The Impact of Salmon Bias on the Hispanic Mortality Advantage:

New Evidence from Social Security Data

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Abstract

A great deal of research has focused on factors that may contribute to the Hispanic mortality paradox in the United States. In this paper, we examine the role of the salmon bias hypothesis - the selective return of less-healthy Hispanics to their country of birth - on mortality at ages 65 and above. These analyses are based on data drawn from the Master Beneficiary Record and NUMIDENT data files of the Social Security Administration. These data provide the first direct evidence regarding the effect of salmon bias on the Hispanic mortality advantage. Although we confirm the existence of salmon bias, it is of too small a magnitude to be a primary explanation for the lower mortality of Hispanic than NH white primary social security beneficiaries. Longitudinal surveys that follow individuals in and out of the United States are needed to further explore the role of migration in the health and mortality of foreign-born US residents and factors that contribute to the Hispanic mortality paradox.

Keywords

emigration; Hispanic paradox; mortality; salmon-bias; social security

Introduction

Research has consistently documented lower mortality for Hispanics than for non-Hispanic (NH) whites in the United States. This mortality advantage is greater for foreign-born than for native-born Hispanics and it is substantial even at old ages (Hummer, Benjamins & Rogers 2004; Turra 2004; Elo & Preston 1997; Sorlie et al. 1993). According to recent estimates, Hispanic death rates at ages 65 and above are 10-15 percent lower than the rates of NH whites, differences that translate into a 1.3-year advantage in life expectancy at age 65 for Hispanic men and 0.9-year advantage for Hispanic women (Elo et al. 2004). These findings are puzzling given the lower socioeconomic status of Hispanics, their lesser access to health care, and their lower self-reported health status (Hummer et al. 2004). Several explanations have been proposed for this paradox: cultural factors that influence health behaviors, family dynamics, and social support (Palloni & Arias 2004; LeClere, Rogers & Peters 1997); data problems such as a lack of comparability in reporting of Hispanic origin in vital statistics and census records, age misreporting, and difficulties in linking persons of Hispanic origin among various data sources (Elo et al. 2004; Rosenberg et al. 1999; Elo & Preston 1997); and healthy in-migrant

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and unhealthy out-migrant selection effects (Jasso et al. 2004; Palloni & Arias 2004; Franzini, Ribble & Keddie 2001; Abraido-Lanza et al. 1999; Markides et al. 1997). Nevertheless, uncertainty remains about the relative importance of the various explanations. The purpose of this paper is to test and quantify the effect of the unhealthy out-migrant explanation for the Hispanic mortality paradox at ages 65 and above.

To distinguish between the healthy in-migrant and the unhealthy out-migrant selection effects we begin by briefly outlining the rationale for each. The healthy in-migrant hypothesis proposes that migration is selective of healthier individuals, i.e., migrants are healthier than the average person in both the country of origin and the country of destination. This hypothesis has also been offered as an explanation for the low mortality of immigrant populations in Europe and Canada, although only a few studies have systematically tried to assess its validity (e.g. Khlat & Courbage 1996; Sharma, Michalowski & Verma 1990; Marmot, Adelstein & Bulusu 1984). Recent illustrations of its role in the mortality advantage of foreign-born Hispanics in the United States suggest that its effect is likely to be more important at younger ages than at older ages where the frailty composition of the foreign-born and US-born Hispanics becomes similar (Palloni & Ewbank 2004; Palloni & Morenoff 2001).

The unhealthy out-migrant hypothesis, which is the focus of this article, is often referred to as the salmon bias hypothesis, a phrase coined by Pablo-Mendez a decade ago (Pablos-Mendez 1994). It posits that, in contrast to the healthy in-migrant hypothesis, foreign-born persons who have lived in the United States for some time return to their countries of origin in significant numbers when their health deteriorates. Such return migration may be particularly prevalent among Hispanics because of the cultural importance of family ties and the proximity of Mexico and other Latin American countries to the United States (Abraido-Lanza et al. 1999). This type of selective emigration results in mortality for the US Hispanic population that is lower than if the mortality experience of the return migrants had not been omitted. Because the salmon bias hypothesis proposes that deteriorating health triggers return migration, one would expect its effect on mortality to be more pronounced at older ages when health problems become more prevalent (Palloni & Arias 2004; Palloni & Ewbank 2004).

A second mechanism related to return migration that can affect estimates of Hispanic mortality concerns a data artifact present in prospective mortality follow-up studies. That is, when survey data are prospectively linked to U.S. death registration records, deaths of individuals who emigrated during the follow-up period will be missed. The resulting downward bias in mortality due to this omission will be greatest for subgroups most likely to emigrate, notably the foreign-born (Palloni & Arias 2004; Abraido-Lanza et al. 1999; Elo & Preston 1997). This type of error, in contrast to the salmon bias effect, will occur even when emigration is not selective of unhealthy individuals. Fortunately, the data used in this paper are free of this type of inaccuracy as they capture deaths to individuals who emigrated during the study period.

Until now only indirect empirical evidence has been brought forward either to refute or to support the salmon bias hypothesis as an explanation for the Hispanic mortality paradox. Abraido-Lanza et al. (1999) insightfully pointed out that it cannot explain the mortality advantage of Cubans and US-born Hispanics relative to NH whites, groups whose members rarely emigrate, nor Puerto Ricans residing in the United States whose deaths in Puerto Rico are captured in the US death registration system. However, these explanations do not rule out the possibility that the salmon bias is an important factor in the mortality advantage of other Hispanic groups. In a recent study, Palloni and Arias (2004) concluded that the salmon bias hypothesis may well explain the mortality advantage of foreign-born Mexicans, although not that of other foreign-born Hispanics. Their deduction was based on the finding that the mortality advantage of foreign-born Mexicans relative to NH whites was greater at older ages and the slope of the mortality curve for foreign-born Mexicans was consistent with selective return

migration. In addition, the authors found the self-reported health status of elderly Mexicans who had returned from the United States to Mexico to be poorer than the health status of elderly Mexican-born individuals residing in the United States; a finding that is consistent with the salmon bias hypothesis (Palloni & Arias 2004). The potency of this finding, which is based on two cross sectional surveys, the Mexican Health and Aging Study (MHAS) in Mexico and the National Health Interview Survey (NHIS) in the United States, of course, depends on the comparability of the two data sources. Furthermore, given the relatively small sample sizes, these results should be interpreted with caution (Markides & Eschbach 2005; NCHS 2000).

In this paper, we provide the first direct test of the salmon bias hypothesis on the Hispanic mortality advantage in the United States at ages 65 and above where it is hypothesized to have its greatest impact. We use data from the Social Security Administration's Master Beneficiary Record (MBR) and NUMIDENT data files, which are the only data that we know of that permit a direct test of salmon bias at ages 65 and above. To investigate the potential contribution of salmon bias to low mortality of elderly Hispanics living in the United States, we compared the mortality experience of foreign-born and US-born Hispanic and NH white emigrants to that of foreign-born and US-born Hispanic and NH white US residents. In addition, we examined another migration selection effect that is less commonly discussed in the literature, namely the mortality experience of individuals returning to the United States after living abroad. Mortality differentials between returnees to the U.S. and longer term residents could either partially offset or accentuate the effects of salmon bias.

The remainder of the paper is organized as follows. The next section gives details of the data and methods used in the analysis. We then present our results and examine evidence for the salmon bias hypothesis and the mortality experience of emigrants returning to the United States. The paper ends with a discussion and concluding comments.

Data and Methods

These analyses are based on data from two master files of the Social Security Administration (SSA) - the Master Beneficiary Record (MBR) and the NUMIDENT data files - and cover the period from December 1995 to December 2000. The MBR is the master file of persons entitled to social security benefits, and the NUMIDENT is the master file of applications for a social security number. These data have been used in several previous studies of mortality at older ages in the United States (e.g. Elo et al. 2004; Kestenbaum & Ferguson 2002; Lauderdale & Kestenbaum 2002; Kestenbaum 1997, 1988). Because these data are not publicly available, we had the collaboration of the personnel from the Social Security Administration who extracted and merged individual-level data from the MBR and the NUMIDENT databases to protect the confidentiality of social security recipients. These data were then provided to the authors in a de-identified summary format that permitted the statistical analysis reported here.

Data from the MBR provided information needed to estimate sex-age-place specific mortality and migration: sex, current and last place of residence, and dates of birth and death. We obtained place of current residence for individuals who were alive and place of last residence for deceased persons for each December from 1995 to 2000 from annual snapshots of the MBR. Place of residence was coded as either in the United States or abroad, including Puerto Rico.

Dates of death were obtained from the June 2004 snapshot of the MBR to ensure that we captured all deaths, including those that were recorded some time after their occurrence. Given the seriousness with which SSA carries out its program stewardship responsibilities, the ascertainment of death for primary beneficiaries is close to 100% for deaths that occur in the United States and is nearly as complete for deaths that occur outside the United States. For example, foreign enforcement questionnaires are sent once a year to update information about

beneficiaries, and a failure to complete these questionnaires results in suspension of benefits. Also, occasional validation and integrity investigations are carried out to evaluate the accuracy of this information.

The NUMIDENT file provided information needed to identify Hispanics and NH-whites: race/ ethnicity, country of birth, first name, last name, and father's last name for married women. We used the NUMIDENT information in three ways to identify Hispanics. First, for individuals who applied for a social security number after February 1981, when a Hispanic identifier was added to the race item on the application form, we used it to identify Hispanics. Second, we assumed that those who were born or were residing in Spanish-speaking countries of Latin America or in Spain were Hispanic. Third, for all others we calculated a "Spanishness" score based on the person's first name, last name, or maiden name for women (when available), and county of residence. To do so we used lists of names we had developed based on 93 million original applications for social security numbers filed after February 1981, and information for each county on the percentage of the population aged 65 and older who self-identified as Hispanic in the 1990 census. A person was then presumed to be Hispanic if this "Spanishness" score exceeded a threshold value chosen such that the percentage of the age 65+ Medicare population alive in the end of 1999 identified as Hispanic by our methods was equal to the percentage of the 65+ population counted in the 2000 census as Hispanic. This algorithm was found to perform better in correctly classifying self-identified Hispanics as Hispanic than had we used the 1980 or 1990 Spanish surname lists prepared at the Census Bureau (Word & Perkins 1996; Passel & Word 1980). We identified the smallest percentage of Hispanics (less than 10%) from the Hispanic item on the application forms followed by place of birth (about 40%) and then by our "Spanishness" score (slightly over 50%) with some variation in these percentages by age and sex (for further detail see Elo et al. 2004). NH whites were individuals who self-identified as white on the social security card application and who were not classified as Hispanic.

We studied the mortality and migration experience from December 1995 to December 2000 among individuals who were primary social security beneficiaries in December 1995. Primary social security beneficiaries are individuals (1) who were born in 1929 or later and, if not disabled, had worked a minimum of 10 years to accumulate 40 "quarters of coverage" or (2) who were born before 1929 and who had worked at least as many "quarters of coverage" as the number of years between 1951 and the year when the person attained age 61. Because of our interest in mortality among emigrants, we excluded persons who were living in Puerto Rico in December 1995 because employment in Puerto Rico is covered by social security and thus many Puerto Ricans may have never resided in the United States.

For the same reason, we excluded 'secondary' beneficiaries, those individuals whose entitlement to social security benefits is based on someone else's work history, because many secondary beneficiaries who were living abroad in December 1995 may have never lived in the United States (Kestenbaum 1988). Approximately 25 percent of the elderly in our data were secondary beneficiaries in December 1995 of whom 98.9 percent were women.

In these analyses, we included 21.6 million individuals who were primary social security beneficiaries in December 1995, of whom 0.9 million (4.3%) were Hispanic and 20.7 million (95.7%) were NH white. According to the 2000 US Census, 4.9% of the population ages 65 and above in 2000 was Hispanic (US Census Bureau 2002). We estimated that our data covered approximately 70% of elderly Hispanic men and about 98% of Hispanic male social security beneficiaries. The respective figures for Hispanic women were 40% and 60%, respectively. Similarly, we estimated that our data covered 77% of the elderly NH white men and 86% of NH white male social security beneficiaries. The respective figures for NH white women were 50% and 87%, respectively (tabulations by the authors). Thus, our data covered a smaller

percentage of 65+ year old women than men because women were more likely to be secondary beneficiaries. We address the implications of the less than complete coverage of the US population ages 65 and above in the discussion and conclusions.

We present results for all Hispanic and NH white primary beneficiaries and for selected subgroups. We distinguished three subgroups among NH whites: US-born (79%), foreign-born (5%), and persons whose place of birth was unknown (16%). Among Hispanics we differentiated among four subgroups: US-born (38%), foreign-born (42%), persons born in Puerto Rico (9%), and persons with unknown place of birth (11%). We kept individuals with unknown place of birth as a separate subgroup because we did not have adequate information to impute place of birth and we wanted to assess whether the mortality experience of this group differed substantially from that of the foreign-born and US-born subgroups. We calculated person-years of exposure, number of deaths, and number of migrations for the subgroups detailed above. These data were further classified by sex, 5-year age group, and place of residence. For persons who did not change residence and who died in a given year we assumed that deaths were evenly distributed throughout the year. For individuals who changed residence between United States and elsewhere between one December and the next and who were alive we assumed that the change of residence occurred at mid-year on average. For persons who changed residence and died between one December and the next we assumed that residential moves occurred on average in the first quarter of the year and that deaths were evenly distributed between the move and the end of the year.

Statistical analysis

Because the effect of salmon bias on mortality estimates is a function not only of the magnitude of mortality differentials between emigrants and stayers but also of the volume of migration, we began with a straightforward tabulation of mortality and migration experience during the period December 1995 to December 2000. We calculated person-years lived in the United States and abroad, the percentage of person-years lived outside the US, the volume of migration in and out of the United States, and the number of deaths by place of residence.

We then estimated a series of Poisson regression models to look for evidence for or against the salmon bias hypothesis. Poisson regression is commonly used to estimate mortality with grouped data (e.g. Hu & Goldman 1990). We modeled the number of deaths during the observation period as a function of the number of person-years of exposure, age in 5-year age groups, and place of residence (US residence versus non-US residence). We fit separate models for foreign-born and native-born Hispanic and NH white men and women and for Hispanic and NH white men and women with unknown place of birth. Among the foreign-born Hispanics, we further distinguished those who were born in Puerto Rico from those born elsewhere. Thus we estimated 14 models, each with the following specification:

$$\log E\left(D_{ij}\right) = \log\left(N_{ij}\right) + \eta + \alpha_i + \beta_j \tag{1}$$

where i indexes age group, j indexes place of residence, $E(D_{ij})$ denotes the expected number of deaths, N_{ij} is the number of persons-years lived, α_i is the effect of the ith age group, β_j is the effect of the jth place of residence, and η is the constant term. The interaction term involving age and place of residence was omitted because it was not statistically significant at the 5 percent level in any model of substantive interest. We used the exponentiated parameter estimates for place of residence ($\exp^{\beta(j)}$), obtained from models in which US residence was the omitted category, to assess the relative mortality experience of foreign residents versus US residents.

We also analyzed the experience of persons who migrated during the study period (1996-2000). If migration was precipitated by poor health, we would expect mortality among migrants to be

particularly high immediately following their move. We estimated Poisson regression models to assess the level of post-migration mortality in the year following the move among persons leaving the United States and among returnees to the US relative to that of US residents. Because of the small number of movers, we could not distinguish in these models among foreign-born and native-born Hispanics or foreign-born and native-born NH whites.

Our final model was used to estimate Hispanic and NH white age-specific death rates by gender for (1) primary social security beneficiaries residing in the United States and (2) all primary beneficiaries regardless of their place of residence. This model was of the following form:

$$\log\mathrm{E}\left(D_{ij}\right)=\log\left(N_{ij}\right)+\eta+\alpha_i+\delta_j+(\alpha\delta)_{ij}$$

(2)

where i indexes age group, j indexes place of residence, $E(D_{ij})$ denotes the expected number of deaths, N_{ij} is the number of person-years lived, α_i is the effect of the ith age group, δ_j is the effect of the jth ethnicity, $(\alpha\delta)_{ij}$ is an interaction term between age and ethnicity, and η represents the constant. The salmon bias hypothesis predicts that the ratio of Hispanic to NH-white mortality by age and sex should be appreciably closer to 1 when the mortality estimates are based on all Hispanics regardless of their place of residence than when mortality estimates are based on US residents only.

Results

Table 1 presents the number of person-years of exposure, the number of migrations to and from the United States, and the number of deaths during the study period for the 14 population subgroups. As seen in the first three data columns of Table 1, a larger percentage of foreign-born Hispanics than native-born Hispanics were living abroad in the late 1990s. The same was true for NH whites. Similarly, the volume of migration in and out of the United States was higher among foreign-born Hispanics, persons born in Puerto Rico, and foreign-born NH whites than among native-born Hispanics and native-born NH whites. We were surprised to discover that among foreign-born Hispanics the number of moves to (3,400) and from (3,500) the United States was nearly identical. In contrast, among foreign-born NH whites and Hispanics born in Puerto Rico the net flow was decidedly out of the United States.

Table 2 presents the results from the Poisson regression models estimated to assess the evidence for the salmon bias hypothesis. In all models the omitted category is US residence. Our results were consistent with the salmon bias hypothesis in that mortality was higher among foreign-born primary social security beneficiaries living abroad than among foreign-born beneficiaries living in the United States. At the same time, the size of this excess varied among population subgroups. For example, we found statistically significant excess mortality of 12-25 percent among individuals born in Puerto Rico and 15-20 percent among other foreign-born Hispanics.

Until now the salmon bias hypothesis has been discussed only in the context of the Hispanic mortality paradox. We found that it also applies to the mortality experience of foreign-born NH whites. The mortality of foreign-born NH white women living abroad was 8 percent higher than the mortality of foreign-born NH white women living in the United States. The respective figure for foreign-born NH white men was 10 percent.

We did not find statistically significant excess mortality for emigrants among US-born Hispanics, US-born NH whites, nor among persons whose place of birth was unknown (Table 2). Indeed, we discovered that the mortality of US-born NH white men and women who were living abroad was significantly lower than the mortality of US-born NH white men and women living in the Unites States. These results suggest that US-born NH whites living abroad represent a select group of healthy expatriates. Similarly, Hispanic and NH white men whose place of birth was unknown and who were living abroad had significantly lower mortality than

their counterparts living in the United States, while the mortality of Hispanic and NH white women whose place of birth was unknown did not differ by place of residence. In addition, the mortality of US-born Hispanics living abroad did not differ from that of US-born Hispanics living in the United States.

The salmon bias hypothesis further predicts that the mortality of *recent* emigrants would be particularly high since it is hypothesized that poor health precipitates emigration from the United States. Table 3, which compares the mortality of persons who migrated during the study period to that of US residents, is consistent with this interpretation. Among recent emigrants, excess mortality was most pronounced for Hispanic women (76 percent) followed by the estimated excess for Hispanic men (45 percent). The excess mortality among NH white emigrant men (37 percent) and NH white emigrant women (19%) was lower than among Hispanics, but nevertheless significantly higher than that of NH white US residents.

We also documented excess mortality among recent returnees to the United States. These findings suggest that Hispanic men and NH white men and women who had emigrated from the United States returned when their health deteriorated, as implied by their high mortality in the year following their return to the United States. Thus, at least at ages 65 and above, the health-selective migration of Hispanics and of NH whites appears to operate in both directions, and the effect of salmon bias on mortality rates at older ages is partially counterbalanced by the high mortality of emigrants returning to the United States. Because of the small number of moves during the study period, we could not distinguish between foreign-born and native-born recent migrants in the estimates shown in Table 3. However, as seen in Table 1, among Hispanics, most migrants were either foreign-born or they were born in Puerto Rico. These two groups accounted for 80-90 percent of all moves in and out of the United States among Hispanics. Among NH whites, moves by foreign-born individuals made up 44-60 percent of all moves (Table 1).

In Table 4, we compare two sets of age-sex specific mortality estimates for Hispanics and NH whites, one for U.S residents only and the other for U.S. and foreign residents combined. There is virtually no difference in the Hispanic mortality advantage (measured to two decimal places) between the two sets of estimates. Thus, although we find evidence for the salmon bias hypothesis, at least among primary social security beneficiaries the higher mortality of the foreign-born living abroad does not explain the lower mortality of Hispanics in the United States.

Discussion

Markides and Eschbach (2005) recently noted that the salmon bias hypothesis was the "biggest challenge" to the Hispanic mortality paradox and thus needed further investigation. To our knowledge ours is the first study that has attempted to estimate whether mortality of foreign-born elderly Hispanics who have emigrated from the United States is higher than among foreign-born elderly Hispanics living in the US. It thus provides the first direct test of the impact of salmon bias on the Hispanic mortality paradox at ages 65 and above; earlier investigations could offer only indirect evidence of its role. Our results were consistent with the salmon bias hypothesis. Mortality was higher among foreign-born Hispanic primary social security beneficiaries living abroad than among foreign-born beneficiaries residing in the United States. This excess was 12-25 percent for persons born in Puerto Rico and 15-20 percent for other foreign-born Hispanics. We also found a similar pattern of excess mortality for foreign-born NH white emigrants who experienced 8-10 percent higher death rates than native-born NH whites living in the United States. These results suggest that the salmon-bias hypothesis has more general applicability and it could also contribute to the lower mortality of foreign-born NH white elderly living in the United States.

The salmon bias hypothesis posits that return migration of foreign-born Hispanics is precipitated by poor health which in turn places these emigrants at a greater risk of death than foreign-born Hispanics who remain in the United States. Thus we should find particularly high mortality among recent emigrants. Again our results were consistent with this expectation in that excess mortality was quite high among persons who emigrated during the study period when compared to US residents. This excess risk ranged from 76 percent for Hispanic women to 31 percent for NH white men.

We do not have information on the health conditions of these foreign-born emigrants, however, and thus other explanations for their excess mortality are also plausible. For example, the quality of and access to health care for the elderly is likely to differ between the United States and Latin American and other foreign countries with concomitant differences in survival outcomes (Ross, Pagan and Polsky 2006). In fact, it has been suggested that mortality of the oldest old in the United States is lower than in Europe and Japan at least in part because of greater availability of medical care for the elderly in the United States (Manton & Vaupel 1995).

Also relevant to the discussion of the salmon bias hypothesis, although heretofore not a part of it, is our finding that primary social security beneficiaries who returned to the United States after living abroad also had higher death rates than their US resident counterparts. Among Hispanics most of these return migrants were born either in Puerto Rico or in Spanish-speaking countries of Latin America. Thus the impact of migration on elderly Hispanic mortality in the United States appears to be more complex than previously hypothesized.

We also found higher mortality among NH white return migrants of whom only approximately half were foreign-born. We speculate that this return migration is also related to health selection in that individuals in poor health return to the United States to seek medical care for which they are entitled under the Medicare program. Medicare, the health insurance program for the elderly, covers all US social security beneficiaries and their medical expenses but only in the United States. Thus this coverage provides incentives for individuals to return to the US when they fall ill. More generally, motivation for migration at older ages is likely to differ from that at younger ages. Jasso et al. (2004) hypothesize that migration related selectivity among older immigrants is the opposite of that operating at younger ages - at younger ages immigration is selective of healthier individuals who migrate to the United States to take advantage of work opportunities, while at older ages work related immigration is likely to be minimal and other factors, such as health or family reunification, are likely to play a more important role.

However, regardless of whether the higher mortality among Hispanic emigrants is due to health-related migration or to other factors, when taken together with the volume of emigration, its magnitude is too small to explain a significant part of the Hispanic mortality advantage in the United States among primary social security beneficiaries. Only a small fraction of foreign-born Hispanics ages 65 and older who were also primary social security beneficiaries resided outside the United States in the late 1990s. Furthermore, the bias due to the emigration of individuals with higher mortality is partially offset by the higher mortality of return migrants, particularly among men. Therefore, our findings do not support recent claims that out-migration selection effects would explain the mortality advantage of elderly Hispanics.

Our study points to the importance of following individuals when they move in and out of the United States. Without such longitudinal data it is impossible to test directly the effect of emigration on US mortality. Indirect inference is unlikely to prove adequate either to confirm or refute the salmon bias hypothesis. The social security data used here can only shed light on the role of migration at older ages and only for a subgroup of the elderly. Furthermore, lack of information on health, socioeconomic status, and migration history in these data limits our

ability to examine which factors influence mortality of elderly migrants. Thus, large survey data sets covering a wider age range that also include information on a host of relevant characteristics hypothesized to influence health are needed to assess fully the role of migration in the mortality advantage of foreign-born US residents. Nevertheless, our results suggest that the role of migration on mortality at older ages is far more complex than previously noted. With a sizable increase in foreign-born residents in recent decades, especially among Hispanics, a better understanding of the role of migration on the health of the US population is becoming increasingly important. In addition, in this paper we were unable to distinguish among Hispanic subgroups, except for Puerto Ricans, and it may well be that migration effects are not uniform. Migration flows in and out of the country at older ages is also likely to impact the US health care system as emigrants may return to the United States to seek health care, which is covered by Medicare but only in the United States. This issue will increase in salience as current younger cohorts age and begin to reach retirement age.

Limitations

Our study has several limitations that deserve to be noted. First, we had to restrict our analyses to primary social security beneficiaries, which results in the exclusion of about 25-30 percent of NH white and Hispanic men and about half of NH white and Hispanic women living in the United States and an unknown number of elderly NH whites and Hispanics living abroad. A comparison of the mortality estimates shown in Table 4 with death rates of Hispanic and NH white Medicare Part B recipients that exclude foreign residents but cover a larger percentage of the elderly living in the United States suggest that restricting the data to primary beneficiaries does not substantially bias our mortality estimates (Elo et al. 2004). The differences in age-specific death rates between the two sets of estimates range from 1% to 9% and these differences are similar in magnitude and direction for Hispanics and NH whites and for men and women. Thus, the exclusion of secondary beneficiaries is unlikely to affect our conclusions about the salmon bias hypothesis.

According to the 2000 Census, about 70 percent of the Hispanics who did not qualify for social security benefits were foreign born and most had lived in the United States for more than 10 years (tabulations by the authors). Our data exclude the mortality experience of these individuals. However, there would have to be a large volume of health-related emigration among this group of foreign-born Hispanics and high death rates among the emigrants if their mortality-migration experience were to account for the Hispanic mortality paradox. Even if the probability of emigrating among Hispanic non-beneficiaries were twice as high as among foreign-born Hispanic primary social security beneficiaries, we estimate that the mortality of the foreign-born non-beneficiaries would have to be four times higher than the mortality of U.S. residents for it to eliminate the Hispanic mortality advantage. This is an unlikely possibility given the excess mortality of 15-25% that we document for the foreign-born Hispanics living abroad relative to U.S. residents.

It is, however, possible that we misestimate the volume of migration. We must infer migration from an address change recorded in the MBR. A change of address could reflect a temporary or seasonal move, rather than a migration. Furthermore, because occasionally the address on the MBR is not the address of the beneficiary but that of his or her representative, an address change may not occur although the beneficiary has moved, and, conversely, it may occur although the beneficiary has not moved. These issues would affect our estimates only if they involved changes from a US to a non-US address and vice versa. That our main finding regarding the Hispanic mortality advantage is unaffected by these problems is confirmed by comparing mortality estimates that are based on all primary social security beneficiaries and those based only on US residents (Table 4).

The migration flows that we estimate during the 1996-2000 period are small. In general, migration rates among the elderly are known to be low and our data pertain to individuals who were long-time US residents. It is quite possible that most foreign-born individuals return to their countries of origin prior to or near retirement. For example, projections of the financial health of the social security system assume that 30% of the total foreign-born population will eventually return to their country of origin with most of the return migration (85%) taking place in the first 10 years of US residence (Duleep 1994). Many others are assumed to leave after qualifying for social security benefits. Findings from several studies show that that these late emigrants leave mostly around the age of retirement (Reyes 1997; Ahmed & Robinson 1994; Duleep 1994; Warren & Peck 1980). Another factor likely to reduce emigration at older ages is the very low prevalence of undocumented migrants among the elderly in the United States (Passel 2005). An advantage of the social security data is that they capture not only emigrants who leave after reaching age 65, but also the experience of primary beneficiaries who migrated prior to retirement. Thus, to the extent that health-related migration occurs below age 65 and is reflected in mortality above age 65 our data capture this experience.

Finally, it would be advantageous to estimate the impact of salmon bias separately for various Hispanic subgroups as its effect is hypothesized to vary by Hispanic origin (Palloni & Arias 2004). Unfortunately, the social security data are not well suited for such an investigation because of missing information on place of birth for a sizable fraction of social security beneficiaries. This missing information could also influence our results. The mortality of men whose place of birth was unknown and who were residing abroad was significantly lower than the mortality of men living in the United States among both NH whites and Hispanics. Thus if these men were included among the foreign-born residing abroad, this inclusion would have attenuated the size of the excess mortality among the foreign born men living abroad. Among NH white and Hispanic women the mortality of individuals with unknown place of birth was not significantly different from that of US residents.

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Table 1

Distribution of Person-Years Lived and Events by Population Subgroup, 1996–2000: Primary Social Security Beneficiaries Ages 65 and Above

Population Subgroup	Number of Person-Years (1,000)			Number of Moves (1,000)		Number of Deaths (1,000)	
	U.S. Residence	Foreign Residence	% Foreign	To the U.S.	From the U.S.	U.S. Residence	Foreign Residence
Men							
Hispanics							
U.S.-born	904.7	18.5	2.0	0.7	0.4	44.8	1.0
Foreign-born	954.7	98.4	9.3	3.4	3.5	39.7	5.0
Born in Puerto Rico	198.0	11.6	5.5	0.9	3.5	9.6	0.7
Unknown Place of Birth	196.5	15.9	7.5	0.3	0.6	27.5	2.3
NH Whites							
U.S.-born	38,053.4	68.1	0.2	2.4	2.0	2,071.4	3.2
Foreign-born	1,915.6	236.1	11.0	2.2	4.1	97.5	11.7
Unknown Place of Birth	4,845.8	36.4	0.7	0.4	0.6	840.8	5.7
Women							
Hispanics							
U.S.-born	735.5	5.9	0.8	0.3	0.1	22.2	0.2
Foreign-born	738.4	37.2	4.8	1.3	1.9	18.6	1.2
Born in Puerto Rico	170.1	6.6	3.7	0.6	2.3	5.2	0.2
Unknown Place of Birth	176.1	7.4	4.0	0.1	0.4	20.5	0.9
NH Whites							
U.S.-born	34,649.2	34.7	0.1	1.1	0.9	1,287.0	1.1
Foreign-born	1,944.0	144.4	6.9	1.7	3.2	68.0	4.8
Unknown Place of Birth	6,608.3	44.3	0.7	0.3	0.7	925.5	6.4

Table 2

Estimated Mortality Ratios (foreign residence relative to US residence) from Poisson Models[a] by Population Subgroup, 1996-2000: Primary Social Security Beneficiaries Ages 65 and Above

Population Subgroup	Men	Women
Hispanics		
U.S.-born	1.05 (.152)	0.90 (.180)
Foreign-born	1.15 (.000)[***]	1.20 (.000)[***]
Born in Puerto Rico	1.12 (.004)[**]	1.25 (.001)[**]
Unknown Place of Birth	0.95 (.034)[*]	0.95 (.176)
NH-whites		
U.S.-born	0.91 (.000)[***]	0.86 (.000)[***]
Foreign-born	1.10 (.000)[***]	1.08 (.000)[***]
Unknown Place of Birth	0.92 (.000)[***]	0.99 (.348)

p-values are in parentheses.

[*] p<.05

[**] p<.01

[***] p<.001

[a] Separate Poisson regression models were estimated for each population subgroup, using the specification described in the text.

Table 3

Estimated Mortality Ratios (recent migrants relative to U.S. residents)[a] from Poisson Models[b] by Population Subgroup: Primary Social Security Beneficiaries Ages 65 and above who Migrated between 1996 and 2000

Population Subgroup	Men	Women
1996-2000 Emigrants		
Hispanics	1.45 (.000)[***]	1.76 (.000)[***]
NH-whites	1.37 (.000)[***]	1.19 (.035)[*]
1996-2000 Return migrants to the U.S.		
Hispanics	1.48 (.000)[***]	0.89 (.600)
NH-whites	1.31 (.001)[**]	1.37 (.005)[**]

p-values are in parentheses.

[*] p<.05

[**] p<.01

[***] p<.001

[a] Post-migration mortality of migrants in the year of the move relative to U.S. residents.

[b] Separate Poisson regression models were estimated for each population subgroup, using the specification described in the text.

Table 4

Estimated Age-Specific Mortality Rates (Deaths per 1,000) for Hispanic and NH White Men and Women, and Hispanic to NH White Mortality Ratios, by Place of Residence, 1996-2000: Primary Social Security Beneficiaries Ages 65 and Above

Sex & Age Groups	U.S. Residents				U.S. & Foreign Residents Combined			
	Hispanics	NH Whites	Ratio	95% CI	Hispanics	NH Whites	Ratio	95% CI
Men								
65-69	24.61	28.62	0.86	0.84, 0.88	24.71	28.58	0.86	0.85, 0.88
70-74	34.53	39.49	0.87	0.86, 0.88	34.63	39.45	0.88	0.87, 0.89
75-79	53.07	60.68	0.87	0.86, 0.89	53.28	60.65	0.88	0.87, 0.89
80-84	88.34	99.18	0.89	0.88, 0.90	88.46	99.16	0.89	0.88, 0.90
85-89	142.08	162.57	0.87	0.86, 0.89	142.04	162.52	0.87	0.86, 0.89
90+	248.44	288.22	0.86	0.85, 0.88	248.04	288.14	0.86	0.85, 0.88
Women								
65-69	12.92	15.76	0.82	0.80, 0.84	12.93	15.75	0.82	0.80, 0.85
70-74	18.58	22.76	0.82	0.80, 0.83	18.60	22.74	0.82	0.80, 0.83
75-79	30.72	36.94	0.83	0.82, 0.85	30.92	36.92	0.84	0.82, 0.85
80-84	54.63	63.84	0.86	0.84, 0.87	54.60	63.84	0.86	0.84, 0.87
85-89	98.35	112.07	0.88	0.86, 0.89	98.50	112.09	0.88	0.86, 0.89
90+	199.96	226.96	0.88	0.87, 0.90	199.54	227.00	0.88	0.86, 0.89