.95, 1.26)	1.10	(0.96, 1.26)
Foreign-born Mexican	1.27***	(1.11, 1.46)	1.13	(0.97, 1.31)	1.12	(0.96, 1.30)
U.S.-born Puerto Rican	1.40	(0.88, 2.24)	1.34	(0.83, 2.16)	1.36	(0.84, 2.19)
Island-born Puerto Rican	1.25	(0.97, 1.62)	1.15	(0.88, 1.49)	1.16	(0.89, 1.51)
Foreign-born Cuban	1.01	(0.75, 1.36)	0.95	(0.71, 1.29)	0.96	(0.71, 1.29)
U.S.-born "other" Latino	1.25*	(1.00, 1.57)	1.21	(0.96, 1.52)	1.22	(0.96, 1.54)
Foreign-born "other" Latino	1.29*	(1.06, 1.58)	1.20	(0.98, 1.48)	1.21	(0.99, 1.48)

Note: CI = Confidence interval; HRS = Health and Retirement Study; IRR = Incidence rate ratio.
[a]Model 1 controls for age, sex, and year of interview. [b]Model 2 additionally controls for education and poverty status. [c]Model 3 additionally controls for smoking, physical activity, and health insurance.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 5. IRRs and 95% CI of Metabolic Risk by Race/Ethnicity, Nativity, and Country of Origin, HRS 2006–2012

	M1[a]		M2[b]		M3[c]	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Panel A: All Latinos						
U.S.-born white (ref)						
Latinos	1.24***	(1.17, 1.30)	1.10***	(1.04, 1.17)	1.11**	(1.04, 1.17)
Panel B: Latino Subgroups						
U.S.-born white (ref)						
U.S.-born Mexican	1.33***	(1.23, 1.45)	1.21***	(1.11, 1.33)	1.21***	(1.10, 1.32)
Foreign-born Mexican	1.23***	(1.13, 1.35)	1.05	(0.96, 1.16)	1.08	(0.98, 1.19)
U.S.-born Puerto Rican	0.98	(0.74, 1.30)	0.91	(0.68, 1.20)	0.92	(0.70, 1.21)
Island-born Puerto Rican	1.25*	(1.03, 1.51)	1.10	(0.90, 1.35)	1.03	(0.84, 1.27)
Foreign-born Cuban	1.13	(0.92, 1.39)	1.05	(0.85, 1.29)	1.01	(0.83, 1.24)
U.S.-born "other" Latino	1.07	(0.88, 1.30)	1.02	(0.85, 1.23)	1.04	(0.87, 1.25)
Foreign-born "other" Latino	1.15*	(1.01, 1.30)	1.04	(0.92, 1.18)	1.05	(0.92, 1.19)

Note: CI = Confidence interval; HRS = Health and Retirement Study; IRR = Incidence rate ratio.
[a]Model 1 controls for age, sex, and year of interview. [b]Model 2 additionally controls for education and poverty status. [c]Model 3 additionally controls for smoking, physical activity, and health insurance.
*$p < .05$, **$p < .01$, ***$p < .001$.

Latino subgroup analyses revealed significant heterogeneity in metabolic risk such that U.S.-born Mexicans (IRR = 1.33, 95% CI: 1.23, 1.45), foreign-born Mexicans (IRR = 1.23, 95% CI: 1.13, 1.35), island-born Puerto Ricans (IRR = 1.25, 95% CI: 1.03, 1.51), and foreign-born "other" Latinos (IRR = 1.15, 95% CI: 1.01, 1.30) had a higher rate of metabolic risk than whites, independent of age and sex (Model 1). Including SES (Model 2), the observed Latino subgroup differences were no longer apparent, except for U.S.-born Mexicans. Thus, for U.S.-born Mexicans, the increased metabolic risk cannot be explained by educational attainment or poverty status. Accounting for health behaviors and access to care (Model 3) did not explain greater metabolic risk among U.S.-born Mexicans.

Inflammation Risk

Table 6 shows odds ratio (OR) and 95% CI for inflammation risk by race/ethnicity, nativity, and country of origin. ORs between zero and one indicate lower risk for inflammation, and ORs greater than one indicates greater risk for inflammation. In Model 1, results indicate that Latinos as a pan-ethnic group had an increased risk for inflammation relative to whites (OR = 1.16, 95% CI: 1.02, 1.32), independent of age and sex. However, controlling for SES (Model 2) attenuated the Latino-white difference observed, suggesting that greater inflammation risk was concentrated among Latinos with lower SES. The addition of health behaviors and access to health care did not change the results observed in the previous model.

Latino subgroup analyses revealed that the observed Latino-white difference in inflammation appears to be primarily concentrated among older island-born Puerto Ricans (Model 1). Our findings indicate that island-born Puerto Ricans were more likely to have inflammation than whites (OR = 1.58, 95% CI: 1.01, 2.50), independent of age and sex. Controlling for SES in Model 2 attenuates the observed disparity for island-born Puerto Ricans, indicating that island-born Puerto Ricans with low SES are at higher risk for inflammation. In addition, our results suggest that accounting for SES confers an advantage among foreign-born Mexicans, such that they are less likely to have inflammation than whites (OR = 0.71, 95% CI: 0.56, 0.90). The addition of health behaviors and access to care in Model 3 did not explain greater inflammation risk.

Discussion

This study examined biological risk profiles among a demographically diverse population of older Latinos. These risk profiles included cardiovascular, metabolic, and inflammation markers associated with physiological processes that contribute to the pathophysiology and risk for cardiovascular and metabolic diseases. Consistent with prior research we found that cumulative biological risk was higher among Latinos, when viewed as a pan-ethnic group, relative to whites (Crimmins et al., 2007); although, high levels of biological risk varied substantially within Latino subgroups by nativity and country of origin. Specifically, we document that U.S.-born Mexicans, foreign-born Mexicans, island-born Puerto Ricans, and foreign-born "other" Latinos exhibited significantly higher levels of cumulative biological risk relative to whites. However, this association disappeared for all Latino subgroups, with the exception of U.S.-born Mexicans, once we accounted for educational attainment and poverty status. Consistent with prior research, our findings indicate that high levels of cumulative biological risk observed among Latino subgroups

Table 6. ORs and 95% CI of Inflammation Risk by Race/Ethnicity, Nativity, and Country of Origin, HRS 2006–2012

	M1[a]		M2[b]		M3[c]	
	OR	95% CI	OR	95% CI	OR	95% CI
Panel A: All Latinos						
U.S.-born white (ref)						
Latinos	1.16*	(1.02, 1.32)	0.87	(0.75, 1.00)	0.93	(0.80, 1.08)
Panel B: Latino Subgroups						
U.S.-born white (ref)						
U.S.-born Mexican	1.19	(0.96, 1.48)	0.94	(0.75, 1.17)	0.97	(0.77, 1.22)
Foreign-born Mexican	1.08	(0.87, 1.36)	0.71**	(0.56, 0.90)	0.82	(0.64, 1.05)
U.S.-born Puerto Rican	1.09	(0.55, 2.13)	0.91	(0.47, 1.74)	0.90	(0.46, 1.78)
Island-born Puerto Rican	1.58*	(1.01, 2.50)	1.16	(0.70, 1.91)	1.11	(0.67, 1.85)
Foreign-born Cuban	1.36	(0.86, 2.14)	1.12	(0.72, 1.76)	1.11	(0.72, 1.73)
U.S.-born "other" Latino	1.29	(0.80, 2.05)	1.12	(0.71, 1.77)	1.18	(0.75, 1.86)
Foreign-born "other" Latino	0.95	(0.66, 1.36)	0.73	(0.49, 1.07)	0.81	(0.55, 1.20)

Note: CI = Confidence interval; HRS = Health and Retirement Study; OR = Odds ratio.

[a]Model 1 controls for age, sex, and year of interview. [b]Model 2 additionally controls for education and poverty status. [c]Model 3 additionally controls for smoking, physical activity, and health insurance.

*$p < .05$, **$p < .01$, ***$p < .001$.

relative to whites were related to low socioeconomic status (Crimmins et al., 2007). Moreover, our results indicate that the cumulative biological risk among U.S.-born Mexicans is driving the overall biological risk for Latinos as a pan-ethnic group. Prior studies have documented a U.S.-born Mexican disadvantage in biological risk relative to their foreign-born counterparts, which is indicative of their minority status in U.S. society (Crimmins et al., 2007; Peek et al., 2010). Conversely, U.S.-born Puerto Ricans, foreign-born Cubans, and foreign-born "other" Latinos exhibited comparable biological risk profiles to whites, which highlights the importance of examining the demographic heterogeneity within Latino subgroups by nativity and country of origin.

In addition to documenting differentials in cumulative biological risk among Latino subgroups relative to whites, we examined three physiological systems separately to assess whether overall differences were driven by individual or multiple indicators of biological risk. Our findings indicate that the overall high-risk among Latinos when viewed as a pan-ethnic group relative to whites is largely driven by cardiovascular and metabolic risk indicators. However, contrary to previous findings, our results indicate that U.S.-born Mexicans have a higher overall biological risk relative to whites, which is largely reflective of their higher metabolic risk (Crimmins et al., 2007). Cardiovascular, metabolic, and inflammation indicators also varied largely among older Latinos by nativity and country of origin. For example, U.S.-born Mexicans, foreign-born Mexicans, U.S.-born "other" Latinos, and foreign-born "other" Latinos had higher levels of cardiovascular risk relative to whites. Although, these associations disappeared once we accounted for socioeconomic status. Results from the HCHS/SOL show variation in cardiovascular risk factors among Latinos by country of origin with some subgroups, particularly Puerto Ricans, exhibiting high rates of cardiovascular risk factors compared to Mexicans, Cubans, Dominicans, Central and South Americans (Daviglus et al., 2012). These findings also document that Latinos with lower socioeconomic status have higher rates of cardiovascular risk factors compared to Latinos with higher socioeconomic status, suggesting *both* sociocultural factors and socioeconomic status influence cardiovascular risk among Latinos.

Higher levels of metabolic risk were found for U.S.-born Mexicans, foreign-born Mexicans, island-born Puerto Ricans, and foreign-born "other" Latinos compared to whites. These associations disappeared once we accounted for socioeconomic status, except for U.S.-born Mexicans. Socioeconomic, behavioral characteristics, and health care access did not explain the higher levels of metabolic risk among U.S.-born Mexicans relative to whites. Previous research documenting a continued disadvantage among U.S.-born Mexican Americans has suggested that the health profile among this particular Latino subgroup reflects their minority status and having excess stress that stems from experiences of perceived ethnic discrimination (Flores et al., 2008). In a study of middle-aged and older Latinos in the United States, it was found that Mexican participants who reported greater chronic stress had a significantly higher risk for metabolic syndrome (Ortiz, Myers, Dunkel Schetter, Rodriguez, & Seeman, 2015). Therefore, psychosocial predictors of metabolic risk among older U.S.-born Mexicans should be considered in assessments of cardiovascular and metabolic diseases.

Finally, we document that inflammation risk was also significantly higher among Latinos relative to whites. Analyses of Latino subgroups by nativity and country of origin revealed that the increased risk for inflammation among the overall older Latino population was largely driven by the island-born Puerto Rican population, which was the only Latino subgroup to have increased risk for inflammation relative to whites. However, the increased risk in inflammation among island-born Puerto Ricans was concentrated among those with low socioeconomic status. Research specific to Boston, MA showed that Puerto Ricans with lower income and educational attainment were more likely to engage in unhealthy lifestyle behaviors that increased their risk of inflammation (Sotos-Prieto et al., 2016). This suggests that island-born Puerto Ricans may benefit from following healthy behaviors to reduce inflammation but will need program outreach that considers socioeconomic status to address knowledge gaps to improve health and reduce disparities.

Our study shows that older Latinos with higher metabolic, cardiovascular, inflammation, and overall cumulative biological risk were primarily concentrated among individuals with lower socioeconomic status. The impact of lower educational attainment and high poverty on physiological aging may be the result of the cumulative levels of stress (e.g., discrimination, diminished opportunities, financial strain) associated with low socioeconomic status experienced across the life-course (Seeman, Epel, Gruenewald, Karlamangla, & McEwen, 2010). Empirical research has provided evidence that stress and resource constraints among individuals with low socioeconomic status are associated with physiological dysregulation (Singer & Ryff, 1999). Among older Latinos, sociocultural differences by nativity status and country of origin may contribute to the exposure of real and perceived challenges associated with low socioeconomic status that influence the initiation and progression of physiological dysregulation across the life-course. For example, Mexicans, Puerto Ricans, and "other" Latinos have a higher prevalence of reporting discrimination than Cubans (Pérez et al., 2008) that may influence multisystem biological dysregulation due to the cumulative impact of exposure of unfair treatment. Other factors such as racial identification and phenotypical skin color among older Latino subgroups may serve as another mechanism contributing to psychosocial stressors (e.g., racial discrimination) that influences physiological responses. For example, self-identified Black Latinos have sociodemographic profiles similar to non-Latino Blacks

(i.e., low income, higher levels of poverty, and lower rates of home ownership) (Ortiz & Telles, 2012), which suggests that the accumulative processes of socioeconomic disadvantage due to racial mistreatment increases their vulnerability to disease-related outcomes in later life. Future studies should further disaggregate Latinos by racial identification to understand racialized patterns of physiological functioning. The HRS does include information on race for Latinos, however, there is not a sufficient number of Latinos who self-identify as Black, Native American, or Asian to conduct a meaningful analysis.

Limitations

Our study had several limitations. First, we only have country of origin data specific to the three largest Latino subgroups in the United States: Mexicans, Puerto Ricans, and Cubans, which precludes us from making further inferences about other Latino subgroups captured under the pan-ethnic label. Second, this study does not include additional inflammation biomarkers (e.g., fibrinogen, albumin, IL-6) as they are not available in the HRS. The lack of Latino subgroup differences in inflammation, therefore, should be interpreted with caution since it is based on the only measure of inflammation available in the HRS, C-reactive protein. Third, the biological assessments in the HRS are from blood spots and not whole blood, which is the gold-standard for collecting biological measures, and measures of metabolic functioning in particular. However, prior research has shown that measures derived from blood spots correlate well with those from whole blood samples (Chambers, Percy, Hardie, & Borchers, 2013). Lastly, our sample was comprised of community-dwelling older adults who were able to participate in the HRS biomarker data collection. The sample excludes individuals residing in nursing homes and respondents who were unable to or declined the data collection. Thus, this sample is not representative of the non-institutionalized population and may be healthier than the overall U.S. population.

Despite the above limitations our study makes an important contribution to the literature on the health of older Latinos by documenting the demographic heterogeneity in biological risk profiles by nativity and country of origin. Older Latinos residing in the United States are a demographically diverse population and have unique sociocultural characteristics that may create and sustain differences in biological risk across the life-course. The identification of nativity and country of origin differences in cardiovascular, metabolic, and inflammation risk factors may be used to develop targeted interventions aimed at reducing cardiovascular and metabolic diseases in later life among older Latinos.

Funding

This research work was supported by the National Institutes of Health/National Institute on Aging (R36AG057949 to Catherine Pérez and R00AG039528 to Jennifer A. Ailshire).

Conflict of Interest

None reported.

References

Aranda, E., & Rivera, F. I. (2016). Puerto Rican families in central Florida: Prejudice, discrimination, and their implications for successful intergration. *Women, Gender, and Families of Color*, **4**, 57. doi:10.5406/womgenfamcol.4.1.0057

Arias, E., Heron, M., & Xu, J. (2017). United States life tables, 2014. *National Vital Statistics Reports*, **66**, 1–64.

Bennett, D. A. (2001). How can I deal with missing data in my study? *Australian and New Zealand Journal of Public Health*, **25**, 464–469. doi:10.1111/j.1467-842X.2001.tb00294.x

Brown, L. L., Zhang, Y. S., Mitchell, C., & Ailshire, J. (2018). Does telomere length indicate biological, physical, and cognitive health among older adults? Evidence from the Health and Retirement Study. *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences*, **73**, 1626–1632. doi:10.1093/gerona/gly001

Cantu, P. A., Hayward, M. D., Hummer, R. A., & Chiu, C. T. (2013). New estimates of racial/ethnic differences in life expectancy with chronic morbidity and functional loss: Evidence from the national health interview survey. *Journal of Cross-Cultural Gerontology*, **28**, 283–297. doi:10.1007/s10823-013-9206-5

Center for Disease Control and Prevention. (2017). *National Diabetes Statistics Report, 2017*. Atlanta, GA. Retrieved from http://www.diabetes.org/assets/pdfs/basics/cdc-statistics-report-2017.pdf

Chambers, A. G., Percy, A. J., Hardie, D. B., & Borchers, C. H. (2013). Comparison of proteins in whole blood and dried blood spot samples by LC/MS/MS. *Journal of the American Society for Mass Spectrometry*, **24**, 1338–1345. doi:10.1007/s13361-013-0678-x

Chatterji, P., Joo, H., & Lahiri, K. (2010). *Beware of Unawareness: Racial/Ethnic Disparities in Awareness of Chronic Diseases (No. w16578)*. Cambridge, MA: National Bureau of Economic Research. doi:10.3386/w16578

Cislo, A. M., Spence, N. J., & Gayman, M. D. (2010). The mental health and psychosocial adjustment of Cuban immigrants in south Florida. *Social Science & Medicine*, **71**, 1173–1181. doi:10.1016/j.socscimed.2010.06.001

Cook, S., Togni, M., Schaub, M. C., Wenaweser, P., & Hess, O. M. (2006). High heart rate: A cardiovascular risk factor? *European Heart Journal*, **27**, 2387–2393. doi:10.1093/eurheartj/ehl259

Cowie, C. C., Rust, K. F., Ford, E. S., Eberhardt, M. S., Byrd-Holt, D. D., Li, C.,…Geiss, L. S. (2009). Full accounting of diabetes and pre-diabetes in the U.S. population in 1988-1994 and 2005-2006. *Diabetes Care*, **32**, 287–294. doi:10.2337/dc08-1296

Crimmins, E. M., & Seeman, T. E. (2004). Integrating biology into the study of health disparities. *Population and Development Review*, **30**, 89–107.

Crimmins, E. M., Faul, J., Kim, J. K., Guyer, H., Langa, K., Ofstedal, M. B., … Weir, D. (2013). Documentation of Biomarkers in the 2006 and 2008 Health and Retirement Study. HRS Documentation Report. Retrieved from http://hrsonline.isr.umich.edu/sitedocs/userg/Biomarker2006and2008.pdf

Crimmins, E. M., Guyer, H., Ofstedal, M. B., Wallace, R., & Weir, D. (2008). Documentation of physical measures, anthropometrics

and blood pressure in the Health and Retirement Study. HRS Documentation Report. Retrieved from https://hrs.isr.umich.edu/sites/default/files/biblio/dr-011.pdf

Crimmins, E. M., Kim, J. K., Alley, D. E., Karlamangla, A., & Seeman, T. (2007). Hispanic paradox in biological risk profiles. *American Journal of Public Health*, **97**, 1305–1310. doi:10.2105/AJPH.2006.091892

Crimmins, E. M., Kim, J. K., & Vasunilashorn, S. (2010). Biodemography: New approaches to understanding trends and differences in population health and mortality. *Demography*, **47**(S), S41–S64. doi:10.1353/dem.2010.0005

Crimmins, E., Vasunilashorn, S., Kim, J. K., & Alley, D. (2008). Biomarkers related to aging in human populations. Advances in *Clinical Chemistry*, **46**, 161–216. doi:10.1016/S0065-2423(08)00405-8

Davidson, J. A., Moreno, P. R., Badimon, J. J., Lopez-Candales, A., Maisonet Giachello, A. L., Ovalle, F.,…Kannel, W. B. (2007). Cardiovascular disease prevention and care in Latino and Hispanic subjects. *Endocrine Practice*, **13**, 77–85. doi:10.4158/EP.13.1.77

Daviglus, M. L., Talavera, G. A., Avilés-Santa, M. L., Allison, M., Cai, J., Criqui, M. H.,…Stamler, J. (2012). Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. *JAMA*, **308**, 1775–1784. doi:10.1001/jama.2012.14517

Duany, J. (2002). *The Puerto Rican Nation on the Move: Identities on the Island and in the United States*. Chapel Hill, NC: University of North Carolina Press.

Elo, I. T., Turra, C. M., Kestenbaum, B., & Ferguson, B. R. (2004). Mortality among elderly Hispanics in the United States: Past evidence and new results. *Demography*, **41**, 109–128. doi:10.1353/dem.2004.0001

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. (2001). Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA*, **285**, 2486–2497. doi:10.1001/jama.285.19.2486

Fenelon, A., Chinn, J. J., & Anderson, R. N. (2017). A comprehensive analysis of the mortality experience of Hispanic subgroups in the united states: Variation by age, country of origin, and nativity. *SSM - Population Health*, **3**, 245–254. doi:10.1016/j.ssmph.2017.01.011

Flores, E., Tschann, J. M., Dimas, J. M., Bachen, E. A., Pasch, L. A., & de Groat, C. L. (2008). Perceived discrimination, perceived stress, and mental and physical health among Mexican-origin adults. *Hispanic Journal of Behavioral Sciences*, **30**, 401–424. doi:10.1177/0739986308323056

Fryar, C. D., Ostchega, Y., Hales, C. M., Zhang, G., & Kruszon-Moran, D. (2017). *Hypertension prevalence and control among adults: United States, 2015–2016* (No. . NCHS data brief, no 289.). Hyattsville, MD. Retrieved from https://www.cdc.gov/nchs/data/databriefs/db289.pdf

Garcia, M. A., Downer, B., Chiu, C. T., Saenz, J. L., Rote, S., & Wong, R. (2019). Racial/ethnic and nativity differences in cognitive life expectancies among older adults in the United States. *The Gerontologist*, **59**, 281–289. doi:10.1093/geront/gnx142

Garcia, C., Garcia, M. A., & Ailshire, J. A. (2018). Sociocultural variability in the Latino population: Age patterns and differences in morbidity among older US adults. *Demographic Research*, **38**, 1605–1618. doi:10.4054/DemRes.2018.38.52

Garcia, M. A., Garcia, C., Chiu, C.-T., Raji, M., & Markides, K. S. (2018). A comprehensive analysis of morbidity life expectancies among older Hispanic subgroups in the United States: Variation by nativity and country of origin. *Innovation in Aging*, **2**, 1–12. doi:10.1093/geroni/igy014

Goldman, N., Glei, D. A., Lin, Y. H., & Weinstein, M. (2009). Improving mortality prediction using biosocial surveys. *American Journal of Epidemiology*, **169**, 769–779. doi:10.1093/aje/kwn389

Hauser, R. M., & Willis, R. J. (2004). Survey design and methodology in the Health and Retirement Study and the Wisconsin Longitudinal Study. *Population and Development Review*, **30**, 209–235. doi:10.7826/isr-um.06.585031.001.05.0012.2005

Hayward, M. D., Hummer, R. A., Chiu, C. T., González-González, C., & Wong, R. (2014). Does the Hispanic paradox in U.S. Adult mortality extend to disability? *Population Research and Policy Review*, **33**, 81–96. doi:10.1007/s11113-013-9312-7

Juster, F. T., & Suzman, R. (1995). An overview of the health and retirement study. *The Journal of Human Resources*, **30**, S7. doi:10.2307/146277

Kumar, P. R., Bhansali, A., Ravikiran, M., Bhansali, S., Dutta, P., Thakur, J. S.,…Walia, R. (2010). Utility of glycated hemoglobin in diagnosing type 2 diabetes mellitus: A community-based study. *The Journal of Clinical Endocrinology and Metabolism*, **95**, 2832–2835. doi:10.1210/jc.2009-2433

Lopez, M. H., Gonzalez-Barrera, A., & Cuddington, D. (2013). *Diverse origins: The nation's 14 largest Hispanic-origin groups*. Washington, DC: Pew Hispanic Center. Retrieved from http://www.pewhispanic.org/2013/06/19/diverse-origins-the-nations-14-largest-hispanic-origin-groups/

Markides, K. S., & Eschbach, K. (2005). Aging, migration, and mortality: Current status of research on the Hispanic paradox. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **60** (Spec No 2), 68–75. doi:10.1093/geronb/60.special_issue_2.s68

Martin, C. L., Haan, M. N., Fernandez-Rhodes, L., Lee, A., & Aiello, A. E. (2018). Association between immigration history and inflammatory marker profiles among older adult Mexican Americans. *Biodemography and Social Biology*, **64**, 30–42. doi:10.1080/19485565.2018.1449631

McEwen, B. S., & Seeman, T. (1999). Protective and damaging effects of mediators of stress. Elaborating and testing the concepts of allostasis and allostatic load. *Annals of the New York Academy of Sciences*, **896**, 30–47. doi:10.1111/j.1749–6632.1999.tb08103.x

Morales, L. S., Lara, M., Kington, R. S., Valdez, R. O., & Escarce, J. J. (2002). Socioeconomic, cultural, and behavioral factors affecting Hispanic health outcomes. *Journal of Health Care for the Poor and Underserved*, **13**, 477–503. doi:10.1353/hpu.2010.0630

National High Blood Pressure Education Program. (2004). *The seventh report of the joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. Bethesda, MD: National Heart, Lung, and Blood Institute (US).

Okosun, I. S., Boltri, J. M., Anochie, L. K., & Chandra, K. M. (2004). Racial/ethnic differences in prehypertension in American adults: Population and relative attributable risks of abdominal obesity. *Journal of Human Hypertension*, **18**, 849–855. doi:10.1038/sj.jhh.1001771

Ortiz, M. S., Myers, H. F., Dunkel Schetter, C., Rodriguez, C. J., & Seeman, T. E. (2015). Psychosocial predictors of metabolic syndrome among Latino groups in the Multi-Ethnic Study of Atherosclerosis (MESA). *Plos One*, **10**, e0124517. doi:10.1371/journal.pone.0124517

Ortiz, V., & Telles, E. (2012). Racial identity and racial treatment of Mexican Americans. *Race and Social Problems*, **4**, 41–56. doi:10.1007/s12552-012-9064-8

Peek, M. K., Cutchin, M. P., Salinas, J. J., Sheffield, K. M., Eschbach, K., Stowe, R. P., & Goodwin, J. S. (2010). Allostatic load among non-Hispanic whites, non-Hispanic blacks, and people of Mexican origin: Effects of ethnicity, nativity, and acculturation. *American Journal of Public Health*, **100**, 940–946. doi:10.2105/AJPH.2007.129312

Pérez, D. J., Fortuna, L., & Alegria, M. (2008). Prevalence and correlates of everyday discrimination among U.S. Latinos. *Journal of Community Psychology*, **36**, 421–433. doi:10.1002/jcop.20221

Ridker, P. M. (2003). C-reactive protein: A simple test to help predict risk of heart attack and stroke. *Circulation*, **108**, e81–e85. doi:10.1161/01.CIR.0000093381.57779.67

Roger, V. L., Go, A. S., Lloyd-Jones, D. M., Benjamin, E. J., Berry, J. D., Borden, W. B., … Turner, M. B. (2012). Heart disease and stroke statistics—2012 Update: A report from the American Heart Association. *Circulation*, **125**, e2–e220. doi:10.1161/CIR.0b013e31823ac046

Salazar, C. R., Strizich, G., Seeman, T. E., Isasi, C. R., Gallo, L. C., Avilés-Santa, M. L.,…Kaplan, R. C. (2016). Nativity differences in allostatic load by age, sex, and Hispanic background from the Hispanic Community Health Study/Study of Latinos. *SSM - Population Health*, **2**, 416–424. doi:10.1016/j.ssmph.2016.05.003

Santiago, A. M., & Galster, G. (1995). Puerto Rican segregation in the United States: Cause or consequence of economic status? *Social Problems*, **42**, 361–389. doi:10.2307/3096853

Schafer, J. L. (1999). Multiple imputation: A primer. *Statistical Methods in Medical Research*, **8**, 3–15. doi:10.1177/096228029900800102

Seeman, T., Epel, E., Gruenewald, T., Karlamangla, A., & McEwen, B. S. (2010). Socio-economic differentials in peripheral biology: Cumulative allostatic load. *Annals of the New York Academy of Sciences*, **1186**, 223–239. doi:10.1111/j.1749-6632.2009.05341.x

Singer, B., & Ryff, C. D. (1999). Hierarchies of life histories and associated health risks. *Annals of the New York Academy of Sciences*, **896**, 96–115. doi:10.1111/j.1749–6632.1999.tb08108.x

Sotos-Prieto, M., Bhupathiraju, S. N., Falcon, L. M., Gao, X., Tucker, K. L., & Mattei, J. (2016). Association between a healthy lifestyle score and inflammatory markers among Puerto Rican adults. *Nutrition, Metabolism, and Cardiovascular Diseases: NMCD*, **26**, 178–184. doi:10.1016/j.numecd.2015.12.004

Tienda, & Mitchell. (2006). *Hispanics and the future of America*. Washington, DC: National Academies Press. doi:10.17226/11539

Velez, W., & Burgos, G. (2010). The impact of housing segregation and structural factors on the socioeconomic performance of Puerto Ricans in the United States. *Centro Journal*, **22**, 175–197.

Weinstein, M., Vaupel, J. W., & Wachter, K. W. (2007). *Biosocial Surveys*. Washington, DC: National Academies Press. doi:10.17226/11939

White, K., Haas, J. S., & Williams, D. R. (2012). Elucidating the role of place in health care disparities: The example of racial/ethnic residential segregation. *Health Services Research*, **47**, 1278–1299. doi:10.1111/j.1475-6773.2012.01410.x