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Stress, Allostatic Load and Health of Mexican Immigrants

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Abstract

Objective—To assess whether the cumulative impact of exposure to repeated or chronic stressors as measured by allostatic load, contributes to the "unhealthy assimilation" effects often observed for immigrants with time in the United States.

Methods—We analyzed data from the National Health and Nutrition Examination Survey, 1988–1994, to estimate multivariate logistic regression models of the odds of having a high allostatic load score among Mexican immigrants, stratified by adult age group, according to length of residence in US, controlling for demographic, socioeconomic, and health input covariates.

Results—Estimates indicate that 45–60 year old Mexican immigrants have lower allostatic load scores upon arrival than US-born Mexican Americans, non-Hispanic whites, and non-Hispanic Blacks, and that this health advantage is attenuated with duration of residence in the US.

Conclusions—The findings of our analysis are consistent with the hypothesis that repeated or chronic physiological adaptation to stressors is one contributor to the "unhealthy assimilation" effect observed for Mexican immigrants.

Introduction

A broad array of evidence suggests that immigrants are often healthier when they arrive in the US than comparable native-born persons, but that their health advantage declines with time in the US (Antecol and Bedard 2006; Cho et al. 2006; Dey et al. 2006; Goel et al. 2004; Harker 2001; Jasso et al. 2004; Kandula et al. 2004; Landale et al. 2000; Lara et al. 2005; Singh 2002; Singh and Hiatt 2006; Singh and Siapush 2002; Stephen et al. 1994). The conventional explanation of this immigrant health trajectory is that immigrants are positively selected on health, which explains their health advantage on arrival, and that deterioration in health with time in the US represents an unhealthy effect of assimilation. Previous research has identified several possible explanations of the "unhealthy assimilation" effect: a worsening diet and declining physical activity (Antecol and Bedard 2006; Goel et al. 2004); adoption or intensification of other unhealthy behaviors such as smoking and drinking (Blake et al. 2001; Johnson et al. 2002; Lopez-Gonzalez et al. 2005; Markides et al. 1987;

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Marks et al. 1990; Singh and Siapush 2002); and increased stress as a result of discrimination and the process of acculturation (Araujo and Borrell 2006; Escobar et al. 2000; Finch and Vega 2003; Finch et al. 2000; Gee et al. 2006; Kessler et al. 1999; Paradies 2006; Thomas 1995; Vega and Rumbault 1991; Vega et al. 2004).

In this paper, we take a novel approach to exploring the question of whether stress contributes to the worse health observed among Mexican immigrants with time in the US. Typically, investigators interested in the role of stress have assessed the relationship between health and variables thought to be correlated with stress such as indicators of acculturation (e.g., language and social support) and perceived discrimination. We take a fundamentally different approach by examining how allostatic load scores differ by nativity and by time in the US among Mexican immigrants. Conceptually, allostatic load refers to the cumulative wear and tear on important body systems induced by repeated physiological adaptation to stressors (McEwan 1998). No previous study has used the construct of allostatic load to assess the role that stress may play in the health of immigrants with time in the US.

Mexican Immigrant Health Trajectories

There are surprisingly few studies of how health changes with time since immigration for Mexican immigrants. While there are a larger number of studies of the health trajectories of all foreign-born persons, and some of Hispanic immigrants, Mexican immigrants differ from other immigrants, including other Hispanics, in their modes of acculturation, socioeconomic incorporation, pattern of geographic dispersion, and health-related country of origin characteristics, such as quality of medical care and health behavioral norms. As a result, health trajectories of Mexican immigrants may differ from that of other Hispanics.

Cho et al (2006) and Singh and Miller (2004) analyzed data from the National Health Interview Survey (NHIS) from the early 1990s to study changes in health with time since immigration among Mexican immigrants. Cho et al. (2006) found that the reported health (self-reported health, activity limitations, and number of days in bed due to illness) of Mexican immigrants declined with duration in the US after adjusting for demographic and socioeconomic characteristics. Singh and Miller (2004) reported results similar to Cho et al. (2006). Vega et al. (2004) studied Mexican Americans in Fresno, California and found that Mexican immigrants had lower prevalence of psychiatric disorders, overall, and that time in the US was associated with increased prevalence of psychiatric disorders, particularly among those who entered the US when young. Palloni and Arias (2004) examined linked NHIS-NDI (National Death Index) data and concluded that the Mexican mortality advantage did not decline with time in the US, and that there was evidence of a “salmon-bias” – the return migration of Mexican immigrants in poor health, unemployed, or near death.

Few studies have investigated potential causes of changes in health with time since immigration among Mexican immigrants. A prominent explanation of the “unhealthy assimilation” effect is stress resulting from discrimination and the process of acculturation. A major premise of stress theory is that environmental demands that exceed one’s ability to cope with them result in physiological and behavioral changes that place an individual at risk for illness (Cohen and Kessler 1985; Cohen and Wills 1984). For Mexican immigrants, the process of assimilation may involve both increased exposure to environmental stressors and coping responses that are detrimental to health (Finch and Vega 2003). Acculturation, or the process of adopting and adjusting to a new culture, may be stressful, as immigrants are uprooted, their social networks disrupted, and they may find it difficult to become socially, economically, or culturally incorporated into their new society (Rogler 1994). Stress from acculturation may also lead immigrants to adopt coping mechanisms such as substance use and changes in diet that adversely affect health, although these behavior changes may also reflect assimilation into the ways of the new host society, rather than being indicative of stress, per se. Acculturation among immigrants may also lead to increased contact with the dominant society and a resultant increased exposure to stressful social encounters (Finch and Vega 2003).

Studies that focus on stress-related explanations of the “unhealthy assimilation” effect often study the relationship between indicators of acculturation and health. Burnam et al. (1987) used data on residents of Los Angeles from the Epidemiologic Catchment Area (ECA) to study the relationship between acculturation and prevalence of psychiatric disorders. They found Mexican immigrants to have lower prevalence of psychiatric disorders than US-born persons, and that, among Mexican Americans (immigrants and US-born, together), a high degree of acculturation, as measured by a 26 item scale, was associated with a higher prevalence of psychiatric disorders such as depression and alcohol dependence. However, most of the effect of acculturation was accounted for by nativity. Within nativity, acculturation had no significant association with psychiatric disorders. Kaplan and Marks (1990) used a sample of Mexican Americans from the Hispanic Health and Nutrition Examination Survey (HHANES) and found that greater acculturation, as measured by an eight item scale of language and ethnic identity, was associated with higher rates of depression, although results differed by gender and age, and this study did not adjust for nativity. Vega et al. (2004) studied Mexican Americans in Fresno, California and found that Mexican immigrants had lower prevalence of psychiatric disorders and that time in US was associated with increased prevalence of psychiatric disorders, particularly among those who entered the US when young. Acculturation, which was measured by a person’s language capability, was not a significant predictor of illness. Finally, Ortega et al. (2000) reported that among Mexican Americans drawn from the National Comorbidity Survey, those who were more acculturated reported greater incidence of psychiatric disorders.

Similar studies of the effects of acculturation have been conducted using self-reported measures of physical health. Shetterly et al. (1996) found that acculturation was associated with better self-rated health among Hispanics in Colorado. In contrast, Finch and Vega (2003) found that some aspects of acculturation, in this case legal status stress, were associated with lower levels of self-reported general health among Mexican Americans in Fresno. A similar finding using the same data and sample was reported by Finch et al. (2001a), although in this case, job market stress and not legal status stress was the only measure of acculturation that was significantly related to worse health.

Previous researchers have sought to measure the mental and physical health consequences of discrimination-induced stress among Mexican immigrants. In a series of papers, Finch and colleagues (Finch and Vega 2003; Finch et al. 2000; and Finch et al. 2001a) examined the relationship between perceived discrimination and depression, poor health, and number of chronic conditions among Mexican Americans in Fresno. Generally, but not consistently, they found that greater levels of perceived discrimination were associated with worse mental and physical health. Salgado and Snyder (1987) also found that, among Mexican Americans from Los Angeles California, greater perceived discrimination was associated with depression.

This brief review of the literature reveals that while stress is often cited as an explanation of the “unhealthy assimilation” effect, there is relatively little evidence on this issue. Most of what is known comes from studies that examined how indicators of acculturation and perceived discrimination affect Mexican health. Moreover, there is considerable inconsistency in the findings from these studies.

Acculturation and time in the US are naturally linked and some studies measure acculturation by time in the US, shedding little light on the extent to which negative assimilation effects may be stress-mediated. In addition, the effects of stressors related to discrimination or acculturation may change or accumulate with time in the US, although no study has explicitly incorporated this possibility into the analysis. In this paper, we add to the literature assessing whether stress is a contributing factor to the decline in Mexican immigrant health with time in US by examining the relationship between allostatic load and time in the US. No previous study has used allostatic load, a construct specifically developed to reflect the health consequences of prolonged or cumulative stress, to assess whether the “unhealthy assimilation” effect may be related to stress.

Analytical Framework

To measure the health consequences of stress, we use allostatic load score, a composite biomeasure that builds on the tradition of using biomeasures as indicators of the physiologic consequences of social inequities. Blood-pressure reactivity, cytokine production, waist-to-hip ratio, cortisol levels, sympathetic nerve activity, and glycated hemoglobin levels have been found to be related to socioeconomic status, occupation, birth outcome, and environmental risk (Seeman et al. 2001; Uchino et al. 1996; Roy et al. 1998; Steptoe et al. 2002; Cohen et al. 1999; Marmot et al 1998; Daniel et al. 1999; Schnorpfiel et al. 2003;Weinstein et al. 2003; Wadhwa et al. 2001; Stancil et al. 2000; Maes et al. 1998; Evans 2003; Geronimus et al. 2007). McEwen and colleagues (McEwen 1998; McEwen and Seeman 1999) developed the more global concept of allostatic load, or the cumulative wear and tear on the body's systems owing to repeated adaptation to stressors.

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Stress and the coping required in stressful circumstances induce a physiological response, introducing a complex cascade of stress hormones into the body that, ideally, is shut down when the challenge to homeostasis recedes (McEwan 1998). The body’s ability to respond to acute stress is protective in certain threatening situations (e.g., the “fight or flight” response), yet, when allostatic systems are not completely deactivated, the body experiences overexposure to stress hormones causing health to deteriorate. Allostatic systems can be activated by stressors that are psychosocial (e.g. perceived unfair treatment), environmental (e.g. toxic exposures or ambient stressors in residential areas or work places), or by disregulation of diurnal rhythms (i.e., disruption of the sleep/wake cycle). Long periods of overexposure result in “allostatic load,” which can cause wear and tear on the cardiovascular, metabolic, and immune systems, and, thereby, contribute to the development of chronic conditions such as hypertension, obesity, and diabetes (McEwen 1998; McEwen and Seeman 1999; Seeman et al. 1997). The biomeasures comprising the allostatic load score were chosen to reflect such wear.

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Both the cumulative nature of, and population differences in, allostatic load are born out in empirical studies that indicate increases in allostatic load scores across the life course (Crimmins et al 2003; Geronimus et al 2006). Not only does allostatic load increase absolutely with age within groups, but group differences become more pronounced at older ages. For example, while black-white differences in allostatic load are small in the late teens and early twenties, they widen significantly with increasing age (Geronimus et al 2006). This age pattern is consistent with early health deterioration, or “weathering”, among more disadvantaged groups, as insults to their health accumulate across the life course (Geronimus 1992). If Mexican immigrants are disproportionately exposed to physiological challenges in their residential and work environments, or through persistent high-effort coping with the demands of acculturation or with experiences of discrimination, then greater durations of stay in the US may have adverse health impacts. That is, if stress, per se, contributes to the worse health observed in immigrants with longer stays in the US compared to recently arrived immigrants, one would expect to see evidence of higher allostatic load with time in the US.

By focusing on allostatic load, we look directly at a constellation of biological outcomes that are impacted by the physiological response to chronic stress exposure, rather than measure respondents' subjective assessment of stressors. These biological outcomes are often objectively measured in the data we analyze based on clinical examination, anthropometric measurement and laboratory analysis. While data limitations do not allow us to identify the specific sources of stress among immigrants, this approach contributes evidence on whether there are differences in stress-mediated health outcomes, whatever the source. We hypothesize that stress exposure contributes to the worse health of Mexican immigrants with time in the US, and that those whose residence in the US is of longer duration will have higher allostatic load than those who arrived in the US recently.

We note that some unhealthy behaviors, such as cigarette smoking or poor diet, can, themselves contribute to biological outcomes that are associated with increased allostatic load. If Mexican immigrants are more prone to adopt unhealthy behaviors as they reside in the US for longer periods, this might damage important body systems in ways that intensify allostatic load. Whether to view increased adoption of unhealthy behaviors as *confounding* the association between stress and allostatic load or as one *mechanism* by which stress *contributes* to allostatic load is theoretically ambiguous. In our empirical models, we consider the possibility that increased adoption of unhealthy behaviors is a potential confounder of any association between stress and allostatic load among immigrants with longer-term stays in the US compared to others. To the extent that adoption of these behaviors is more accurately construed as responsive to stressors, this is a conservative approach to studying whether stress contributes to the worse health of Mexican immigrants residing in the US for longer periods.

Empirical Model

To consider the question of whether stress contributes to the general decline in Mexican immigrant health with time in US, we assess whether the health consequences of stress, as measured by allostatic load, differ by time in US among immigrants in a regression framework controlling for potential confounders. Specifically, for Mexican immigrants of a specific age, we specify the following regression model:

$$ALL\_LOAD_{it}=\alpha+\sum_{k=1}^{K}\lambda_k\, TIME\_US_{itk}+\gamma_1 HB_{it}+\gamma_2 HI_{it}+\gamma_3 DV_{it}+X_{it}\Gamma+\delta_t+e_{ijt} \tag{1}$$

In equation (1), the allostatic load (*ALL_LOAD*) of immigrant i in year t is a function of: time in US (*TIME_US*), which is measured by k dummy variables indicating different lengths of stay in US; health behaviors such as tobacco use (*HB*); and health inputs such as doctor visits (*DV*) and health insurance (*HI*), which is a proxy for use of other health care services. Equation (1) also includes additional controls for person characteristics such as gender, marital status, education, and controls for year effects.[1]

Note that equation (1) is specified for persons of a specific age. In the analysis, we use two age groups because of limited sample size: 30 to 44 year-olds and 45 to 60 year-olds. The

[1]Sample size limitations prevent separate analyses by gender. Preliminary analyses indicated that separate analyses by gender, or even allowing the effect of time in US to differ by gender did not have sufficient statistical power to yield informative estimates. This is a limitation of the study.

age restriction is imposed to account explicitly for the possibility that the relationship between time in US and allostatic load may differ by age of arrival. Being in the US for 20 years may have different implications for persons age 35 years than for persons age 55 years.[2] As specified in equation (1), immigrants are grouped into narrower age groups and thus age at arrival will be less of a confounding influence for estimates of the effect of time in US.

We also conduct two sets of secondary analyses. As a bridge to the earlier literature on the unhealthy assimilation effect, we repeat our analyses of Mexican immigrants using self-reported health as the outcome. In this way, we note whether we can, in effect, replicate in NHANES data, findings of others using the NHIS. Finally, to address whether stress and its health consequences can explain the erosion with time in US of any health advantage on arrival (or “healthy immigrant” effect), we estimate regressions of allostatic load including US-born persons in the analysis. We use three groups of US-born as referents: Mexicans, non-Hispanic whites, and non-Hispanic Blacks. US-born Mexicans are an appealing group to use as a reference group because of their common heritage, although they, too, may face discrimination or acculturative stress, as many are second generation. Using non-Hispanic whites and non-Hispanic blacks as referent groups allows us to contextualize the experience of Mexican Americans within the broader context of racial stratification in the United States. In all analyses, we apply sampling weights and statistical procedures to account for the complex sample design.

Data

Data for the analysis come from the National Health and Nutrition Examination Survey, 1988–1994 (NHANES III). The NHANES surveys, conducted by the National Center for Health Statistics (NCHS), used stratified, multistage probability samples to provide national estimates of health and nutritional status for the civilian, non-institutionalized population of the United States. An important strength of using NHANES data compared to other surveys is that many health outcomes are measured objectively and diagnoses of chronic disease, such as hypertension or diabetes, are not conditioned on health service access or utilization. We use data from the NHANES III because unlike more recent waves of NHANES data, they provide information on nativity and time in US. The sample selected for analysis includes Mexican Americans, both US- and foreign-born, and non-Hispanic US-born white and Black persons between the ages of 30 and 60. The number of foreign-born Mexican immigrants aged 30 to 60 in the NHANES III is approximately 700, with approximately 500, or 70 percent, being between the ages of 30 and 44.

Dependent Variables

To measure allostatic load, we employ the algorithm used by Geronimus et al. (2006) who adapted Seeman et al’s (1997) model for use with NHANES, which does not collect data on primary mediators, and for use in samples of broad age range compared to the primarily elderly samples in which allostatic load algorithms were initially developed. Allostatic load is measured by 10 biomeasures: systolic and diastolic blood pressures, body mass index (BMI), glycated hemoglobin, albumin, creatinine clearance, triglycerides, C-reactive protein, homocysteine, and total cholesterol. For each biomeasure, we determine the high-risk threshold empirically based on the distribution of that biomeasure in our sample. Following a standard approach, participants with a biomeasure reading beyond the threshold (defined as <25th percentile for creatinine clearance and albumin and >75th percentile for all

[2]There may be cohort effects (year of arrival effects), but these effects cannot be identified. Year of arrival is a linear combination of year, age and time in US, all of which are included in equation (1).

others) receive a point for that biomeasure (Seeman et al. 1997; Seeman et al. 2001; Crimmins et al. 2003). The points are then summed to obtain the allostatic load score, with a maximum score of ten. In the NHANES sample, high risk thresholds are: albumin (4.2 g/dl); BMI (30.9); c-reactive protein (.41 mg/dl); creatinine clearance (66 mg/dl); diastolic blood pressure (80 mmHg); glycated hemoglobin (5.4%); homocysteine (9 umol/l); systolic blood pressure (127 mmHg); total cholesterol (225); and triglycerides (168 mg/dl). We include those on medication for diabetes, hypertension, or high cholesterol in the determination of high-risk status when assigning points for glycated hemoglobin, blood pressure, or total cholesterol.[3]

Following Geronimus et al (2006), and for ease of interpretation, we construct the dependant variable by dichotomizing allostatic load scores according to a high score threshold. We estimate models using two different thresholds (3 or 4) to assess whether estimates are sensitive to the cutoff choice. We defined a high score as above either three or four based on previous literature suggesting that differences between groups in subsequent morbidity and mortality are seen when allostatic load scores reach 3 or 4 (Geronimus et al. 2006; Seeman et al. 1997). We note these thresholds are close to our sample means, suggesting that having a high score may be conceived as being above the mean.

Self-rated health is conceptualized as an individual’s specific assessment of their overall health status at the time of data collection. Self-rated health is an ordered categorical variable coded in descending order with response categories 1-excellent, 2-very-good, 3-good, 4-fair, and 5-poor. Following a standard approach, we constructed a dichotomous measure of poor self-rated health equal to one if respondent indicated that his health was fair or poor and zero otherwise.[4]

Explanatory Variables

Our key explanatory variable is time in US. We measure this variable by a set of dummy variables indicating that the person has been in the US 10 or fewer years, 11 to 20 years, or 21 or more years. Ideally, we would use finer categories of time in US, but limited sample sizes prevent us from doing so. We did experiment with slightly finer divisions for the younger age cohort, which is larger. Results were qualitatively similar to those reported in the text (results available from authors upon request).

Regression models included demographic, socioeconomic, and health input covariates. Demographic variables included age, gender and marital status. Age was coded as a set of dummy variables with response categories 30–34, 35–39, 40–44, 45–49, 50–54 and 55–60. Gender is a dichotomous variable equal to one for male and zero female. Marital status is measured by a dichotomous indicator of married (married-spouse in household, married-spouse not in household, living as married) and not married (widowed, divorced, separated and never married). Rural/Urban status is equal to one if a person lived in a place that is not located within an urbanized area as defined by the U.S. Census Bureau and that has less than 2,500 inhabitants. Respondents not qualifying as rural were classified as urban. Socioeconomic variables included education and income. Education was measured by a set of dummy variables indicating the following: 0–8 years, 9–11 years (some high school), 12 years (high school graduate), some college and college graduate. Poverty Income Ratio is a

[3]We assume that those taking medication (and, thus, previously diagnosed with a chronic disease) have already experienced systemic deterioration.

[4]We also constructed a measure of good health, which is equal to one if person reported their health to be excellent or good. Results using this measure were qualitatively the same, but of opposite sign, as those reported in the text pertaining to poor health. Results are available from authors upon request.

continuous income-to-needs variable measuring the ratio of household income to the poverty threshold which is adjusted for family size and composition

Two measures of health inputs were included in the regression analyses. Health insurance is a dichotomous variable coded yes or no. Number of doctor's visits in the past year was coded as an ordered categorical variable in ascending order with response categories none, 1, 2, 3–5, 6–11 and 12 or more. In addition, we included measures of health behaviors: smoking, physical activity and fruit and vegetable consumption. Smoking status is a dichotomous variable coded yes or no. The amount of physical activity the respondent regularly engages in is an ordered categorical variable with response categories low, medium and high. Fruit and vegetable intake is a continuous variable reflecting the total servings consumed per day.

Results

Table 1 presents sample means of allostatic load by nativity, ethnicity and time in US. Note that the mean allostatic load score is approximately three for those ages 30 to 44 and 4.5 for those ages 45 to 60, approximately at our high score cut-offs. Table 1 reveals that US-born Mexicans and foreign-born Mexicans have significantly higher mean allostatic loads than US-born, non-Hispanic whites. Among foreign-born Mexicans, mean allostatic load and the proportion of persons with a high allostatic load score tend to increase with time in the US, particularly among the older cohort. Among those 45 to 60, foreign-born Mexicans who have lived in US for 10 or fewer years have the lowest allostatic load score and the smallest proportion of persons with a high allostatic load. In contrast, foreign-born Mexicans who have lived in the US for 21 or more years have the highest allostatic load score and the greatest proportion of persons with a high allostatic load. Non-Hispanic Blacks have the highest allostatic load scores than any other group.

To assess whether time in the US has an independent association with allostatic load among foreign-born Mexicans, we estimated a regression model similar to equation (1). The estimates, which are reported as odds ratios from a logistic regression, are presented in Table 2. The dependent variable is a dichotomous variable indicating whether a person had an allostatic load of three or more, or four or more. Separate analyses were conducted for two age groups: 30 to 44 and 45 to 60. For each group, we estimate two specifications to assess how sensitive estimates of the effect of time in the US are to the addition of measured characteristics that may be confounding influences: a model that includes a basic set of covariates and another that includes an extended set of covariates, including health behaviors and health care inputs (see notes to Tables for list of variables).

For the sample of younger persons (30 to 44), there is little evidence to suggest that time in the US is associated with an increased probability of having a high allostatic load score. This is true whether a high allostatic load score is defined as three or more or four or more. For example, those who have been in the US for between 11 and 20 years, have virtually the same probability of having a high allostatic load score as newer arrivals (0 to 10 years) who are the reference group (OR=1.08 or 1.15 in models with the extended covariate set). Estimated odds ratios for those in the US for 21 or more years are of similar magnitude (OR 1.18 or 1.19, extended covariate set), but neither estimate is significantly different from 1.00.

Among Mexican immigrants who are older (ages 45–60), the probability of having high allostatic load increases markedly with time in the US. For this older age group, the odds of having an allostatic load score of at least three, more than double for those who have been in the US for 11 to 20 years, compared to those who arrived in the US in the past 10 years

(2.39 or 2.19 in models with the basic or extended covariate set, respectively). The same group has a 43 percent (OR 1.43) higher probability of having an allostatic load score of at least four than more recent arrivals. Among older immigrants who have been in the US for 21 or more years, the odds of having a high allostatic load score are approximately four (OR 3.85) to five and one-half times (OR 5.53) higher than those who have been in US for 10 or fewer years.

In sum, estimates in Table 2 for immigrants who are 45–60 years old are consistent with the view that stress and its health consequences may accumulate or increase with time in US and be a partial explanation of the "unhealthy assimilation" effect. Moreover, there is no evidence that health behaviors or medical care confound this association as the odds ratios remain stable or increase, once the extended set of covariates are controlled.

Table 3 presents estimates of odds ratios from a logistic regression designed to assess whether there are differences in allostatic load by nativity, and whether any such differences vary with time in the US of the foreign-born. We use three different reference groups: US-born Mexicans, US-born, non-Hispanic whites, and US-born, non-Hispanic Blacks. Using US-born Mexicans and US-born non-Hispanic Blacks as comparison groups may understate the role of stress on immigrant health because these groups may be affected by discrimination and US-born Mexicans may face acculturation issues associated with being second (or third) generation immigrants. In fact, as Table 1 documents, the mean allostatic load of US-born Mexicans and non-Hispanic Blacks is significantly higher than that of US-born non-Hispanic whites. For these analyses, we report only estimates obtained using a measure of high allostatic load defined as three or more; estimates obtained from models using the alternative cutoff of four or more are qualitatively the same (results available upon request).

Estimates indicate that in the younger cohort, foreign-born Mexicans tend to have a lower likelihood of having high allostatic load (value of three/four or more) than US-born Mexicans and non-Hispanic Blacks, but a greater likelihood of having a high allostatic load score than US-born non-Hispanic whites. The former result is consistent with a healthy migrant effect. Most estimates are statistically significant. Estimates indicate that foreign-born Mexicans: are 14 percent (OR 0.86) to 29 percent (OR 0.71) less likely to have a relatively high allostatic load than US-born Mexicans; are 40 percent (OR 0.60) to 48 percent (OR 0.52) more likely to have a high allostatic load score than US-born, non-Hispanic whites. However, regardless of the reference group, estimates do not indicate a statistically significant relationship between time in the US and allostatic load. Consistent with evidence in Table 2, the estimates in Table 3 provide little evidence of an unhealthy assimilation effect for the younger cohort of Mexican immigrants.

Among older cohorts, there is evidence consistent with a pronounced healthy migrant effect. Foreign-born Mexicans who are recent arrivals (0 to 10 years) have a significantly lower probability of having a high allostatic load score than the three other demographic groups. Odds ratios of the association between being foreign-born and allostatic load for this group (i.e., newer arrivals) are 0.13, 0.38 and 0.42 depending on the reference group and are statistically significant. A much different story emerges for older, foreign-born Mexicans who have been in the US longer. Among this older cohort, foreign-born Mexicans who have been in the US between 11 and 20 years have about the same probability of having a high allostatic load score as US-born Mexicans and US-born non-Hispanic whites, and their advantage vis-à-vis US-born Blacks has diminished markedly. For those foreign-born Mexicans who have been in the US the longest, their odds of having a high allostatic load score are double (OR 2.08) that of US-born whites, about the same as US-born Mexicans, and approximately 40 percent (OR 0.61) lower than non-Hispanic Blacks.

To summarize, for the older cohort of foreign-born Mexicans, there is strong evidence that is consistent with both a healthy migrant effect and an unhealthy assimilation effect, as those in the US for 10 years or less exhibit less than half the probability of having high allostatic load than US-born non-Hispanic whites, but this large advantage is eliminated for those residing in the US for 11–20 years. Even more striking, those in the US for more than 20 years suffer a large disadvantage as they face twice the odds of high allostatic load as non-Hispanic whites.

In addition to the analyses just presented, we also assessed the relationship between time in US and individual components of allostatic load: BMI, systolic and diastolic blood pressure and cholesterol. Estimates obtained using these dependent variables are not included because they confirm the findings presented. Foreign-born Mexicans generally arrive in US healthier—lower blood pressure, lower BMI, but higher cholesterol—than US-born Mexicans, and the health advantage deteriorates with time in US for older Mexican immigrants.

In Table 4 we present estimates from regressions where we replace high allostatic load score with a dichotomous measure of self-reported fair or poor general health as the outcome. Among the younger cohort, longer durations in the US are associated with a lower probability of reporting fair or poor health, although these results are not statistically significant. When the extended covariate set is included, a small estimated increase in the odds of reporting fair or poor health is seen for those in the US 21 years or more relative to more recent arrivals, compared to those in the US 11–20 years (relative to more recent arrivals), but in both cases the point estimate fails to reach statistical significance at conventional levels. In sum, there is little evidence of an unhealthy assimilation effect for the younger cohort of foreign-born Mexicans.

Among older immigrants, estimates are consistent with a significant unhealthy assimilation effect. The probability of being in fair or poor health increases significantly with time in the US. Those in the US for 11–20 years are estimated to be about three times more likely to report being in fair or poor health than those in US 10 or fewer years, although these estimates are not significant. However, those in the US 21 or more years are 875 percent (OR=9.75) more likely to report being in fair or poor health than those in US 10 or fewer years in the specification with the basic set of covariates; and 781 percent (OR 8.81) more likely to report being in poor health than those in US 10 or fewer years, after controlling for the extended set of covariates.

Evidence on Selection

An important limitation of our analysis is its cross-sectional nature. Previous research has provided some evidence that selective migration with respect to health by Mexican immigrants is most likely to be migration back to Mexico of the less healthy (Abraido-Lanza 1999; Palloni and Arias 2004). This “salmon bias” would imply that a cross-sectional study of changes in health with time in the US, such as ours, provides a conservative test of the hypothesis that health deteriorates among Mexican immigrants with time in the US.

To provide some evidence on this point, we examined how time in US is correlated with socioeconomic status. We found that conditional on age and gender, time in the US is positively associated with educational attainment and negatively associated with poverty. That is, among the older immigrants (ages 45–60), those who have been in the US for 20 years or more are more highly educated and less likely to be poor than those who have been in the US for a shorter time. This is exactly the same group where we find consistent evidence of stress-mediated health deterioration with time in the US. Thus, our findings imply that the immigrants who have the highest probability of having a high allostatic load score (45–60 year olds in the US for at least 20 years), do so despite having the most advantaged socioeconomic profiles. Further, while it is possible that 45–60 year old immigrants increased their educational attainment during their residence in the US, it may be more plausible that this association reflects either cohort effects or the return migration of the least educated and the poorest immigrants as, unlike income, educational status is often a relatively stable feature of adult life. Regardless of the cause, the bias resulting from the association between socioeconomic profile and time in the US would lead us to underestimate the increased probability of having high allostatic load with time in the US.

Conclusion

A prominent hypothesis to explain the “unhealthy assimilation” effect observed for Mexican immigrants is that repeated experience with stressors linked to discrimination and acculturation adversely affects Mexican immigrant health as time in the US increases. While plausible, this hypothesis has not been extensively studied. Also, it has been examined in an indirect fashion where measures thought to be correlated with stress are correlated with health.

In this paper, we tested this hypothesis in an arguably more direct way. Specifically, we used the concept of allostatic load, which was developed to measure the health consequences of prolonged exposure to stress, to assess whether the cumulative impact of exposure to repeated or chronic stressors is a partial explanation of the “unhealthy assimilation” effect often observed for immigrants. Consistent with a healthy migrant effect, we found evidence that 45–60 year old Mexican immigrants are healthier upon arrival than US-born Mexican Americans or non-Hispanic whites or blacks. Consistent with a stress-mediated “unhealthy assimilation” effect, we also found that the health advantage of this group disappeared with time in the US. In this age-group, those immigrants who resided in the US for at least 20 years exhibited twice the probability of having high allostatic load than US-born non-Hispanic whites and about the same probability as US-born Mexicans and non-Hispanic blacks. Estimates of the increased probability of having high allostatic load with time in the US for this age group also remained stable in the presence of controls for health behaviors and indicators of medical care utilization, suggesting that such factors are not confounders and that the poorer health of Mexican immigrants with longer stays in the US should not be reduced to the adoption of unhealthy lifestyles alone.

Data limitations constrained us to use a cross-sectional design, rather than to follow immigrants longitudinally to observe whether their health changed with time or whether selective migration might threaten the validity of our results. However, previous literature and some evidence we presented point to a “salmon bias” being the most likely form of selection bias. A salmon bias would serve to dampen evidence of health deterioration with time in the US, suggesting that our findings are likely to underestimate the extent to which health deteriorates with time in the US.

In contrast, our findings for younger adult immigrants (ages 30–44) do not offer consistent evidence of either a healthy migrant effect or of a stress-mediated unhealthy assimilation effect with time in the US. A possible explanation for the divergence in findings between the older and younger cohorts for allostatic load is that our capacity to detect such relationships is likely smaller among this younger age group. Allostatic load is conceived as a measure of cumulative wear and tear on the body’s systems that results from chronic and prolonged exposure to stress (McEwan 1998; Crimmins 2003; Geronimus et al 2006). In the current study, the absence of evidence of an unhealthy assimilation effect among younger immigrants may be a result of both the cumulative nature of allostatic load and the age pattern of weathering. At young ages, the effects of unhealthy assimilation on allostatic load may not yet be observable, or may be too small to detect with our current sample size. Had we been able to include primary mediators in our allostatic load algorithm, our ability to pick up differences at younger ages might have been improved.

A strength of our study is the use of a measure of stress-mediated wear and tear on the body that is derived from objective clinical exam data and lab tests performed as part of a national survey, rather than relying only on self-reported health measures, alone, or on variables that are more steps removed from the stress process. Importantly, our measure of health is not affected by differential access to health care. The findings of our analysis are consistent with the hypothesis that repeated or chronic physiological adaptation to stressors is one cause of the “unhealthy assimilation” effect. Our findings neither rule out other potential contributors, nor provide a quantitative estimate of how important stress is relative to other potential contributors.

This study also was subject to several limitations. First, we had relatively small samples that resulted in imprecise estimates in some cases, and a limited ability to draw firm inferences. Small samples also prevent us from conducting analyses separately by gender. Second, measurement error in years since immigration may result in significant bias (Jasso et al. 2004). However, such measurement error would serve to dilute evidence of health deterioration with time in the US. Third, we could not control for all of the potentially confounding influences. We found little evidence of confounding by those variables we were able to include, such as smoking, diet, physical activity or medical care utilization. Still, there may be unobserved factors that are correlated with year of or age at immigrant arrival and past determinants of health.

In light of the limitations of the current study as well as those that pertain to the previous literature, we cannot conclude that the repeated physiologic response to stressors to which Mexican immigrants may be disproportionately exposed contributes to the apparently worsening health of Mexican immigrants with time in the US. However, our findings, at least for the older age group we studied, are robust and consistent with that hypothesis and, as such, add to a growing body of evidence in favor of the plausibility of cumulative stress hypotheses to help explain racial/ethnic and socioeconomic inequalities in health.

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Table 1

Allostatic Load Score by Nativity, Ethnicity and Time in the US

Age 30 to 44	**Mean Score Allostatic Load**	**Proportion with Score of 3+**	**Proportion with Score of 4+**
US-born White (N=1314)	2.50	0.43	0.26
US-Born Blacks (N=1244)	3.23**	0.61**	0.39**
US-born Mexican (N=569)	3.15**	0.58**	0.41**
Foreign-born Mexican (N=575)	2.92**	0.55**	0.34**
In US 0 to 10 years	2.83	0.52	0.32
In US 11 to 20 years	2.91	0.55	0.34
In US 21 or more yrs	3.10	0.63**	0.38
Age 45 to 60			
US-born White (N=1188)	4.14	0.76	0.58
US-Born Blacks (N=655)	4.75**	0.87**	0.71**
US-born Mexican (N=355)	4.62**	0.84**	0.71**
Foreign-born Mexican (N=261)	4.46**	0.80	0.67**
In US 0 to 10 years	3.96	0.72	0.50
In US 11 to 20 years	4.22	0.81**	0.61
In US 21 or more yrs	4.56**	0.80**	0.77**

Notes:

1. ** Indicates estimate is statistically different at the 0.05 level from the corresponding estimate for US-born White.

Table 2

Associations (Odds Ratios) Between Time in US and Allostatic Load Among Foreign-born Mexicans

	Age 30–44			Age 45–60		
	Score of 3+	**Score of 3+**	**Score of 4+**	**Score of 3+**	**Score of 3+**	**Score of 4+**
In US 11 to 20 years	1.05 (p<.42)	1.08 (p<.37)	1.15 (p<.28)	2.39** (p< .05)	2.19* (p<.08)	1.43 (p<.50)
In US 21 or more yrs	1.29 (p< .24)	1.18 (p< .33)	1.19 (p<.32)	3.85*** (p<.01)	5.53*** (p<.01)	4.60*** (p<.01)
Extended Covariates	No	Yes	Yes	No	Yes	Yes
Observations	522	510	510	200	200	200

Notes:

1. Reference category is persons in US 10 or fewer years.

2. Score of 3+ refers to when Allostatic load is measured as a dichotomous variable indicating a value of three or more. Score of 4+ refers to when Allostatic load is measured as a dichotomous variable indicating a value of four or more.

3. Basic covariate set includes age dummy variables, sex dummy variables, education dummy variables, marital status dummy variables, poverty indicator, rural/urban residence indicator, and wave of study.

4. Extended covariate set includes the additional variables: smoking indicator, fruit and vegetable consumption, health insurance, doctor visits and level of physical activity.

5. *OR is statistically significant p<.10;

** OR is statistically significant p<.05;

*** OR is statistically significant p<.01

Table 3

Associations (Odds Ratios) Between Nativity and Time in US, and Allostatic Load Among Foreign-born Mexicans and US-born (Mexicans, non-Hispanic Whites, non-Hispanic Blacks)

Reference Group	Age 30–44			Age 45–60		
	US-born Mexicans	US-born Whites	US-born Blacks	US-born Mexicans	US-born Whites	US-born Blacks
In US 0 to 10 years	0.71* (p<.09)	1.56* (p<.08)	0.52*** (p<.01)	0.38** (p<.05)	0.42* (p<.09)	0.13*** (p<.01)
In US 11 to 20 years	0.71* (p<.06)	1.45* (p<.08)	0.50*** (p<.01)	0.90 (p<.42)	1.16 (p<.38)	0.43** (p<.03)
In US 21 or more yrs	0.86 (p<.32)	1.70** (p<.05)	0.60* (p<.07)	0.96 (p<.46)	2.08** (p<.05)	0.61 (p<.12)
Extended Covariate Set	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1034	1760	1646	509	1290	771

Notes:

1. Reference category is listed in column heading.

2. Allostatic load is measured as a dichotomous variable indicating a value of three or more.

3. Basic covariate set includes age dummy variables, sex dummy variables, education dummy variables, marital status dummy variables, poverty indicator, rural/urban residence indicator, and wave of study.

4. Extended covariate set includes the additional variables: smoking indicator, fruit and vegetable consumption, health insurance, doctor visits and level of physical activity.

5. *OR is statistically significant p<.10;

** OR is statistically significant p<.05;

*** OR is statistically significant p<.01

Table 4

Associations (Odds Ratios) Between Time in US and of Poor/Fair Self-rated Health Among Foreign-born Mexicans

	Age 30–44		Age 45–60	
In US 11 to 20 years	0.66	0.43	3.01	2.46
In US 21 or more yrs	0.60	0.75	9.75***	8.81***
Extended Covariate Set	No	Yes	No	Yes
Number of Observations	507	495	197	197

Notes:

1. Reference category is persons in US 10 or fewer years.

2. Self-rated health is measured as a dichotomous indicator of poor health, equal to one if self-rated health is reported as fair or poor, otherwise equal to zero.

3. Basic covariate set includes age dummy variables, sex dummy variables, education dummy variables, marital status dummy variables, poverty indicator, rural/urban residence indicator, and wave of study.

4. Extended covariate set includes the additional variables: smoking indicator, fruit and vegetable consumption, health insurance, doctor visits and level of physical activity.

5. *OR is statistically significant p<.10;

** OR is statistically significant p<.05;

*** OR is statistically significant p<.01