

# Does Selective Migration Explain the Hispanic Paradox? A Comparative Analysis of Mexicans in the U.S. and Mexico

Georgiana Bostean

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**Abstract** Latino immigrants, particularly Mexican, have some health advantages over U.S.-born Mexicans and Whites. Because of their lower socioeconomic status, this phenomenon has been called the epidemiologic “Hispanic Paradox.” While cultural theories have dominated explanations for the Paradox, the role of selective migration has been inadequately addressed. This study is among the few to combine Mexican and U.S. data to examine health selectivity in activity limitation, self-rated health, and chronic conditions among Mexican immigrants, ages 18 and over. Drawing on theories of selective migration, this study tested the “healthy migrant” and “salmon-bias” hypotheses by comparing the health of Mexican immigrants in the U.S. to non-migrants in Mexico, and to return migrants in Mexico. Results suggest that there are both healthy migrant and salmon-bias effects in activity limitation, but not other health aspects. In fact, consistent with prior research, immigrants are negatively selected on self-rated health. Future research should consider the complexities of migrants’ health profiles and examine selection mechanisms alongside other factors such as acculturation.

**Keywords** Hispanic paradox · Limitation · Mexican · Self-rated health · Selection · Chronic conditions

## Introduction

Research has identified an “immigrant health paradox” in which immigrants have better health than the native-born, higher socioeconomic status groups in several destination countries [1–3]. In the United States, this health paradox is best documented and strongest among Mexicans, who are the largest Latino group, with approximately 29 million Latinos in the U.S. being of Mexican origin [4]. Mexicans are also among the poorest and least educated U.S. Latino groups [5]. Despite their lower average socioeconomic statuses, Mexican immigrants have some health advantages, such as lower mortality rates, compared to U.S.-born Mexicans, other Latinos, and Whites. Two main explanations have come to dominate the research on this epidemiologic “Hispanic paradox” [6]: (a) Latino health is protected by cultural factors, such as a traditional diet and familial support, that deteriorate with acculturation, and, (b) migrants are selected by health status, with healthier people immigrating to the U.S. and unhealthy people emigrating from the U.S. Many studies have examined cultural explanations [7–9], finding that immigrants who have been in the U.S. longer have worse health than recent arrivals, but less research has addressed selection explanations.

Selective migration may shape the health profiles of U.S. Mexican immigrants through two primary mechanisms—called the “healthy migrant” and “salmon-bias” hypotheses. First, healthier people may be more likely to migrate [10, 11], a hypothesis called the “healthy migrant” effect. Immigrants are not a random cross-section of their origin countries’ populations, but rather are selected on certain characteristics, for example education [12, 13]. Yet it is unclear whether migrants are also selective in terms of their health. The second hypothesis, called the “salmon-bias,” is that unhealthy people emigrate from the United

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G. Bostean (✉)  
Cancer Prevention and Control Research, Fielding School  
of Public Health and Jonsson Comprehensive Cancer Center,  
University of California, Los Angeles, 650 Charles Young Drive  
South, A2-125 CHS, Box 956900, Los Angeles,  
CA 90095-6900, USA  
e-mail: gbostean@ucla.edu

States, inflating the average population health of the remaining immigrants [14]. Indeed, until the recent tightening of border security, many Mexicans engaged in circular migration, going back-and-forth between Mexico and the United States [15], which could affect the accuracy of health statistics.

Despite evidence suggesting that migrants may be healthier than non-migrants, few studies have adequately examined selective migration. With a few notable exceptions [11, 16–18], most studies that examine the Paradox or migrant health selectivity use data from the destination country only [14, 19, 20], which cannot assess whether migrants are healthier than the non-migrant populations they leave behind or whether return migrants are less healthy than immigrants who stay in the destination country. To answer those questions, data from both the origin and destination countries are necessary.

The few studies that use origin and destination data may be of limited generalizability. A recent longitudinal study assessed whether self-rated health and several biological risk indicators (such as blood pressure) predicted subsequent U.S. migration among Mexicans, finding weak support for the healthy migrant hypothesis [11]. However, this study focused on these biomarkers, which may be indicators of risk for later disease, rather than current health conditions. Another study combined U.S. and Mexican data to examine adults ages 65 and over, finding support for the salmon-bias and healthy migrant hypotheses [17]. However, selection mechanisms may vary for younger and older adults since both the likelihood of emigrating from Mexico, and that of returning to Mexico vary with age [15]. Most Mexican immigrants come to the U.S. as young working-age adults [21], whose reasons for migrating are usually financial and likely quite different from those of older adults, who may migrate to accompany family members; therefore, results from studies on older adults may not be generalizable to younger migrants. Another study that combined U.S. and Mexican data not only used older adult samples, but the national surveys were completed almost a decade apart; thus, apparent differences between the migrant and non-migrant populations could be misattributed to selective migration rather than to demographic and health changes over the decade [16]. Thus, these studies do not adequately capture the full, binational picture of migrant health selectivity.

The present study aims to fill gaps in the existing literature by combining Mexican and U.S. data from overlapping years to examine health selection among Mexican immigrants, ages 18 and over. Activity limitations, self-rated health, and chronic conditions will be examined among recent and longer-term Mexican immigrants in the United States, and non-migrants and return migrants in

Mexico. U.S.-born Mexicans and Whites will also be included for comparability with previous research. These health measures are important both in assessing whether there is a “Latino paradox” in these outcomes, and also in that they may contribute to the Latino mortality advantage. Physical activity is associated with lower mortality [22] and being sedentary with increased mortality [23]; thus, those who are limited in their ability to perform moderate or vigorous physical activity are likely to be at higher risk of mortality. Poor self-rated health is also related to mortality risk among respondents in the U.S. [24] and other countries [25]. Finally, chronic conditions also predict mortality [26].

This study tests the following hypotheses:

“Healthy migrant” hypothesis: Mexican immigrants in the U.S. are healthier than non-migrants in Mexico.

“Salmon-bias” hypothesis: Return-migrants (those who migrated to the U.S. and subsequently returned to Mexico) are less healthy than Mexican immigrants in the U.S.

Note that these hypotheses are not competing; there may be support for either one or both. The results from this study will shed light on the “Hispanic paradox” and ethnic health disparities by examining whether selective migration shapes Mexicans’ health profiles.

## Method

### Data and Sample

The 2002 Mexican Family Life Survey (MxFLS) and the 2001–2003 U.S. National Health Interview Survey (NHIS) were chosen based on their comparability (see “Appendix 1”), and the availability of immigration, health and family context measures. The MxFLS is a nationally-representative survey of the Mexican population, with the baseline survey administered in the year 2002 [27]. It contains information on 35,000 individuals in 8,500 households, collected from one-on-one interviews conducted in respondents’ homes with all household members ages 12 and older. The NHIS is nationally-representative of the U.S. civilian non-institutionalized population [28], collected using in-home computer-assisted personal interview. The datasets were appended and analyses carried out in Stata 10.1. After limiting the sample to adults ages 18 and older, and excluding cases missing information on immigration, age, sex, education, employment or marital status, the final analytic sample size of the combined U.S. and Mexico data was 160,265.

## Dependent Measures

### *Activity Limitations*

Respondents ages 50 and older in the MxFLS were asked how much difficulty they have doing each of the following activities: (a) carry a bucket, (b) walk 5 km, (c) climb stairs, (d) kneel down, (e) dress with no help, (f) use the toilet with no help, and (g) stand up from the floor (see “[Appendix 1](#)” for the question wording). For each question, responses were coded 0 if the respondent reported no difficulty with the activity, 1 if the respondent reported having any difficulty, and 2 if the respondent reported not being able to do the activity at all (in the NHIS, those who reported that they do not do the activity were coded as missing). Summing the responses to the seven questions resulted in a scale ranging from 0 (no difficulty at all) to 14 (cannot do any of the activities). Because of the highly skewed distribution of the responses (nearly 70 % of the combined sample reported no limitation), the measure was dichotomized, coded as 0 for no difficulty at all, and 1 if any difficulty was reported with any of the activities. A limitation of this measure is that in the MxFLS, only persons ages 50+ were asked these questions, so some of the cell sizes were small. For this reason, estimates for activity limitation should be interpreted with caution.

### *Self-Rated Health*

Self-rated health is a self-assessment of the respondent’s overall physical health. In both surveys, the five-point self-rated health scale is dichotomized, a common approach when the response distribution is highly skewed [29–31]. The self-rated health variable is coded 1 for those reporting the worst health (“poor” or “fair” in the NHIS; “very bad” or “bad” in the MxFLS) and 0 for those reporting the best health (“excellent,” “very good” or “good” in the NHIS; “very good,” “good,” or “regular” in the MxFLS).

### *Chronic Conditions*

The surveys asked whether the respondent has ever been told that he or she has diabetes, heart disease, hypertension, or cancer. The conditions were aggregated into a variable coded 1 if the respondent has any of the conditions and 0 if none. Because respondents can only report conditions that they have been told they have, there may be some group differences in reporting due to differences in health care utilization and the likelihood of being diagnosed. The self-reported nature of the data is a limitation.

## Independent Measures

The combined surveys allow comparison of several groups. From the MxFLS, non-migrant Mexicans (those who

reported never moving outside the country) and return migrants were examined. Return migrants were identified in the permanent migration section of the questionnaire, as those who responded that they had at least one change of residence (lasting one year or more) to the United States. From the U.S. NHIS, the following groups are included: (a) Mexican immigrants who have lived in the U.S. less than 5 years, (b) Mexican immigrants who have lived in the U.S. 5 years or more, (c) U.S.-born Mexicans, and (d) U.S.-born Whites. Socio-demographic controls include: age (range 18–85, top coded at 85), sex (male = reference group), marital status (married/cohabiting = reference), education (never attended or kindergarten = reference), and employment last week (working for pay = 1).

## Analysis

Tables 1 and 2 present the socio-demographic characteristics of the Mexico and United States samples, respectively. Both unweighted and weighted estimates, representative of the respective population, are presented for each country. In Table 3 the age-standardized rates of each health condition are presented. These were calculated using the weighted MxFLS and NHIS to obtain the crude rates of each health condition for each group. Then, using the 2000 Mexican Census to obtain data on the age distribution of the Mexican population ages 18 and over, direct standardization methods [32] were used to adjust the crude rates using the year 2000 Mexican population (ages 18 and over) as the standard population. Finally, Table 4 presents logistic regression odds ratios of activity limitation, self-rated health, and chronic conditions using the unweighted data, since current statistical methods preclude the calculation of a single function to weight the data. In the regressions, non-migrant Mexicans are the reference group, and Chi-square tests examined differences between other selected migrant groups; these results are noted in-text, but omitted from tables in the interest of space.

A methodological issue with combining these surveys was how to weight the data to be nationally-representative of their respective populations. Since the sampling frames differ between the surveys, and both have complex sampling designs with stratification, clustering, and sampling weights, it was not possible to create a single likelihood function to adjust for both designs and populations sampled [c.f., 33]. This was addressed by carrying out analyses within each survey separately, both unadjusted and adjusted for sample design, and then comparing the results. Moreover, the unweighted data from the MxFLS were compared to Mexican Census data to gauge whether using unweighted data produces biased estimates (see “[Appendix 2](#)”). This method of combining surveys is a step toward developing more refined methods of analyzing data from

**Table 1** Socio-demographic characteristics of sample adults ages 18+, Mexico

	Unweighted percentage				Weighted percentage			
	Whole sample	Non-migrant Mexican	Return migrant Mexican	<i>p</i> value	Whole sample	Non-migrant Mexican	Return migrant Mexican	<i>p</i> value
Age <sup>a</sup>	40.2 (39.9–40.39)	40.2 (39.9–40.4)	39.5 (37.9–41.1)		39.6 (39.3–39.9)	39.6 (39.3–39.9)	39.6 (37.6–41.5)	
Female	55.9	56.5	27.6	***	56.7	57.2	27.1	***
Marital status				*				*
Married/cohab	67.6	67.5	73.9		67.0	66.9	74.8	
Never married	22.1	22.2	16.4		22.7	22.9	15.5	
Div./sep./widowed <sup>b</sup>	10.4	10.4	9.7		10.3	10.3	9.7	
Education								*
Never attended/ kindergarten	9.8	9.8	7.3		9.5	9.5	7.3	
Elementary/junior high school	68.0	67.9	73.9		64.7	64.5	75.0	
High school or equivalent	13.0	13.0	10.9		14.2	14.3	8.8	
College+	9.3	9.3	7.9		11.7	11.7	9.0	
Employment status (last week)				***				***
Working for pay	52.5	52.2	65.5		54.1	53.8	67.4	
n	17,523	17,193	330					

Source: Mexican Family Life Survey 2002

\*\*\* *p* < 0.001, \*\* *p* < 0.01, \* *p* < 0.05 (two-tailed test), *p* value obtained from design-based *F* statistic from Pearson’s  $\chi^2$  test

<sup>a</sup> Mean (95 % confidence intervals in parentheses). <sup>b</sup> Divorced, separated or widowed

combined complex surveys. The results of this study should be interpreted with this issue in mind and future research should flesh this out with greater efficacy than could be done in this study.

## Results

### Sample and Population Characteristics

Tables 1 and 2 present the socio-demographic characteristics of the Mexico and United States samples, respectively. In the Mexican data, it is important to note that the difference between the unweighted and weighted estimates was small, lending confidence to analyses in which estimates are unweighted. On average, the Mexican population was around 40 years old, more likely to be female, married or cohabiting, with education up to the 8th grade level, and employed. Compared to non-migrant Mexicans, return migrants were significantly more likely to be male, married, employed, and have lower education. Overall, the U.S. population (Table 2) was slightly older, more educated, and had higher employment, but there are significant

differences by ethnicity and immigrant status. Importantly, Mexican immigrants were much more likely than U.S.-born Mexicans to have completed the NHIS in Spanish or both English and Spanish.

### Population Health: The United States and Mexico Compared

To account for the fact that the U.S. population was older than the Mexican population, age-standardized rates of the diagnosed health conditions are presented in Table 3. These rates reveal some important differences in health conditions by nativity and ethnicity. Mexican immigrants have lower rates of chronic conditions than U.S. Whites, supporting the “Hispanic Paradox.” However, compared to non-migrant Mexicans, Mexicans in the U.S. were disadvantaged, and U.S.-born Mexicans had higher rates of chronic conditions than Mexican immigrants. In terms of self-rated health, U.S.-born Mexicans had higher age-adjusted rates of poor health compared to non-migrant Mexicans, U.S. Mexican immigrants, and U.S.-born Whites.

**Table 2** Socio-demographic characteristics of sample adults ages 18+, U.S.

	Whole sample	Mexican immigrant, <5 years.	Mexican immigrant, 5+ years	U.S.-born Mexican	U.S.-born White	<i>p</i> value
<i>Unweighted percentage</i>						
Age <sup>a</sup>	44.8 (44.7–44.8)	29.2 (28.7–29.5)	39.6 (39.3–39.8)	38.5 (38.1–38.7)	47.1 (46.9–47.2)	***
Female	53.0	46.1	49.8	52.9	52.3	***
Marital status						***
Married/cohab	64.2	62.6	75.9	56.1	67.7	
Never married	19.2	31.9	13.6	28.5	15.6	
Div./sep./widowed <sup>b</sup>	16.9	5.5	10.5	15.3	16.7	
Education						***
Never attended/kindergarten	0.7	3.3	3.9	1.2	0.2	
Elementary/junior high school	7.9	43.8	42.8	9.5	3.1	
High school or equivalent	42.0	43.5	39.5	52.8	40.9	
College+	49.4	9.3	13.9	36.5	55.8	
Employment status (last week)						***
Working for pay	61.6	62.2	62.9	62.9	61.7	
Language of Interview						***
English only	87.8	13.8	32.1	80.6	97.4	
Spanish or combination	9.0	83.6	65.6	15.6	0.1	
<i>n</i>	197,158	2,486	11,080	11,082	118,094	
<i>Weighted percentage</i>						
Age <sup>a</sup>	45.1 (44.8–45.2)	29.2 (28.7–29.6)	39.3 (38.9–39.7)	38.6 (38.1–39.0)	46.7 (46.3–46.8)	***
Female	52.0	44.8	47.8	51.9	51.7	***
Marital status						***
Married/cohab	64.3	61.5	76.9	56.8	66.9	
Never married	19.4	32.9	13.8	27.8	16.7	
Div./sep./widowed <sup>b</sup>	16.3	5.8	10.2	14.7	16.3	
Education						***
Never attended/kinder	0.5	3.2	3.9	1.0	0.2	
Elementary/junior high school	5.8	42.9	41.1	8.7	3.1	
High school or equivalent	41.1	44.1	40.2	51.1	40.7	
College+	52.7	9.9	14.9	39.2	56.1	
Employment status (last week)						***
Working for pay	61.8	63.3	64.2	63.9	61.8	
Language of Interview						***
English only	92.26	15.5	34.5	83.1	97.5	
Spanish or combination	4.7	82.2	63.4	13.4	0.1	

Source: National Health Interview Survey 2001–2003

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$  (two-tailed test),  $p$  value obtained from design-based  $F$  statistic from Pearson's  $\chi^2$  test. May not sum due to rounding error

<sup>a</sup> Mean (95 % confidence intervals in parentheses). <sup>b</sup> Divorced, separated or widowed

#### Are Mexican Immigrants in the U.S. Selected on Health?

Table 4 presents logistic regression results to test the selection hypotheses. In terms of activity limitation, Mexicans in the U.S. (both U.S.-born and immigrants) and

U.S.-born Whites had lower odds of having an activity limitation compared to non-migrant Mexicans. Return migrants also had slightly lower odds compared to non-migrants, although the 5 % difference in odds did not reach statistical significance (OR = 0.951, ns), possibly because of the small number of return migrants over the age of 49

**Table 3** Age-standardized prevalence rates of chronic conditions and poor/fair self-rated health, U.S. and Mexico

	Mexico	United States			
	Whole population	Mexican immigrants, <5 years in U.S.	Mexican immigrants, ≥5 years in U.S.	U.S.-born Mexicans	U.S.-born Whites
Chronic conditions <sup>a</sup>					
Rate (95 % confidence interval)	15.76 (15.02–16.50)	14.89 (11.56–18.22)	20.32 (19.21–21.43)	26.33 (25.03–27.63)	26.03 (25.59–26.47)
Poor/fair self-rated health <sup>b</sup>					
Rate (95 % confidence interval)	4.82 (4.41–5.22)	13.04 (10.64–15.44)	12.74 (11.98–13.51)	12.87 (12.17–13.57)	7.70 (7.46–7.95)

*Source:* Author's calculations based on 2002 Mexican Family Life Survey, 2001–2003 National Health Interview Survey, and Mexican Census 2000. Crude rates estimated using weighted 2002 Mexican Family Life Survey (for Mexican sample) and 2001–2003 National Health Interview Survey (for U.S. sample). Age distribution data were obtained from Mexican Census 2000 (Censo General de Poblacion y Vivienda, 2000). Notes: Rates are per 100 and age-adjusted to the 2000 Mexican standard population. The Mexican population is not disaggregated because there were too few return migrants to standardize by age

<sup>a</sup> Diagnosed chronic conditions: have been told you have at least one of the following: diabetes, hypertension, cancer, and heart disease

<sup>b</sup> Ranking of own health as 4 or 5 on a scale of 1–5, where 1 is best health and 5 is worst health

( $n = 46$ ). However, return migrants had significantly higher odds of limitation compared to Mexican immigrants in the United States, both recent ( $\chi^2 = 18.75$ ,  $p < 0.001$ ) and established ( $\chi^2 = 13.96$ ,  $p < 0.001$ ). Moreover, the difference between recent and established Mexican immigrants was significant ( $\chi^2 = 7.63$ ,  $p < 0.01$ ), hinting at a possible acculturation effect whereby the odds of limitation increase with time in the U.S. The fact that Latinos had lower odds of limitation than Whites contradicts previous research [10]. This discrepancy may reflect actual difference in activity limitation, or differences in study designs—the younger ages included here (age 50 and older, vs. 65 and older), or different operationalization of activity limitation. Because these analyses are restricted to ages 50 and over, some of the cell sizes were small, so estimates for activity limitation should be interpreted with caution.

Among adults ages 18 and over, self-rated health patterns revealed that non-migrant Mexicans had lower odds of reporting fair or poor health compared to almost all other groups, with the exception of Mexican return migrants whose odds of poor health were not significantly lower than non-migrant Mexicans (OR = 0.748, ns). Specifically, recent U.S. immigrants had 2.5 times greater odds, more established immigrants almost 4 times greater odds, and U.S.-born Mexicans 6 times the odds of reporting poor health. White Americans also had much higher odds of poor health (OR = 4.366,  $p < 0.001$ ). Moreover, return migrants were less likely than Mexican immigrants in the U.S. to report poor health. For example, contrary to both selection hypotheses, the differences between both return migrants and established immigrants ( $\chi^2 = 31.28$ ,  $p < 0.001$ ) and return migrants versus recent immigrants ( $\chi^2 = 17.68$ ,  $p < 0.001$ ) were statistically significant.

Broadly, the results for overall chronic conditions mirrored those for self-rated health, but the magnitude of the differences was smaller. Neither recent immigrants nor return migrants differed significantly from non-migrant Mexicans in the odds of having at least one of the four conditions examined. However, established Mexican immigrants, and U.S.-born Mexicans and Whites had significantly higher odds of chronic conditions than non-migrant Mexicans. These findings were similar to those for self-rated health, which increases the credibility of the self-rated health reports, since many individuals take specific health conditions such as chronic conditions into account in their health self-ratings [34].

## Discussion

Using combined data from the United States and Mexico, this study examined migrant health selectivity, testing the “healthy migrant” and “salmon-bias” hypotheses as explanations for the health outcomes of U.S. Mexicans. The results revealed several important health differences between Mexicans in the United States and those in Mexico, providing mixed support for these selection hypotheses, depending on the health measure in question, and suggesting a deleterious health effect of time in the United States. In line with previous research, U.S.-born Mexicans fared worse than first generation Mexican immigrants in all health conditions, and worse than non-migrant Mexicans in Mexico in terms of self-rated health and chronic health conditions. Moreover, recent immigrants had lower odds of poor health than more established immigrants. Although these cross-sectional data cannot

**Table 4** Selected health conditions: logistic regression odds ratios

	Activity limitation <sup>a</sup>	Poor self-rated health <sup>b</sup>	Chronic conditions <sup>c</sup>
<i>Sample</i>			
Non-migrant Mexican—MxFLS	Ref.	Ref.	Ref.
Return migrant—MxFLS	0.951 (0.232)	0.748 (0.217)	0.825 (0.149)
U.S. Mexican imm, <5 years—NHIS	0.110*** (0.048)	2.635*** (0.228)	1.072 (0.125)
U.S. Mexican imm, 5+ years—NHIS	0.372*** (0.028)	3.795*** (0.175)	1.450*** (0.068)
U.S.-born Mexican—NHIS	0.598*** (0.045)	6.149*** (0.306)	2.371*** (0.119)
U.S.-born White—NHIS	0.687*** (0.037)	4.366*** (0.192)	2.439*** (0.093)
<i>Socio-demographic controls</i>			
Age	1.026*** (0.001)	1.023*** (0.001)	1.056*** (0.001)
Sex			
Male	Ref.	Ref.	Ref.
Female	1.440*** (0.035)	0.857*** (0.015)	1.036* (0.018)
Marital status			
Married/cohab	Ref.	Ref.	Ref.
Divorced/separated/widowed	1.183*** (0.030)	1.329*** (0.028)	1.016 (0.021)
Never married	1.193*** (0.059)	0.933* (0.028)	0.817*** (0.021)
Education			
Never attended/kindergarten	Ref.	Ref.	Ref.
Elementary/junior high school	0.702*** (0.048)	0.678*** (0.038)	1.726*** (0.102)
High school	0.489*** (0.039)	0.343*** (0.020)	1.526*** (0.099)
College+	0.390*** (0.031)	0.179*** (0.011)	1.356*** (0.088)
Employment status last week			
Not working for pay	Ref.	Ref.	Ref.
Worked for pay	0.418*** (0.011)	0.318*** (0.006)	0.673*** (0.012)
n	33,977	160,085	84,109

Source: Combined NHIS 2001–2003 and MxFLS 2002

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$  (two-tailed test).

Standard errors in parentheses

<sup>a</sup> Activity limitation analysis restricted to those age 50+ (see text for detail). <sup>b</sup> Poor/fair self-rated health (coded 1 if respondent rated health as 4 or 5 on scale of 1–5). <sup>c</sup> Chronic conditions is coded 1 if the respondent has been told by health professional that he/she has at least one of the following: diabetes, heart disease, hypertension, cancer

formally examine longitudinal changes that occur with time in the U.S., this finding corroborates previous research suggesting that acculturation has deleterious effects on immigrant health [7, 13, 35]. Mexicans' negative health outcomes highlight the importance on focusing not just on their "paradoxical" positive health outcomes because those may obscure major public health problems, such as obesity and diabetes, in this population.

Overall, this study's findings provided support for *both* a healthy migrant effect and salmon-bias for activity limitation, but these selection effects did not appear relevant in self-rated health or chronic conditions. Mexican immigrants in the United States had lower odds of activity limitation than non-migrants. This suggests that Mexicans without physical impairments are more likely to migrate, supporting the healthy migrant hypothesis. The salmon-

bias hypothesis was supported by the finding that return migrants have higher odds of activity limitation than Mexicans in the United States. A plausible explanation is that having an activity limitation hinders migration to the United States among those in Mexico, but encourages Mexicans in the U.S. to re-emigrate back to Mexico. As a heuristic, a scenario where this may be in play, for example, is when a Mexican immigrant who came to the United States with no functional impairment, subsequently develops an activity limitation and is no longer able to work (perhaps only temporarily), and consequently returns to Mexico. Future research might examine how long return migrants have been in Mexico and the duration of their physical limitation to shed light on this issue.

Furthermore, immigrants have poorer self-rated health than those in Mexico, which is consistent with previous research that found poor self-rated health was related to higher odds of migration in rural male and females, suggesting the opposite of a healthy migrant effect [11]. However, due to the subjective nature of self-rated health, it is unclear to what extent this difference in self-rated health is related to cultural or linguistic differences in response to the self-rated health question. A recent study examining two U.S. surveys found that those who interview in Spanish language are more likely to rate their health as fair or poor, net of demographic and some health differences [36], and that the “fair” category (“regular” in Spanish versions of the surveys) likely accounts for much of the difference; however, the same study did not find these language effects when examining the 2002 NHIS. In this study, over 80 % of recent Mexican immigrants completed the interview in Spanish (or both English and Spanish), and the self-rated health question wording in the NHIS and the MxFLS is very similar. The high percentage of recent immigrants who were surveyed in Spanish supports the validity of the conclusion that Mexican immigrants’ poorer self-rated health (compared to non-migrants) is a real difference in subjective health rather than a reporting difference. Moreover, consistent with other recent research, return migrants in this study did not differ in self-rated health from non-migrants [37]. Thus, this study indicates that physical/functional ability plays a role in predicting who returns to Mexico, whereas self-rated health and chronic conditions (as a whole) do not.

This study attempted to address the challenges of combining surveys noted by others [16], but is not without limitations. First, the validity of cross-cultural comparisons, especially of subjective measures, is uncertain. It is possible that immigrants’ greater odds of poor self-rated health are due to cultural differences in reporting, rather than differences in health. For this reason, the results for self-rated health should be interpreted with this limitation in mind. However, the surveys used here were chosen

based on comparability to reduce some of the potential bias arising from analyzing different cultures and populations. An advantage of using a Mexican survey is that the question wording is appropriate to the Mexican context, yet still comparable to the U.S. survey. Moreover, there were methodological challenges with combining datasets. This study takes a preliminary step toward developing appropriate methods for examining selection using the exploratory method of combining origin and destination samples, and addresses this issue by comparing the samples and populations in each survey.

The second issue with combining these surveys had to do with how to weight the data to be nationally-representative of the respective populations. This was addressed by carrying out analyses within each survey separately, and by comparing the analyses that were unadjusted to those adjusted for sample design. Since the sampling frames differ between the surveys and both surveys were based on complex sampling designs, with stratification, clustering, and sampling weights, it was not possible to create a single likelihood function to adjust for both designs and populations sampled [c.f., 33]. Instead, analyses used unweighted data. Yet comparisons of the unadjusted Mexican survey data to Mexican Census data (see “Appendix 2” for Census data) suggest the differences are small and would not produce biased estimates. Nevertheless, the results of this study should be interpreted with this issue in mind and this method is a step toward developing more refined methods of analyzing data from combined complex surveys.

Future research may build upon the knowledge gained from this study in several ways. The next step is to examine chronic conditions separately to understand whether there are selection effects for specific conditions that are masked when examining the conditions in aggregate. Although national-level surveys are useful in their generalizability, research should take regional differences (such as characteristics of the sending and receiving communities) into account, which this study was unable to do due to data constraints. In addition, there are documented gender differences in the impetus for and experience of migration [38–40], as well as in health outcomes among immigrants [10] and the broader U.S. population [41, 42], that substantiate the need to examine potential sex differences in selection.

More research is needed to understand whether U.S. immigrants are selected on health, and, if so, which immigrant groups and on what health dimensions. Yet the lack of evidence for selection effects in this study points to other mechanisms at play in the Hispanic Paradox. It is likely that a complex confluence of factors lead to lower mortality in Latino immigrants, including some health-protective behaviors, such as lower rates of smoking [43]. Moreover, the rapid deterioration of immigrants’ health

with time in the United States and across immigrant generations suggests that aspects of Latino immigrants' lives in the United States are deleterious to health. Some of the factors contributing to immigrants' health include discrimination and acculturative stress [44, 45], language and structural barriers [46], and adoption of health-risky behaviors—for example, worsening diet [47]—many of which are linked to the built environment [48].

## Conclusions

This study aimed to contribute to existing knowledge about migrant health by examining health selectivity among Mexican immigrants. It provided insight into the benefits and challenges of combining origin and destination data to examine selective migration as an explanation for health disparities between migrant and non-migrant populations. This undertaking is valuable for several reasons. First, it is among the few to test migrant health selectivity by combining U.S. and Mexican data [16, 17]. Second, this is the first study to the authors' knowledge to calculate age-standardized rates of multiple health outcomes in the United States and Mexico by ethnicity and migration status. Third, the study assessed the potential for combining the U.S. NHIS and MxFLS for use in comparative analyses. Finally, the study highlighted how selection processes operate differently for various health conditions, finding that migrants are selective in some health aspects, but not others.

Like their non-Latino compatriots, the health profile of U.S. Latinos is complex. The epidemiologic “Hispanic Paradox” provides hope that Latinos may not suffer the same burden of disease as other groups of low socioeconomic standing, yet evidence points to troubling increases in morbidity over the past decades, and for immigrants, with time in the U.S. and across generations. This study has provided evidence that there is no simple explanation for Latinos' perplexing health outcomes, such as simply that healthier people migrate. Rather, migrants are positively

selected in some health aspects, negatively selected in others, and in yet other health outcomes, there is no selection effect. In sum, selective migration plays a role in explaining *some* of U.S. Latinos' health outcomes, but is not the only explanation and does not account for the Paradox. To more effectively address the health needs of this large immigrant group, more attention should be paid to migrants' worsening health over time in the United States, and the role of selective migration in shaping migrant health should be considered alongside other factors such as acculturation.

The results of this study are a step toward understanding how the health of Mexican immigrants in the United States compares to those in Mexico, and suggests the importance of assessing the role of selective migration in shaping migrant health profiles in destination countries globally. Considering that this immigrant health paradox has also been documented in other immigrant-receiving countries, it is important that researchers ask to what extent selective migration explains migrant health in various destination countries among varied immigrant groups. By examining migrant health in bi-national perspective, this study has taken a step in this direction.

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## Appendix 1

See Table 5.

**Table 5** Comparison of measures: U.S. National Health Interview Survey and Mexican Family Life Survey

	NHIS	MxFLS- Spanish (original)	MxFLS- English translation
Self-rated health	Would you say your health in general is excellent, very good, good, fair, or poor?	Actualmente, ¿podría decir que su salud es (...)?	Currently, could you say that your health is (...)?
	1. Excellent	1. Muy buena	1. Very good
	2. Very good	2. Buena	2. Good
	3. Good	3. Regular	3. Regular
	4. Fair	4. Mala	4. Bad
	5. Poor	5. Muy mala	5. Very bad

**Table 5** continued

	NHIS	MxFLS- Spanish (original)	MxFLS- English translation
Activity limitation	<p>By yourself, and without using any special equipment, how difficult is it for you to</p> <p>... Lift or carry something as heavy as 10 pounds such as a full bag of groceries?</p> <p>... Walk a quarter of a mile—about three city blocks?</p> <p>... Stoop, bend, or kneel?</p> <p>... Walk up 10 steps without resting?</p> <p>... Stand or be on your feet for about 2 h ?</p> <p>Do you need the help of other persons with...dressing?</p> <p>...using the toilet, including getting to the toilet?</p> <p>0. Not at all difficult</p> <p>1. Only a little difficult</p> <p>2. Somewhat difficult</p> <p>3. Very difficult</p> <p>4. Can't do at all</p> <p>6. Do not do this activity</p>	<p>Si usted tuviera que (...)</p> <p>A. Llevar una cubeta pesada (por ejemplo llena de agua) a 20 metros, ¿podría hacerlo ?</p> <p>B. Caminar 5 kilómetros, ¿podría hacerlo ?</p> <p>C. Inclinarsse, sentarse en cuclillas o arrodillarse, ¿podría hacerlo ?</p> <p>D. Subir escaleras sin ayuda, ¿podría hacerlo ?</p> <p>E. Vestirse sin ayuda, ¿podría hacerlo ?</p> <p>F. Pararse de una silla sin ayuda, ¿podría hacerlo ?</p> <p>G. Ir al baño sin ayuda, ¿podría hacerlo ?</p> <p>H. Levantarse del suelo y ponerse de pie sin ayuda, ¿podría hacerlo?</p> <p>1. Fácilmente</p> <p>3. Difícilmente</p> <p>5. No lo podría hacer</p>	<p>If you had to (...)</p> <p>A. Carry out a heavy bucket (full of water, for example) for 20 meters, could you do it ?</p> <p>B. Walk 5 km, could you do it [...]?</p> <p>C. Bend, sit on your knees, or squat, could you do it?</p> <p>D. Climb up stairs without help, could you do it?</p> <p>E. Dress up without help, could you do it?</p> <p>G. Go to the bathroom without help, could you do it ?</p> <p>H. Raise from the floor and get on your feet without help, could you do it ?</p> <p>1. Easily</p> <p>3. Difficultly</p> <p>5. Can't do it</p>
Heart disease	<p>Combined the following questions:</p> <p>Ever had heart problems</p> <p>Ever been told you had a myocardial infarction</p> <p>Ever been told you had angina</p> <p>Ever been told you had coronary heart disease?</p> <p>1. Yes</p> <p>2. No</p>	<p>¿Alguna vez ha sido usted diagnosticado(a) con Enfermedad del corazón?</p> <p>1. Si</p> <p>3. No</p>	<p>Have you ever been diagnosed with heart disease?</p> <p>1. Yes</p> <p>3. No</p>
Diabetes	<p>Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes? [If Female, add: Other than during pregnancy].</p> <p>1. Yes</p> <p>2. No</p>	<p>¿Alguna vez ha sido usted diagnosticado(a) con Diabetes?</p> <p>1. Si</p> <p>3. No</p>	<p>Have you ever been diagnosed with diabetes?</p> <p>1. Yes</p> <p>3. No</p>
Hypertension	<p>Have you EVER been told by a doctor or other health professional that you had Hypertension, also called high blood pressure?</p> <p>1. Yes</p> <p>2. No</p>	<p>¿Alguna vez ha sido usted diagnosticado(a) con Hipertensión?</p> <p>1. Si</p> <p>3. No</p>	<p>Have you ever been diagnosed with hypertension?</p> <p>1. Yes</p> <p>3. No</p>
Cancer	<p>Have you EVER been told by a doctor or other health professional that you had cancer or a malignancy of any kind?</p> <p>1. Yes</p> <p>2. No</p>	<p>¿Alguna vez ha sido usted diagnosticado(a) con Cáncer?</p> <p>1. Si</p> <p>3. No</p>	<p>Have you ever been diagnosed with cancer?</p> <p>1. Yes</p> <p>3. No</p>

Questions verbatim from the NHIS Codebook and MxFLS questionnaires (Spanish and English)

## Appendix 2

See Table 6.

**Table 6** Selected characteristics of Mexican adults ages 18+, Mexico census 2000

	Percent of population (%)
Age	
18–29	37
30–49	40
50–69	17
70+	5
Female	51
Marital status <sup>a</sup>	
Married/cohabiting	60
Never married	31
Divorced/separated/widowed	9
Education	
Elementary	50
Secondary (junior high)	22
High school or higher	28
No response	1

Source: Mexico census 2000 (Censo General de Población y Vivienda 2000)

Percentages may not sum due to rounding. <sup>a</sup> Calculated for population ages 15+

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