Education and Mortality Risk among Hispanic Adults in the United States*

Sarah A. McKinnon[1]

Robert A. Hummer[1]

[1] Population Research Center and Department of Sociology, University of Texas at Austin.

* Paper prepared for presentation at the Population Association of America 2006 Annual Meeting (Los Angeles, CA). We thank Starling Pullum for her computing assistance. This research was supported, in part, by a population center infrastructure grant from the National Institute of Child Health and Human Development (Grant # 5 R24 HD 42849). Please contact Sarah McKinnon at sarah@prc.utexas.edu with any questions or comments.

Introduction

In the United States, the impact of socioeconomic status on racial and ethnic mortality differentials is undeniable. Researchers have consistently found that groups with higher levels of socioeconomic status, namely whites and Asian Americans, have better mortality outcomes than those with lower overall socioeconomic status, such as blacks and American Indians (e.g. Kitagawa and Hauser 1973; Pappas et al. 1993; Elo and Preston 1996; Hayward et al. 2000; Rogers et al. 2000; Molla et al. 2004; Hummer et al. 2004). Indicators of socioeconomic status including income, education, employment status, occupation, and wealth have been found to be strongly associated with mortality risks among a variety of different populations and across time. Yet, for one racial/ethnic group, Hispanics, the link between socioeconomic status and mortality is not as apparent. For at least two decades now, researchers have noted that, in spite of an overall socioeconomic status that is similar to that of blacks, Hispanics tend to exhibit mortality rates much more like those of whites (Markides and Coreil 1986). Termed the epidemiologic paradox, this phenomenon has received a substantial amount of research interest. Initially, most studies demonstrated support for the paradox and concluded that Hispanics appeared to have similar mortality risks when compared to non-Hispanic whites and/or more favorable risks compared to non-Hispanic blacks (Rosenwaike 1987; Abraído-Lanza et al. 1999; Hummer et al. 2000; Elo et al. 2004). Subsequent research has been more critical of the observed findings and has offered a variety of other potential explanations (e.g., immigrant selectivity, return migration selectivity, and racial/ethnic misclassification) for the apparent paradoxical situation for Hispanics (Palloni and Arias 2004; Palloni and Morenoff, 2001; Palloni and Ewbank 2004).

Although both earlier and later studies have contributed to a greater knowledge of overall Hispanic mortality patterns, analyses of the direct effect of socioeconomic status on their

mortality patterns are lacking. As the definition of the epidemiologic paradox is based largely on the unexpectedly low mortality rates of Hispanics given their particular socioeconomic status, thus implying that their socioeconomic status is not impacting their mortality in the expected direction, we believe that this is a critical omission that demands research attention. Therefore, our primary goal in this paper is to quantify the effect that individual-level socioeconomic status has on the mortality for Hispanics as compared to other groups. We select education as our measure of socioeconomic status for several important reasons. First of all, it is fairly constant, changing very infrequently once individuals become adults. Secondly, it has been strongly linked to adult health and mortality outcomes in the U.S. population and among other race/ethnic subgroups. And, finally, it is often considered to be the driving socioeconomic variable in differentiating health and mortality patterns across the lifecourse (Crimmins 2005; Mirowsky and Ross 2003; Smith 2005). In this paper we specifically address three questions: 1) To what extent do differences in education influence mortality differentials between Hispanics and whites and between Hispanics and blacks? 2) Does the education-mortality relationship differ for Hispanic groups in comparison to blacks and whites? 3) How does the education-mortality relationship among Hispanics differ when separate age and nativity groups of adults are considered? To best answer these questions, we utilize data from multiple years of the National Health Interview Survey (NHIS) linked with the Multiple Cause of Death File (MCD), heretofore referred to as the NHIS-MCD. Specific age subpopulations (e.g., 25-59 and 60+) and nativity groups (e.g., foreign-born and native-born) will be separately examined in part of this work to most appropriately address the above questions.

Background

General Studies of Socioeconomic Differences in Mortality

The role of socioeconomic status for mortality risk is well-established. One of the earliest and most comprehensive studies in the United States was conducted by Kitagawa and Hauser (1973), utilizing national and metropolitan (Chicago) mortality data from 1960. The researchers found that higher levels of education were associated with lower overall mortality, infant mortality, and cause-specific mortality risks. They determined that the association was similar for both whites and non-whites; at that time, however, the non-white population of the United States was mostly black. Higher levels of income were also related to lower mortality risks, although the magnitude was somewhat smaller than that of education. For both socioeconomic measures, mortality differentials were greatest for men and for persons aged 25-64.

Utilizing the National Mortality Followback Survey and the National Health Interview Survey (NHIS) from 1986, Pappas et al. (1993) directly compared their findings with those of Kitagawa and Hauser. They reported that lower income and education continued to be associated with higher mortality rates for whites and blacks and for both genders. In addition, they concluded that the relationship between the two socioeconomic status indicators and mortality had actually strengthened since Kitagawa and Hauser's analysis. More recent research in the area of socioeconomic status and mortality has continued to confirm the basic findings of both of the above studies (Elo and Preston 1996; Rogers et al. 2000; Molla et al. 2004), although with some controversy regarding whether or not the socioeconomic mortality differentials are actually increasing or decreasing. Nonetheless, all of these studies have found that both education and income are very strong predictors of adult mortality risk in the United States, even after controlling for a variety of background demographic factors.

A recent study conducted by Smith (2005) provides evidence that studies of socioeconomic status and mortality risk should focus more on education rather than income. Smith found consistent evidence that poor adult health can, and does, impact income by reducing one's ability to work. Therefore, those at greater risk of mortality would also be more likely to have a lower income due to these prior health conditions. In contrast, adult levels of education are rarely affected by adult health because, for the most part, individuals complete their education prior to turning 25 years of age. Smith also found education to be a very strong predictor of health change among persons aged 51 and older; that is, persons with lower levels of education were much more likely to experience negative health during the follow-up period. Moreover, sociological work has strongly emphasized the importance of education for the health outcomes of adults across the lifecourse. Mirowsky and Ross (2003) most forcefully argue that higher levels of education impact individuals' sense of control over their lives, which helps to encourage healthy living. Further, higher levels of education can directly lead to better and more stable employment, higher incomes, and an overall higher standard of living, all of which are associated with better health and lower mortality. We follow the lead of Smith (2005) and Mirowsky and Ross (2003) and focus this study on educational mortality differences among adults.

Studies of Socioeconomic Status and Mortality among Hispanics

The concept of an epidemiologic paradox for Hispanic health was first introduced by Markides and Coreil (1986) based upon a review of studies that examined the health and mortality of Hispanics residing in the southwestern region of the United States. In terms of mortality, Markides and Coreil discovered the life expectancy rates among southwestern Hispanics were comparable to those of whites and substantially higher than those of blacks. In

addition, they also found Hispanic mortality rates from cardiovascular disease and some cancers were significantly lower than rates of nonwhites and more comparable to those of whites. After a thorough review of the studies, the authors concluded that, indeed, a paradox does seem to exist in which "...the health status of Hispanics in the Southwest is much more similar to the health status of other whites than that of blacks although socioeconomically, the status of Hispanics is closer to that of blacks" (p. 253). However, this review did not include any studies that specifically examined the role of socioeconomic status at the individual level for Hispanic mortality risk. In addition, few of the early studies on Hispanic health and mortality differentiated between persons born in the U.S. and those born outside the U.S. and, with their regional focus on the southwest, the authors were primarily presenting information on Hispanics of Mexican-origin.

Although Markides and Coreil concluded their review by stating that future research on the paradox should focus on the effect of socioeconomic (as well as cultural and genetic) factors on Hispanic health, very few studies have examined the impact of such factors on Hispanic mortality, especially in comparison to non-Hispanic whites and blacks. Most recently, social demographic research work in this area has focused more on the technical aspects of Hispanic mortality estimates, e.g., trying to account for selective out-migration, making corrections for questionable data, dealing with the issue of race/ethnic reporting, and more (Elo et al. 2004; Hummer et al. 2004; Palloni and Arias 2004; Turra et al. 2004). Although this whole set of studies agrees that officially reported Hispanic mortality rates are too low because of data quality issues, there is not yet consensus with regard to whether or not Hispanic adult mortality rates are actually slightly lower than whites, the same as whites, or slightly higher than whites. The answer to this question more than likely depends on the Hispanic subgroup in question, whether

or not immigrant Hispanics are separated out from native-born Hispanics, the specific causes of death and age groups that are examined, and the ever-present data quality issues that are particularly important when studying a very mobile population like Hispanics.

A few studies have given some attention to socioeconomic factors of Hispanic mortality. Sorlie et al. (1993) analyzed data from the National Longitudinal Mortality Study and determined that Hispanics tended to have overall and cause-specific mortality rates that were lower than or did not differ significantly from those of non-Hispanics. Their analysis was stratified by not only age and sex but also specific Hispanic and nativity group as well. In terms of socioeconomic status, the authors found that controlling for income had a similar effect on mortality for both Hispanics and non-Hispanics. In a similar study using data from an early version of the NHIS-MCD data set, Liao et al. (1998) analyzed mortality differentials between Hispanic and non-Hispanic groups. They reported that non-Hispanic blacks between the ages of 18 and 64 demonstrated consistently higher relative risks of mortality than non-Hispanic whites. In contrast, Hispanics had greater mortality risk only among the youngest age group (18-44) and equal or lower mortality risks than non-Hispanic whites for all other ages. Among Hispanic sub-groups, they determined that Mexican-origin Hispanics displayed lower mortality risks than other Hispanics. Likewise, they found lower mortality rates among Hispanics born outside the U.S. Socioeconomic status appeared to influence Hispanic mortality as controlling for income led to lower mortality risks vis-à-vis whites for all Hispanic groups across all age groups.

Hummer et al. (1999) also used NHIS-MCD and found that overall mortality risk was significantly higher among non-Hispanic blacks than among non-Hispanic whites, yet found no significant difference between whites and Mexican Americans or other Hispanics. Whereas controlling for nativity did result in a significantly higher mortality risk for both Mexican

Americans and Other Hispanics in comparison to whites, models that included both nativity and socioeconomic status (as well as controls for age, gender, and marital status) closed these gaps. In addition, the researchers conducted regression analyses utilizing racial/ethnic groups that had been differentiated into foreign- and native-born subgroups. They found that foreign-born individuals tended to have lower mortality risks than native-born individuals within most groups. Further, once the controls were included in the models, mortality risk was lower for all foreign-born groups. Thus, they argue that nativity status is a very important axis of differentiation when considering mortality patterns among race/ethnic groups.

In an analysis that further differentiated among the Hispanic subgroups, Hummer et al. (2000) found that Mexican American, Cuban, and other Hispanics had adult mortality risks that did not significantly differ from those of white non-Hispanics. In contrast, Central/South Americans had significantly lower risks while Puerto Ricans had higher risks of mortality. By separate age and sex groups, they found higher mortality risk among Mexican American and Puerto Rican males and females between the ages of 18 and 44 and Cuban and other Hispanic men between the ages of 18 and 44. For all other age and sex groups, mortality risks were equal to or lower for Hispanics than for whites. Thus, it is very important for age subgroups to be considered when comparing the mortality patterns of Hispanics and non-Hispanics. Hummer et al. also found that socioeconomic status had a strong impact on differentiating the mortality risk of Hispanics and non-Hispanic whites, especially for Hispanics of Mexican or Puerto Rican origin. Controlling for income, education, and employment status, Puerto Ricans no longer demonstrated significantly higher mortality risk compared to whites whereas Mexican Americans demonstrated a significantly lower risk than whites. For all other Hispanic groups, the inclusion of socioeconomic status measures resulted in mortality risks that were either

comparable to or better than those of whites. However, they did not formally test interaction terms that could have determined whether or not socioeconomic factors differed in their effects on mortality across the race/ethnic groups.

In 2003 Hunt et al. published the results of an analysis of 14 years of data from the San Antonio Heart Study. Their study results suggest higher Mexican American mortality in comparison to whites from this city in Texas. They reported that Mexican Americans not only demonstrated significantly higher all-cause mortality but also significantly higher cardiovascular and coronary heart disease mortality. However, once controlling for an index of socioeconomic status that included years of education and neighborhood-level income (low income, middle-income, or high-income, respectively), Mexican Americans no longer demonstrated a risk that differed significantly from whites for either all-cause or cause-specific mortality.

Contrary to the above findings, Lin et al. (2003) examined data from the National Longitudinal Mortality Study and concluded that Hispanics had a higher life expectancy than both non-Hispanic whites and blacks. This finding held true for both genders and at all ages (25, 45, and 65). Although their subsequent analysis was limited to only non-Hispanic blacks, non-Hispanic whites, and Hispanic whites, the authors determined that the impact of socioeconomic status for mortality risk seemed to be weakest among Hispanics. Specifically, they found that increasing levels of education and income resulted in the smallest improvements for white Hispanics compared to non-Hispanic whites and blacks for each sex-age group. Likewise, differences in life expectancy between the employed and unemployed were smallest for Hispanics. However, it must be noted that the small number of white Hispanics in certain subgroups of the population resulted in incomplete comparisons. For example, for both men and women, there were insufficient numbers of white Hispanic at the highest education and income

levels to accurately compare with whites and blacks. Moreover, neither specific Hispanic ethnic groups, nor different nativity groups, were considered.

In one of the most recent studies on this topic, Hummer et al. (2004) examined mortality differentials among elderly race/ethnic subpopulations in the United States utilizing NHIS-MCD data from 1989-1997 and, once again, concluded that mortality rates were more favorable for both Mexican-origin and other Hispanic populations when compared to whites and blacks. The authors also determined that nativity status and length of residence in the United States impacted mortality risk, although controlling for nativity did not completely explain the advantageous Hispanic mortality rates. On the whole they found that socioeconomic status had only a modest impact on mortality risk among the elderly Hispanic population. Indeed, after the inclusion of both education and income measures in a regression model predicting mortality, the hazard ratios for Mexican Americans and other Hispanics (compared to whites) only decreased by .05 and .01, respectively.

Although the findings of the above studies vary to some degree, there is some evidence that socioeconomic status impacts Hispanic adult mortality in the expected direction, but perhaps with weaker effects than for other race/ethnic subgroups. However, very few of the previous studies specifically examined socioeconomic effects and none did so in comparison to both non-Hispanic whites and blacks. In addition, many focused on income as its primary measure of socioeconomic status, a potentially problematic socioeconomic variable (Smith 2005). Also, many of the studies to date have not differentiated foreign-born Hispanics from native-born Hispanics, which may be very critical in examining socioeconomic differences in mortality. Educational levels are much lower among foreign-born Hispanics in comparison to native-born Hispanics, especially for Mexican Americans (Saenz 2004). Further, educational changes in the

United States have been so profound over the past 40 years that older persons need to be separated out from younger persons if at all possible when conducting education-mortality analyses. In order to better understand the degree to which the socioeconomic status of Hispanic groups impacts their mortality risk relative to both whites and blacks, careful comparisons across age and nativity groups must be made. This study attempts to address these issues by providing analyses of the impact of educational attainment on mortality risk for Hispanic subgroups as well as for non-Hispanic blacks and whites. Age subgroups and nativity subgroups are separately examined as an important part of this effort.

Data, Measurement, and Methods

Data Set

This study utilizes data from the National Health Interview Survey (NHIS) for the years 1986-1994 linked to the National Death Index (NDI) for the years 1986-1997 (NHIS-MCD) to analyze educational differences in Hispanic adult mortality. NHIS is a cross-sectional nationally representative survey of the civilian non-institutionalized population residing in the United States. (NCHS, 1997) Although the primary purpose of NHIS is to provide information about health, mortality information is available from linkages made from identifying information of adults 18 and older to the NDI. The linkages are conducting utilizing the following criteria: social security number, first and last name, middle initial, father's surname, month and year of birth, age, sex, race, state of birth, and state of residence. The criteria are weighted and summed to determine the quality of potential matches. Although it is not possible to link every individual, we utilize a method recommended by the National Center for Health Statistics that is believed to correctly match 97-98% of individuals (NCHS, 1997). Individuals with poor identifying information, termed ineligibles, are dropped from the study. The advantages of this dataset

include the use of self-reported race/ethnicity from the NHIS and a very large sample size as a result of the merging of six years of survey data with nine years of mortality follow-up data. Further, there is detailed information on a number of demographic and socioeconomic factors that allow for in-depth adult mortality analyses (i.e., Rogers et al. 2000).

Measurement

Race/ethnicity was constructed utilizing two questions in the NHIS. The first, Hispanic Origin, was used to identify the specific Hispanic ethnic groups: Mexican origin, Puerto Rican, and other Hispanics (Cuban, other Latin American, Spanish, and Hispanic but unsure of origin). For persons who identified themselves as non-Hispanic, the second question, Main Racial Background, was used to identify non-Hispanic blacks and whites. As the focus of our study was limited to Hispanics and non-Hispanic whites and blacks, we excluded the following categories: Aleut, Eskimo, or American Indian; Asian/Pacific Islander; other; multiple races; and unknown. We selected Completed Years of Education as our education measure. We categorized education into: 1) Less than 11 years; 2) 12 years; and 3) 13 or more years. Demographic variables included age, sex, marital status, and nativity. In our analyses we utilize age as both a continuous control variable as well as a stratifying variable (25 to 59 and 60 and above). In order to allow for sufficient time for individuals to complete their education, we exclude all individuals below the age of 25 from our analyses. Marital status is measured as a dichotomous variable with currently married individuals differentiated from widowed, divorced, separated, and never married individuals. After 1988 NHIS included a question regarding the number of years an individual has resided in the US. As this question was only asked of individuals who were not born in the United States, nativity status could be ascertained. Thus, for those surveyed after

1988 we differentiate the foreign-born from the native-born. For those surveyed earlier we denote their nativity status as missing.

Methodology

Descriptive analyses are provided for each racial/ethnic group in our sample. Mortality risks are analyzed using proportional hazard models (Allison 1984). In our first model we examine mortality risk for Hispanic adults of all ages compared to whites and blacks controlling only for age, sex, and marital status. The next model includes the addition of nativity status and the third model includes both nativity status and education. In order to test the effect of education on each racial/ethnic group's mortality risks we add a race/ethnicity by education interaction term in our final model. Several of the studies we review above suggest that relationships between education and mortality for the race/ethnic groups are differentiated by age. Therefore, provide proportional hazard models for all age groups as well as for the age groups of 25 to 59 and 60 and above. Finally, in our last set of models, each race/ethnic group is considered separately, with subgroups by nativity also separated out, to best determine if the effect of education on mortality risk differs by race/ethnicity and nativity. Again, we not only conduct hazard models for all ages but also for younger and older adult age groups. All regression coefficients are reported as hazard ratios throughout the analyses. We weight the data according to NHIS-provided weights. While descriptive analyses were conducted using SAS version 9.1, we use Sudaan version 9.0.1 to adjust for the design effects of the NHIS.

Results

Descriptive Results

Table 1 provides descriptive statistics for the demographic and mortality outcome variables for each racial and ethnic group. Whites and blacks constitute the majority of the

sample, followed by Mexican Americans and other Hispanics. The non-Hispanic groups also tend to be older and have a substantially lower percentage of foreign-born. Blacks have, by far, the lowest percentage of currently married individuals (51%) followed by Puerto Ricans (61.5%). In terms of socioeconomic status, Mexican Americans and Puerto Ricans appear to be the most disadvantaged groups whereas whites are the most advantaged. Both Mexican Americans and Puerto Ricans have the highest percentage of people with less than 12 years of education (52.7% and 41.5%) and the lowest percentage of people with 13 or more years of education (19.9% and 26.8%). Consistent with their age compositions, mortality during the follow-up period was highest among non-Hispanic whites (9.0%) and blacks (9.3%) and lowest among Mexican Americans (4.6%).

Table 1 about here

Hazard Models

Table 2 presents the mortality risks of each Hispanic subgroup as well as non-Hispanic blacks compared to non-Hispanic whites for ages 25 and above. As seen in the first model controlling for demographic variables, only blacks have a significantly higher mortality risk than whites. In contrast Mexican-Americans and Puerto Ricans do not differ from whites while other Hispanics are significantly lower. With the inclusion of nativity status both blacks and Puerto Ricans now demonstrate significantly higher mortality risks while the risk among other Hispanics remains significantly lower. Mexican Americans continue to not demonstrate any statistically significant differences from whites, thus, substantiating the assertion of an epidemiologic paradox spelled out by Markides and Coreil (1986).

Table 2 about here

We include our key measure of education in Model 3. Consistent with previous research (Liao et al. 1998; Hummer et al. 2000), controlling for SES leads to significantly lower mortality risk among Mexican Americans vis-à-vis whites. In addition, Puerto Ricans no longer demonstrate a significant difference while the mortality risk of blacks diminishes somewhat (although remains significant). In Model 4, interaction terms for the multiplicative effects of education by race/ethnicity are included, thus allowing us to identify a possible differential impact of education for the specific race/ethnic groups. For ease in interpreting this model we have graphed the results of education on mortality risk for each racial/ethnic group (Graph 1). According to the graph, whites with less than 12 years of education experience a 1.5 times greater risk of death than whites with 13 or more years of education. However, Mexican Americans and other Hispanics with less than 12 years of education experience 1.4 and 1.1 times greater risk than whites with 13 or more years of education. Although their hazard ratios are not statistically significant they are somewhat less than the hazard ratios of whites. In contrast, both Puerto Ricans and blacks with the lowest educational attainment experience greater mortality risks than their white counterparts (1.6 and 1.7).

Graph 1 about here

Continuing on with the graph we find that whites with exactly 12 years of education experience a 1.2 times greater risk of death than whites with 13 or more years of education. For both Mexican Americans and other Hispanics the mortality risks are quite a bit lower and statistically different from those of the referent group (0.9 and 1.1). Again, Puerto Ricans and blacks demonstrate much higher mortality risks than their white counterparts. Examining the last columns we find that the mortality risks of Mexican Americans, Puerto Ricans and other Hispanics are almost identical to those of non-Hispanic whites. However, blacks continue to

demonstrate elevated mortality rates, evidence of a lack of return for educational attainment among this group.

As there is sufficient prior evidence that associations between education and mortality vary by age, we next extend our analysis by estimating hazard models of race/ethnicity, education, and mortality for specific age groups. Table 3 focuses on adults aged 25 through 59. In the first model we see that younger adult Mexican Americans, Puerto Ricans, and non-Hispanic blacks all have significantly elevated mortality risks when compared to younger adult non-Hispanic whites. Only other Hispanics demonstrate a mortality risk that does not differ significantly from that of whites. With the inclusion of nativity this pattern does not change although the coefficients do increase somewhat. As with Table 2 once SES is included in the model, the coefficients decrease for every group especially among Mexican Americans who no longer demonstrate significantly higher mortality risks.

Table 3 about here

Once again, we have graphed the results of the final model from Table 3. According to Graph 2, the overall effect of education for younger adults of every race and ethnic group is much stronger than when we included all adult ages. In addition, the effect vis-à-vis whites also varies somewhat. Whereas whites at the lowest educational level experience a mortality risk that is 2.2 times greater than whites at the highest educational level, other Hispanics experience only a 1.6 times greater risk. In contrast, the risk of mortality among Mexican Americans with less than 12 years of education appears to be quite similar to the risk to their white counterparts. Consistent with the previous graph, Puerto Ricans and blacks demonstrate a much higher penalty for low education with hazard ratios of 2.8. Among whites with 12 years of education the mortality risk is 1.4 times greater than the mortality risk of whites with 13 or more years of

education. The effect of education for both Mexican Americans and other Hispanics at this educational level differs very little from that of whites (1.3 and 1.4, respectively). Again, Puerto Ricans and blacks demonstrate a pattern of greater risks than whites. Finally, at the highest educational level every non-white group experiences elevated mortality risk, demonstrating that perhaps education does have less of an effect than it does for whites.

Graph 2 about here

Table 4 turns to an identical set of models for adults 60 and older. Here, racial/ethnic and educational differences in mortality are less pronounced in comparison to younger adults. This finding has been documented previously and is believed to be most likely due to mortality selection (Crimmins 2005; Hummer et al. 2004). Model 1 shows that for individuals aged 60 and above, non-Hispanic blacks are the only group to demonstrate a significantly higher mortality risk than non-Hispanic whites. Moreover, older Mexican American and other Hispanic display a significantly lower mortality risk than older whites at these ages (with Puerto Ricans approaching significance as well). This pattern remains consistent in the next model, even net of the protective effect of foreign-born nativity. Controlling for education in Model 3, results in a modest reduction in the hazard ratios for each of the minority groups in comparison to whites. However the mortality risk to blacks remains statistically higher while the risks to Mexican Americans and other Hispanics remain statistically lower than those of non-Hispanic whites. Again, the risk to Puerto Ricans appears lower as well and approaches significance.

Table 4 about here

Once the interaction terms for race/ethnicity by education are included (Graph 3), we can see clear evidence that education has a much weaker effect on all racial/ethnic groups aged 60 and above. For older white adults with less than 12 years of education the risk of death is only

1.3 times greater the risk for older white adults with 13 or more years of education. Among all Hispanic groups the risk is even less with a consistent hazard ratio of 1.1. This pattern is evident in the next educational level as well. Whereas whites with 12 years of education have a hazard ratio of 1.2, the hazard ratios of Mexican Americans, Puerto Ricans, and other Hispanics with 12 years of education are 0.7, 1.0, and 0.9, respectively. Although the only group which had significant differences from whites was Mexican Americans at 12 years of education there is a clear pattern suggesting that the effect of education on mortality risks are not consistent across all groups and, in fact, appear much weaker among older Hispanics.

Graph 3 about here

Based upon our analyses in the previous tables and accompanying graphs, education does appear to have a somewhat weaker effect for many of the racial/ethnic groups than it does for whites. In Table 5, we further analyze the education-mortality relationship by estimating models separately for each race/ethnic group. Furthermore, we split Mexican Americans and other Hispanics into foreign- and native-born subgroups because of the high percentage of immigrants within each of those groups. Thus, we present separate proportional hazard models for the following groups: foreign-born Mexican Americans, US-born Mexican Americans, Puerto Ricans, foreign-born other Hispanics, US-born other Hispanics, non-Hispanic blacks, and non-Hispanic whites. We do not differentiate between foreign-born and US-born Puerto Ricans because Puerto Rico is a commonwealth of the United States and because of the small sample size for Puerto Ricans.

Table 5 about here

The effect of education demonstrated in Table 5 is strong and in the expected direction for non-Hispanic blacks and non-Hispanic whites. That is, both blacks and whites with lower

levels of education have higher mortality risks than blacks and whites with higher educational levels. However, within Mexican American and other Hispanic groups, the mortality risk is significantly higher only among US-born individuals with less than 12 years of education. Among all the Hispanic subgroups, education appears to have, by far, the greatest impact on Puerto Ricans. Puerto Ricans with less than 12 years of education have twice the mortality risk than Puerto Ricans with 13 or more years of education. Although not statistically significant (most likely due to a small sample size), Puerto Ricans with 12 years of education do have a hazard ratio of 1.61.

Table 6 about here

To incorporate differential effects by age, Table 6 and Table 7 replicate the above results for those aged 25-59 and those aged 60 and above. In Table 6 we see that, once again, both black and white younger adults have statistically higher mortality risks with lower educational attainment. Likewise, education appears to have a weaker effect for both Mexican Americans and other Hispanics with only US-born Mexican Americans with less than 12 years of education demonstrating a statistically higher risk. Puerto Ricans are more similar to whites and blacks as lower education substantially and significantly increases their mortality risks. Table 7, which includes only individuals aged 60 and above, finds even fewer consistent effects of education. In fact, of all racial/ethnic groups only non-Hispanic whites have significantly higher hazard ratios at every educational level. Whereas blacks with less than 12 years of education do have a significantly higher mortality risk, blacks with 12 years of education do not. In fact, no other racial/ethnic group even approaches significance with the sole exception of foreign-born Mexican Americans with 12 years of education and this coefficient is in the opposite direction than one would expect (0.10).

Table 7 about here

Conclusion

The purpose of this paper is to test the main premise of the epidemiologic paradox, namely, that the socioeconomic status of Hispanics does not have the effect expected on their risk of mortality. To accomplish this we attempted to quantify the individual-level effect that education has on Hispanic mortality vis-à-vis the effect that it has on non-Hispanic whites and blacks. By using interaction terms and creating separate models for each relevant racial/ethnic group, we are able to clearly see that, indeed, socioeconomic status does not have the same impact for some of the Hispanic subgroups as it does for non-Hispanic whites and blacks. Specifically, in Tables 2-4 and Graphs 1-3 we find a distinct pattern in which mortality risks for both Mexican Americans and other Hispanics are often lower than those of non-Hispanic whites at identical educational levels and with identical controls.

Significant amounts of prior research (Hummer et al. 1999; Hummer et al. 2000; Singh and Siapush 2002) as well as our own analyses highlight a "healthy immigrant" effect for racial/ethnic groups in the United States. Therefore, we found it crucial to determine if the effect of education on mortality (or lack, thereof) was consistent for both US- and foreign-born Hispanics. By conducting separate hazard models for US- and foreign-born Mexican Americans and other Hispanics as well as for Puerto Ricans, non-Hispanic whites, and non-Hispanic blacks we are able to directly address this issue. In Tables 5-7 we find that whereas both non-Hispanic whites and blacks have significantly higher mortality risks at lower educational levels, Mexican Americans and other Hispanics do not. Instead, the education coefficients for these two groups are mostly insignificant and even occasionally demonstrate lower mortality risks for those with lower levels of education. Although research has found that mortality patterns can differ

substantially by age (Hummer et al. 2000), our findings held true even after conducting separate analyses for those aged 25 to 59 and those 60 and above.

In summary, it is our finding that; indeed, in the case of Hispanic mortality an epidemiologic paradox does exist. Although some researchers have attempted to argue that the paradox is not truly a paradox but more likely the result of data artifacts or return migration of ill immigrants (Palloni and Arias 2004; Palloni and Morenoff, 2001; Palloni and Ewbank 2004), our research suggests otherwise. Clearly, socioeconomic status does not have the same impact for most Hispanic groups that it has for non-Hispanic whites.

Table 1. Descriptive Statistics of Mortality Risk Factors and Outcomes by Race/Ethnicity, US, 1986-1994

	Mexican American	Puerto Rican	Other Hispanic	Non-Hispanic Black	Non-Hispanic White
Demographic Variables					
Age[+]					
Mean in years (sd)	41.3(13.8)	42.4(13.7)	44.2(15.0)	46.8(15.9)	48.8(16.6)
Sex					
% Male	49.6	43.9	45.4	44.1	47.7
% Female	50.4	56.1	54.6	55.9	52.3
Nativity					
% Foreign-born	34.9	45.7	47.4	4.4	3.2
% US-born	37.5	24.6	22.4	64.2	64.1
% Missing	27.6	29.7	30.2	31.5	32.7
Marital Status					
% Married	74.4	61.5	68.0	51.0	73.0
% Not married	25.6	38.5	32.0	49.0	27.0
Socioeconomic Variables					
Education					
% Less than 12 years	52.7	41.5	31.1	32.4	18.8
% 12 years	27.4	31.7	30.7	37.4	39.0
% 13 or more years	19.9	26.8	38.3	30.2	42.3
Outcome Variables					
% Died during follow-up	4.6	5.4	5.2	9.3	9.0
% Survived during follow-up	95.4	94.6	94.8	90.7	91.0
Group N[+]	21,993	4,788	14,274	77,366	466,100

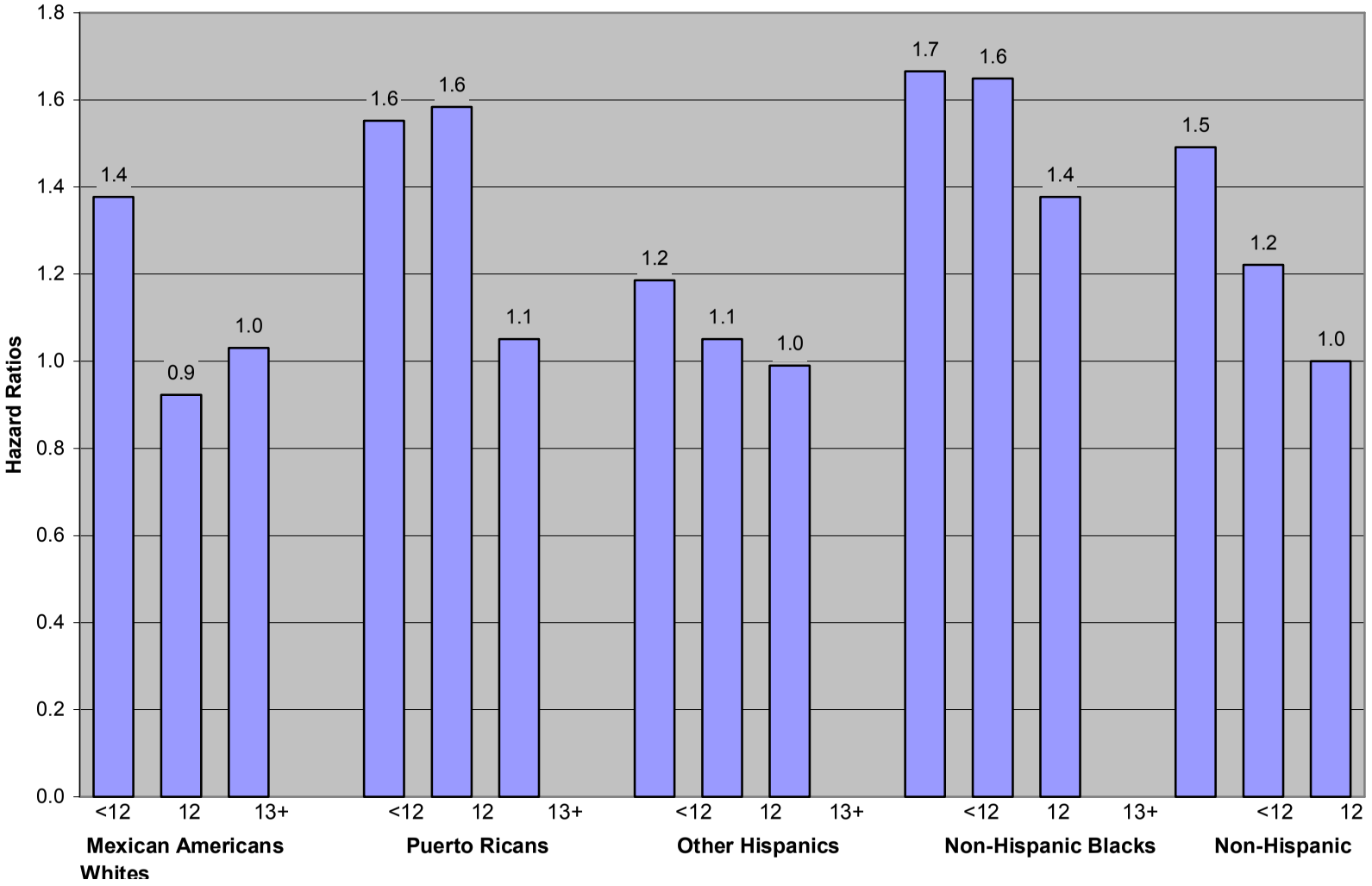
[+]Not weighted

Table 2. Overall Adult Mortality Risks for Hispanic Subgroups and Non-Hispanic Blacks Relative to Non-Hispanic Whites Ages 25 and Above (n = 584,521)

	Hazard Ratios			
	Model 1	Model 2	Model 3	Model 4
Ethnicity (N-H White)				
Mexican American	0.97	1.01	0.91*	1.03
Puerto Rican	1.11	1.21**	1.10	1.05
Other Hispanic	0.83**	0.88**	0.86**	0.99
Non-Hispanic Black	1.30**	1.30**	1.21**	1.38**
Demographic Variables				
Age (continuous)	1.09**	1.09**	1.08**	1.08**
Sex (Female)				
Male	1.87**	1.87**	1.88**	1.88**
Marital Status (Married)				
Not Married	1.31**	1.31**	1.30**	1.30**
Nativity (US Born)				
Immigrant		0.81**	0.80**	0.80**
Missing		0.99	0.98*	0.98*
Socioeconomic Variables				
Education (13+ years)				
Less than 12 years			1.45**	1.49**
12 years			1.22**	1.23**
Interaction Variables				
Race/Ethnicity*Education				
Mexican American*Less than 12 years				0.90
Mexican American*12 years				0.73^{+}
Puerto Rican*Less than 12 years				0.99
Puerto Rican*12 years				1.24
Other Hispanic*Less than 12 years				0.80**
Other Hispanic*12 years				0.87
Black*Less than 12 years				0.81**
Black*12 years				0.98
-2*Log Likelihood	710,370	710,240	709,296	709,237
Degrees of Freedom	7	9	11	19

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

Mortality Risk* by Racial/Ethnic Group and Education Level: All Ages



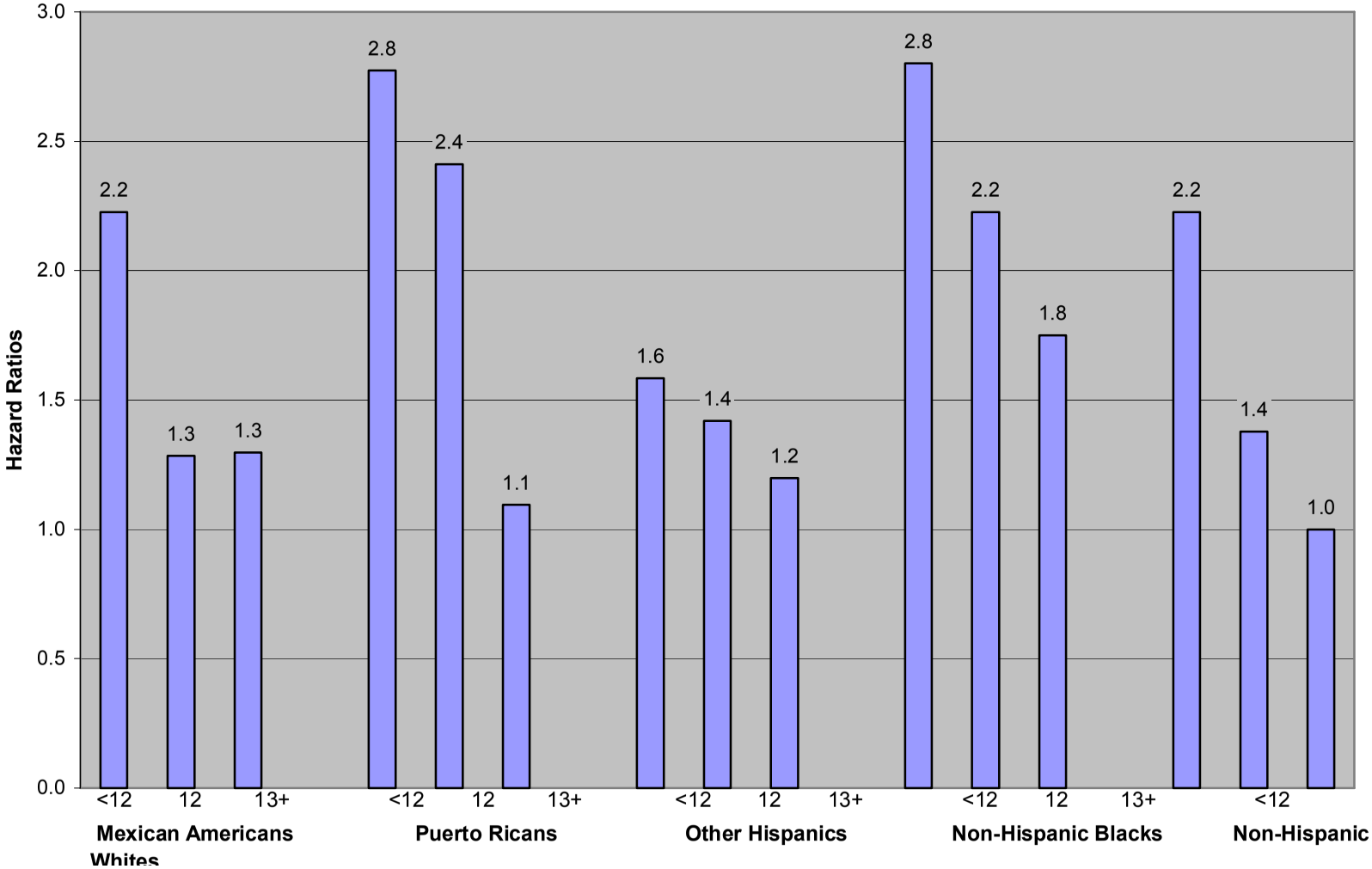
*Controlling for age, sex, nativity, and marital status

Table 3. Overall Adult Mortality Risks for Hispanic Subgroups and Non-Hispanic Blacks Relative to Non-Hispanic Whites Ages 25 to 59 (n = 428,778)

	Hazard Ratios			
	Model 1	Model 2	Model 3	Model 4
Ethnicity (N-H White)				
Mexican American	1.26**	1.32**	1.05	1.30^{+}
Puerto Rican	1.51**	1.65**	1.38**	1.09
Other Hispanic	0.93	1.01	0.94	1.19
Non-Hispanic Black	1.70**	1.71**	1.50**	1.76**
Demographic Variables				
Age (continuous)	1.09**	1.09**	1.08**	1.08**
Sex (Female)				
Male	1.81**	1.81**	1.83**	1.83**
Marital Status (Married)				
Not Married	1.77**	1.77**	1.73**	1.73**
Nativity (US Born)				
Immigrant		0.77**	0.74**	0.74**
Missing		1.02	0.98	0.98
Socioeconomic Variables				
Education (13+ years)				
Less than 12 years			2.05**	2.23**
12 years			1.37**	1.38**
Interaction Variables				
Race/Ethnicity*Education				
Mexican American*Less than 12 years				0.77^{+}
Mexican American*12 years				0.72^{+}
Puerto Rican*Less than 12 years				1.14
Puerto Rican*12 years				1.60
Other Hispanic*Less than 12 years				0.60**
Other Hispanic*12 years				0.86
Black*Less than 12 years				0.72**
Black*12 years				0.93
-2*Log Likelihood	203,245	203,217	202,381	202,332
Degrees of Freedom	7	9	11	19

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

Mortality Risk by Racial/Ethnic Group and Education Level: Ages 25 to 59



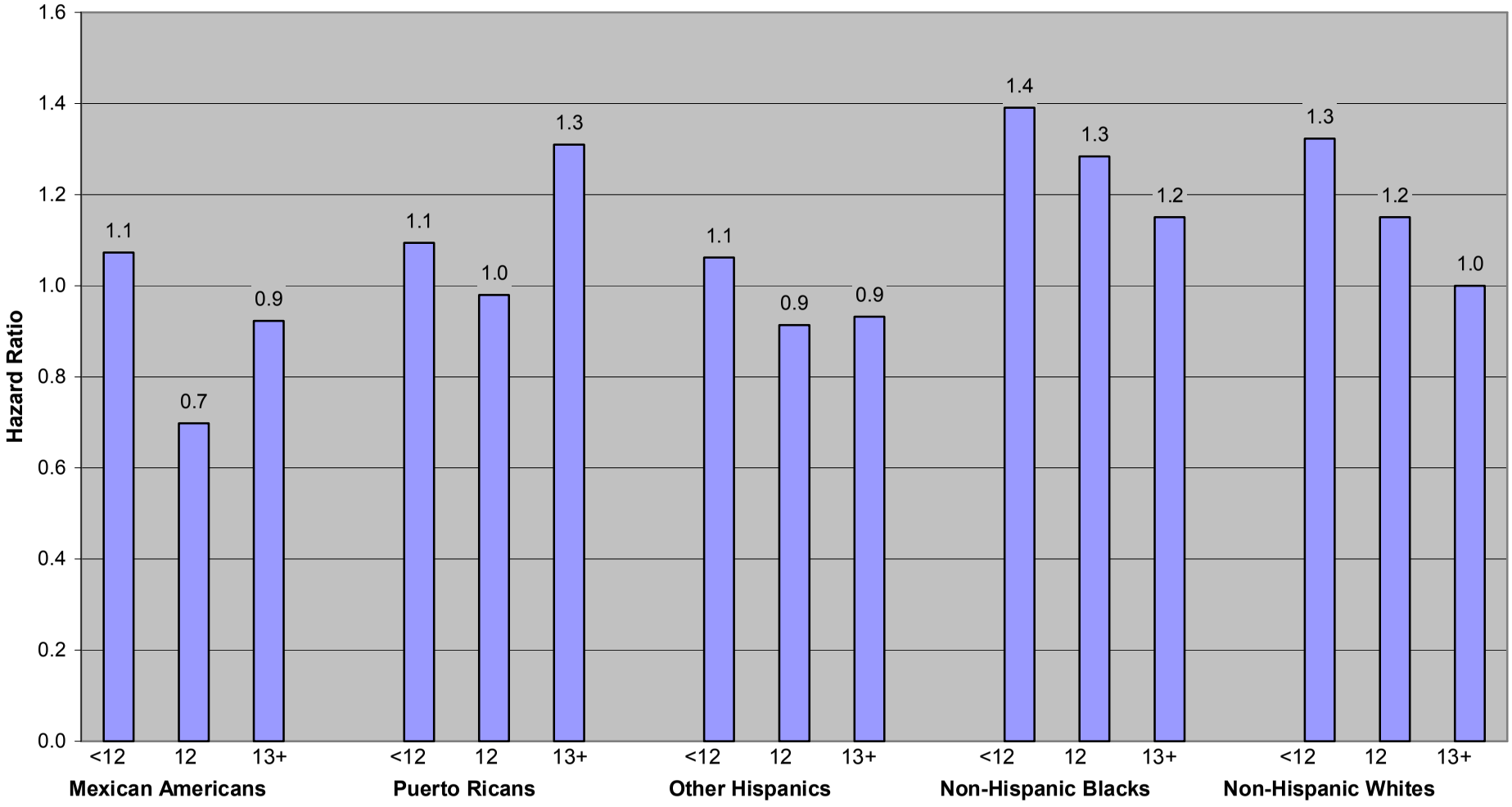
*Controlling for age, sex, nativity, and marital status

Table 4. Overall Adult Mortality Risks for Hispanic Subgroups and Non-Hispanic Blacks Relative to Non-Hispanic Whites Ages 60 and Above (n = 155,743)

	Hazard Ratios			
	Model 1	Model 2	Model 3	Model 4
Ethnicity (N-H White)				
Mexican American	0.83**	0.86*	0.80**	0.93
Puerto Rican	0.85^{+}	0.93	0.86^{+}	1.31
Other Hispanic	0.79**	0.84**	0.82**	0.93
Non-Hispanic Black	1.14**	1.13**	1.07**	1.15*
Demographic Variables				
Age (continuous)	1.08**	1.08**	1.08**	1.08**
Sex (Female)				
Male	1.85**	1.85**	1.85**	1.85**
Marital Status (Married)				
Not Married	1.22**	1.22**	1.21**	1.21**
Nativity (US Born)				
Immigrant		0.83**	0.82**	0.82**
Missing		0.98	0.97*	0.97*
Socioeconomic Variables				
Education (13+ years)				
Less than 12 years			1.31**	1.32**
12 years			1.14**	1.15**
Interaction Variables				
Race/Ethnicity*Education				
Mexican American*Less than 12 years				0.88
Mexican American*12 years				0.65*
Puerto Rican*Less than 12 years				0.63
Puerto Rican*12 years				0.65
Other Hispanic*Less 12 years				0.86
Other Hispanic*12 years				0.86
Black*Less than 12 years				0.91
Black*12 years				0.97
-2*Log Likelihood	516,138	516,088	515,655	515,641
Degrees of Freedom	7	9	11	19

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

Mortality Risk by Racial/Ethnic Group and Education Level: Ages 60 and Above



*Controlling for age, sex, nativity, and marital status

Table 5. Overall Adult Mortality Risks by Age, Sex, Nativity, and Education for Hispanic Ethnicities and Non-Hispanic Blacks and Whites, All Ages, Both Sexes

	Hazard Ratios						
	Mexican American Foreign-Born	Mexican American Missing or US-Born	All Puerto Ricans	Other Hispanic Foreign-Born	Other Hispanic Missing or US-Born	Black Non-Hispanic	White Non-Hispanic
	(n = 7,885)	(n = 14,083)	(n = 4,786)	(n = 6,912)	(n = 7,351)	(n = 77,366)	(n = 466,100)
Demographic Variables							
Age (continuous)	1.06**	1.07**	1.06**	1.09**	1.08**	1.07**	1.09**
Sex (male)							
Female	1.59**	1.98**	1.68**	1.75*	1.81*	1.87**	1.88**
Marital Status (Married)							
Not Married	1.35^{+}	1.48**	1.26	0.95	1.07	1.28**	1.29**
Socioeconomic Variables							
Education (13+ years)							
Less than 12 years	1.29	1.51**	1.99**	1.20	1.28*	1.50**	1.44**
12 years	0.75	0.96	1.61	1.12	1.08	1.23**	1.20**
-2*Log Likelihood	4,265	10,859	3,911	3,675	7,131	101,251	578,132
Degrees of Freedom	5	5	5	5	5	5	5

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

Table 6. Overall Adult Mortality Risks by Age, Sex, Nativity, and Education for Hispanic Ethnicities and Non-Hispanic Blacks and Whites, Ages 25 to 59, Both Sexes

	Hazard Ratios						
	Mexican American Foreign-Born	Mexican American Missing or US-Born	All Puerto Ricans	Other Hispanic Foreign-Born	Other Hispanic Missing or US-Born	Black Non-Hispanic	White Non-Hispanic
	(n = 7,130)	(n = 12,077)	(n = 4,142)	(n = 5,779)	(n = 5,965)	(n = 59,006)	(n = 334,636)
Demographic Variables							
Age (continuous)	1.04**	1.07**	1.04**	1.07**	1.06**	1.07**	1.09**
Sex (male)							
Female	1.52**	2.36**	1.82**	1.52	2.00**	1.83**	1.81**
Marital Status (Married)							
Not Married	0.87	2.02**	1.50	1.37	1.57**	1.54**	1.82**
Socioeconomic Variables							
Education (13+ years)							
Less than 12 years	1.41	1.67**	2.91**	1.58^{+}	1.44	1.76**	2.17**
12 years	1.10	0.98	2.24*	1.40	1.18	1.31**	1.37**
-2*Log Likelihood	2,695	5,287	2,315	1,222	3,031	41,645	147,620
Degrees of Freedom	5	5	5	5	5	5	5

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

Table 7. Overall Adult Mortality Risks by Age, Sex, Nativity, and Education for Hispanic Ethnicities and Non-Hispanic Blacks and Whites, Ages 60 and Above, Both Sexes

	Hazard Ratios						
	Mexican American Foreign-Born	Mexican American Missing or US-Born	All Puerto Ricans	Other Hispanic Foreign-Born	Other Hispanic Missing or US-Born	Black Non-Hispanic	White Non-Hispanic
	(n = 727)	(n = 1,782)	(n = 616)	(n = 1,115)	(n = 1,386)	(n = 18,344)	(n = 131,464)
Demographic Variables							
Age (continuous)	1.09**	1.07**	1.05**	1.08**	1.10**	1.06**	1.08**
Sex (male)							
Female	1.73*	1.50**	1.51	1.71^{+}	1.58**	1.86**	1.86**
Marital Status (Married)							
Not Married	1.56^{+}	1.04	0.99	0.87	0.74*	1.16**	1.21**
Socioeconomic Variables							
Education (13+ years)							
Less than 12 years	0.88	1.22	0.92	1.06	1.24	1.26**	1.31**
12 years	0.10*	0.81	0.81	0.98	1.06	1.09	1.15**
-2*Log Likelihood	1,461	4,628	1,376	2,228	4,044	65,513	435,756
Degrees of Freedom	5	5	5	5	5	5	5

Source: 1986-1994 National Health Interview Survey-Multiple Cause of Death Linked File (NCHS, 1997)
**p < .01; *p < .05; $^{+}$p <.10

References

Abraído-Lanza, Ana F., Bruce P. Dohrenwed, Daisy S. Ng-Mak, J. Blake Turner. 1999. The Latino Mortality Paradox: A Test of the "Salmon Bias" and Healthy Migrant Hypotheses. *American Journal of Public Health* 89: 1543-1548.

Allison, Paul. *Event History Analysis*. Beverly Hills: Sage Publications. 1984.

Ana F. Abraído-Lanza, Maria T. Chao and Karen R. Flórez. 2005. Do healthy behaviors decline with greater acculturation? Implications for the Latino mortality paradox. *Social Science and Medicine* 61: 1243-55.

Crimmins, Eileen M. 2005. Socioeconomic Differentials in Mortality and Health at the Older Ages. *Genus* LXI(1): 163-178.

Crimmins, Eileen M., Mark D. Hayward, Teresa E. Seeman. Race/Ethnicity, Socioeconomic Status, and Health. Chapter 9 in *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*, edited by N. Anderson, R. Bulatao, and B. Cohen. Washington, DC: National Academies Press.

Elo, Irma T., Cassio M. Turra, Bert Kestenbaum, B. Reneé Ferguson. 2004. Mortality among Elderly Hispanics in the United States: Past Evidence and New Results. *Demography* 41: 109-128.

Elo, Irma T. and Samuel H Preston. 1996. "Educational Differentials in Mortality: United States, 1979-85." *Social Science Medicine* 42:47-57.

Hayward, Mark D.; Toni P. Miles Eileen Crimmins; and Yu Yang. 2000. The Significance of Socioeconomic Status in Explaining the Racial Gap in Chronic Health Conditions. *American Sociological Review.* 65: 910-930.

Hummer, Robert A., Maureen R. Benjamin, Richard G. Rogers. 2004. Racial and Ethnic Disparities in Health and Mortality among the US Elderly Population. Chapter 3 in *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*, edited by N. Anderson, R. Bulatao, and B. Cohen. Washington, DC: National Academies Press.

Hummer, Robert A., Richard G. Rogers, Charles B. Nam, Felicia B. Le Clere. 1999. Race/Ethnicity, Nativity, and US Adult Mortality. *Social Science Quarterly* 80: 136-53.

Hummer, Robert A., Richard G. Rogers, Sarit H. Amir, Douglas Forbes, W. Parker Frisbie. 2000. Adult Mortality among Hispanic Subgroups and Non-Hispanic Whites. *Social Science Quarterly* 81: 459-76.

Hunt, Kelly J.; Roy G. Resendez; Ken Williams; Steve M. Haffner; Michael P. Stern; and Helen P. Hazuda. All-Cause and Cardiovascular Mortality among Mexican-American and Non-

Hispanic White Older Participants in the San Antonio Heart Study – Evidence against the "Hispanic Paradox". *American Journal of Epidemiology* 158: 1048-57.

Kitagawa, E. M. and P. M. Hauser. 1973. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology*. Cambridge, MA: Harvard University Press.

Liao, Youlian; Richard S. Cooper; Guichan Cao; Ramon Durazo-Arvizu, Jay S. Kaufman, Amy Luke, and Daniel L. McGee. 1998. Mortality Patterns among Adult Hispanics: Findings from the NHIS, 1986 to 1990. *American Journal of Public Health.* 88: 227-232.

Lin, Charles C.; Eugene Rogot; Norman J. Johnson; Paul D. Sorlie; Elizabeth Arias. 2003. A further study of life expectancy by socioeconomic factors in the National Longitudinal Mortality Study. *Ethnicity and Disease.* 13: 240-7.

Markides, KS and J Coreil.1986. The Health of Hispanics in the Southwestern United-States - An Epidemiologic Paradox. *Public Health Reports* 3: 253-265.

Mirowsky, John, and Catherine E. Ross. 2003. *Education, Social Status, and Health*. New York: Aldine De Gruyter.

Molla, Michael T., Jennifer H. Madans, Diane K. Wagener. 2004. Differentials in Adult Mortality and Activity Limitation by Years of Education in the United States at the End of the 1990s. *Population and Development Review* 30: 625-46.

Palloni, Alberto and Elizabeth Arias. 2004. Paradox Lost: Explaining the Hispanic Adult Mortality Advantage. *Demography* 41: 385-415.

Palloni, Alberto and Douglas C. Ewbank. Selection Processes in the Study of Racial and Ethnic Differentials in Adult Health and Mortality. *Critical Perspectives on Racial and Ethnic Differences in Health and Late Life.* The National Academies Press: Washington, DC; 2004.

Palloni, Alberto and Jeffrey D. Morenoff. 2001. Interpreting the Paradoxical in the Hispanic Paradox: Demographic and Epidemiologic Approaches. *Population Health and Aging Annals of the New York Academy of Sciences* 954: 140-174.

Pappas, Gregory; Susan Queen, Wilbur Hadden, and Gail Fisher. 1993. The Increasing Disparity in Mortality between Socioeconomic Groups in the United States, 1960 and 1986. *New England Journal of Medicine* 329:103-109.

Rogers, Richard G., Robert A. Hummer, and Charles B. Nam. 2000. *Living and Dying in the USA: Behavioral, Health, and Social Differentials of Adult Mortality.* San Diego, CA: Academic Press.

Rosenwaike, Ira. 1987. Mortality Differentials among Persons Born in Cuba, Mexico, and Puerto Rico Residing in the United States. *American Journal of Public Health* 77: 603-606.

Saenz, Rogelio. *Latinos and the changing face of America***.** Russell Sage Foundation. 2004.

Singh, G.K. and M. Siapush. 2002. "Ethnic-Immigrant Differentials in Health Behaviors, Morbidity, and Cause-Specific Mortality in the United States: An Analysis of Two National Data Bases." *Human Biology* 74(1): 93-109.

Smith, James P. 2005. "Unraveling the SES-Health Connection." *Population Development and Review* 30: 108-132.

Sorlie, Paul D., Eric Backlund, Norman J. Johnson, Eugene Rogot.. 1993. "Mortality by Hispanic Status in the United States." *JAMA* 270: 2464-2468.

Turra, Cassio M., Irma T. Elo, Bert Kestenbaum, and B. Renee Ferguson. 2005. The Impact of Salmon Bias on the Hispanic Mortality Advantage: New Evidence from Social Security Data. Paper presented at the annual meeting of the Population Association of America, Philadelphia, PA.