Could "Acculturation" Effects be Explained by Latent Health Disadvantages among Mexican Immigrants?

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ABSTRACT—This paper tests portions of a new theory of immigrant health changes by focusing exclusively on latent biomarkers of future health risks. Using data from the National Health and Nutrition Examination Survey III, 1988-1994—we uncover the typically observed immigrant health advantage among recent immigrants that diminishes among long-term immigrants. In addition, we observe worse health among native-born Mexican-Americans relative to non-Hispanic Whites. Finally, although our theory suggests that recent immigrants might have latent health risks due to disadvantaged childhood experiences, our evidence indicates that they are possibly selective with respect to infectious disease exposure as well.

INTRODUCTION

The pattern of relatively advantaged health outcomes for immigrants may be a somewhat recent phenomenon in the United States (Guttman, Frisbie, DeTurk, and Blanchard 1998), but we cannot be certain, since national health surveys have only recently begun to collect information regarding ethnicity in general and Hispanic status in particular. For example, most national studies find that rates of Latino fetal deaths (Guendelman and Abrams 1994; Guendelman, Chavez, and Christianson 1994), infant mortality (DHHS 2000), low birth-weight, very low birth-weight (DHHS 2000), and adult mortality (Hummer, Rogers, Nam, and LeClere 1999)—are virtually identical to rates observed among non-Hispanic Whites and are significantly lower than those observed among non-Hispanic Blacks. Researchers have attributed this "Latino advantage" to selective migration of healthy individuals (Hummer, Rogers, Nam, and LeClere 1999; Weeks and Rumbaut 1996), many of whom may be significantly healthier than the populations from which they originated (Palloni and Morenoff 2001). Although most studies have focused on Latino sub-groups, a handful of studies find that this advantage accrues to most immigrant groups (see e.g., (Frisbie, Cho, and Hummer 2001; Hummer, Biegler, De Turk, Forbes, Frisbie, Hong, and Pullum 1999; Hummer, Rogers, Nam, and LeClere 1999). In short, what is perceived to be a Latino paradox (Markides and Coreil 1986) may be more accurately described as an immigrant paradox.

INTERNATIONAL EVIDENCE

There is ample evidence that an immigrant paradox is not exclusive to Latin American immigrants to the United States; in fact, similar patterns exist among immigrants from such countries as Turkey, China, and Vietnam (Razum, Zeeb, Akgun, and Yilmaz 1998). That is, this pattern appears to be replicated across for the world among immigrants from less developed countries with relatively high rates of infectious disease to developed societies whose disease burdens are largely chronic, rather than infectious. In virtually all cases, the initial health advantages among immigrants are eroded as, over time and generations, they begin to adopt the behavioral health profiles of the native population, and ultimately begin to die from similar causes (Razum, Zeeb, and Rohrmann 2000).

ACCULTURATION AND HEALTH

Again, most studies also find that the initial health advantage observed among recent immigrants declines with time spent in the host country. The decline is not necessarily a natural duration or aging effect, but may be the product of acculturation to standards of the native population (for a review see (Vega 1994). These studies further suggest there are salutary aspects of native cultures that minimize stress, reduce the likelihood of engaging in poor health behaviors, and provide social support to minimize the effects of stress, unhealthy lifestyles and other health threats (Balcazar, Castro, and Krull 1995; Elder, Woodruff, and J.G. Candelaria 1998; Hazuda, Haffner, Stern, and Eifler 1988). Acculturation to norms and ways of life of the United States may strip away these protective factors and lead to declining health. Conversely, those who are able to maintain the protective components of native cultures and ethnic affiliation are able to stave off the negative effects of acculturation. For example, research has shown that living among co-ethnics and/or relatively unacculturated subpopulations is protective of health (Eschbach, Ostir, Patel, Markides, and Goodwin 2004; Finch, Boardman, Kolody, and Vega 2000; Gorman 1999; Harris 1999; Scribner and Dwyer 1989).

DIMENSIONS OF THE LATINO PARADOX

Since it is generally observed that Hispanics are in better health than other race/ethnic groups (particularly Black adults and infants) who possess similar socio-economic profiles, this advantage is referred to as an 'epidemiological paradox' (Markides and Coreil 1986). That is, since poverty and low socio-economic status are known to be risk factors for virtually all health outcomes (Link and Phelan 1995), it is surprising that Hispanics have health profiles similar to non-Hispanic Whites who have relatively advantaged socio-economic profiles. Unfortunately, this paradox has been loosely referred to and a thorough review of the literature by Palloni and Morenoff (2001) has identified three dimensions along which this phenomenon varies. The first dimension relates to the outcome of interest, the second relates to the target population, and the third relates to the contrast population (i.e., reference group) among whom these paradoxical rates are compared to. First, disparate literatures have largely found the paradox to exist for infant and child mortality, adult mortality, and birthweight—less is known about disease incidence. Second, the target population has generally been identified as either, a) immigrants in the US born in Mexico, b) immigrants in the US born in Mexico and other South/Central American countries, or c) the Spanish surname population in the US. Third, both the non-Hispanic White (NHW) population and the non-Hispanic Black (NHB) population have served as comparison groups although most of the literature utilizes the NHW population as the reference group to demonstrate the paradox. In the end, the Hispanic paradox (a.k.a. the epidemiological paradox) is generally only observed for the Mexican-origin population (relative to NHW's) for mortality, birth outcomes, and general health status.

One explanation for the finding of health advantages among recent immigrants is that the paradox is an artifact of poor *data reliability*. For pooled population estimates, failure to record Hispanic-origin on vital statistics may lead to discrepancies between numerators and denominators of mortality rates. In follow-up studies of mortality (passive or active), the possibility of return migration among Hispanics who are seriously ill may indicate a *salmon bias* in which individuals who die in Mexico are rendered "statistically immortal" since death certificates are not shared between Mexico and the US. One of the most plausible explanations, the *healthy migrant hypothesis*, suggests that only healthiest members of the sending communities migrate and arrive with superior health. Although a recent study argues against this explanation using multi-generational data (Abraido-Lanzo, Dohrenwend, Ng-Mak, and Turner 1999), their results may have ignored the fact that health advantages may be passed from generation to generation. At the very least, anecdotal evidence suggests that seriously ill people would tend not to migrate due to the rigors of travel (even the sometimes short distance between border towns in California and Mexico, e.g.) and comparisons of bi-national mortality rates indicate that migrants must be healthier than non-migrants since mortality rates are much higher in Mexico. Regardless of the plausibility of the healthy migrant hypothesis, it does not necessarily preclude the possibility of observed health declines with increased levels of acculturation.

Most studies find that the initial health advantage observed among recent immigrants declines with time in the US; more nuanced studies find that this is not necessarily a natural duration or aging effect, but rather, the product of acculturation to US society (Vega 1994). These studies suggest that there are salutary aspects of Hispanic culture that minimize stress, reduce the likelihood of engaging in deleterious health behaviors, and provides social support to minimize the effects of stress, unhealthy life-styles and other health threats (Balcazar, Castro, and Krull 1995; Hazuda et al. 1988; Elder at al. 1998). It is thought that acculturation to US norms and ways of life strip away these protective factors and lead to declines in health.

Conversely, those who are able to maintain the protective aspect of native cultures and ethnic affiliation are able to stave off the negative effects of acculturation. For example, there is some evidence that living among co-ethnics and/or relatively un-acculturated sub-populations is protective of health (Eschbach et al. 2004; Finch, Kolody, and Vega 1999; Scribner and Dwyer 1989). In addition to potentially leading to behavioral changes, the acculturation process itself may be deleterious since it leads to frustration related to language conflict and possibly discrimination (Finch, Kolody, and Vega 2000). However, acculturation effects have been difficult to test as many variables correlated with acculturation are themselves correlated with the health outcomes used to test the presence of these relationships.

One of the key factors that is culpable for the health declines associated with acculturation is the adoption of risky health behaviors endemic to US culture. On average, Hispanics tend to have lower rates of smoking, smoke fewer cigarettes, and consume diets high in fiber (Rogers and Crank 1988; Jones, Gonzalez, and Pillow 1997). Hispanic women also have babies at younger ages and are much less likely to use substances during pregnancy than are NHW and NHB women (Finch et al. 2000). One important study finds that higher levels of acceptance and mastery of behaviors and attitudes associated with the dominant US culture increases the likelihood of drug and alcohol use among Latinas (Glick and Moore 1990). Acculturation is typically defined as the learning of new cultural information and social skills (including language) and the subsequent levels of adherence to cultural preferences and ethnic loyalties (Vega and Gil 1998), and is frequently operationalized in terms of the extent to which Latinas rely on Spanish or English in their daily communicative activities (Cuellar, Harris, and Jasso 1980). The use of language behavior as the "conceptual core" of acculturation is appropriate because "embedded in language is cultural imagery, values, knowledge of customs, and access to a cultural group and its respective artifacts" (Vega and Gil 1998:128). Finally, Marin, Posner, and Kinyon (1993) find that not only do Latinos change their drug-related behaviors with increased acculturation, but they also change their attitudes and expectancies that they have towards particular drug-related behaviors. In other words, drug-use among acculturated Latinos is not a simple 'knee-jerk' reaction to the perceived behaviors of the dominant culture (i.e. mimicking), but rather a more complex social learning process that involves a fundamental cognitive restructuring of information and an incorporation of English-language cultural artifacts.

APPROPRIATE MEASURES

As noted above, the presence of contrasts in health outcomes between immigrants and native-born Hispanics have been well documented. Further, some analyses have shown differences that are further delineated according to level of acculturation. These analyses lend the greatest evidence towards an acculturation effect for Hispanic health since birth-weight, for example, is accurately recorded for most children born in the US. However, analyses that rely on infant mortality as an outcome are less reliable since a woman may have returned to Mexico before her infant died which means that subsequent analyses will erroneously consider these infants to be alive and will bias estimates of infant-mortality rates, particularly among the least acculturated who are less likely to stay in the US. This same source of bias is magnified among assessments of adult mortality as there is some evidence that return migration may be associated with disease and illness among non-citizens. Return migration leads to "statistical immortality" in most survival-rate estimates of mortality.

Use of varying measures of morbidity as a primary health outcome is another, less frequently used, approach, than identifying the presence of the paradox with mortality rates. However, asking survey respondents if they have a particular condition is reliant on sequences of events in which individuals have recognized a problem, sought treatment, and were diagnosed with a specific disease. Sub-population groups, such as Hispanics, with low rates of health insurance coverage and utilization are less likely to be diagnosed even when disease is present. Further, Hispanics are more likely to somatize mental health problems as physical health problems leading to further difficulties with proper diagnosis of problems and identification of disease.

Therefore, relying on self-reported morbidity, while often a better indicator of future mortality than physician-reported morbidity, may be heavily biased by processes (i.e. low rates of health care coverage and utilization and somatization tendencies) that are more prevalent among unacculturated immigrant groups. Further, the use of diseases as an outcome may confound duration effects with acculturation effects. That is, health risks incurred (and accumulated) in Mexico may not manifest themselves until immigrants have been in the US for a long time and this duration may be correlated with acculturation leading to false conclusions. The ability to capture latent health risks becomes virtually impossible for most disease outcomes and makes it difficult to assess whether disease is truly the product of acculturation processes.

The use of self-reported health (SRH) status as an indicator is another oft-used approach and this robust indicator has been shown to be equally predictive of future mortality across ethnic groups (McGee et al. 1999). However, among Hispanics, SRH status is highly correlated with levels of acculturation and may reflect artifactual cultural and language biases (Finch et al. 2002). In many cases, SRH is observed to be highly discordant with other, more objective measures of health among immigrant Hispanic groups (Angel and Guarnaccia 1989) and may reflect transient, acute emotional distress rather than chronic physical health problems. Much of this perceived emotional distress may be the result of immigration and acculturation processes which, although they may have long-term health implications, have less severe morbidity and mortality implications in the immediate future.

Therefore, the ability to assess whether Hispanics experience a health advantage over other race/ethnic groups and whether this advantage declines with acculturation is plagued by health measurement problems that are difficult to overcome. For this reason, we propose using a more objective indicator of physiological health that will enhance our understanding of the biological processes through which constructs such as acculturation ultimately affect health. Use of such objectively measured biological parameters frees us from biases associated with: 1) follow-up studies of mortality, 2) potentially artifactual subjective health ratings, and 3) self-reported morbidity status. We propose to use a variety of objective indices of biological risk derived from the concept of allostatic load as a multi-systems view of biological risk. Most importantly, our key predictors (i.e., Hispanic ethnicity, nativity, and acculturation) should not be correlated with the error term in our models of allostatic load, as they often are in models of mortality, self-reported morbidity, and subjective health status.

'TIME TRAVEL WITH OLIVER TWIST': A THEORY

One glaring omission to the literature has been a systematic accounting of the breadth and depth of evidence that has been generated by researchers interested in Latino health in particular, and immigrant health in general (c.f., (Palloni and Morenoff 2001). In short, there is a general lack of theory that might describe how all of these seemingly related processes might hold together while not wholly contradicting the current evidence. Researchers in Germany (Razum and Twardella 2002) have recently proposed such a theory that applies to most first-generation immigrant populations now living in industrialized countries, not just to Latinos living in the United States, and offers both a life-course perspective on the health transition that immigrants might undertake as well as a disease-specific accounting of what might happen to immigrants in terms of the leading causes of death and perinatal health. This theory is grounded in a literary allegory in which Dickens' *Oliver Twist* and colleagues travel through time from "a society with pervasive poverty and high mortality, mainly from infectious and maternal causes, to a society that has in the past 150 years undergone a gradual shift to a lower mortality, mainly from chronic, lifestyle-related diseases such as ischaemic heart disease" (Razum and Twardella 2002). This thought experiment is argued to parallel the experience of many immigrants from less-developed countries to industrialized countries. This theory consists of several sub-components related to the ways in which immigrants make the transition from a disease burden that partially reflects the burden in their countries of origin—minus the lack of sanitation, clean water, and high rate of infectious disease—to a disease burden similar to the population in host countries.

First, upon migrating, immigrants will benefit from environmental and public health measures that prevent the epidemic spread of infectious disease, and from advances in biomedicine that provide a cure for many conditions; this will result in a "substantial and almost immediate decline in their risk of dying from maternal and infectious causes, and as a result, their overall mortality and in many cases their infant mortality will be lower than that of their population of origin—irrespective of (self-) selection of particularly healthy individuals into migration" (Razum and Twardella 2002). This theory also implies that counterfactual comparisons between rates of disease between migrant populations and sending populations is not necessarily *a priori* evidence of a selection effect.

Second, the prevalence of life-style related risk factors for heart disease and particular cancers is potentially lower in countries of origin. For example, obesity and a lack of physical activity are much more rare and as such, "it will take many years before…today's immigrants experience a measurable effect of lifestyle-related cardiovascular risk factors on their mortality" (Razum and Twardella 2002). In addition, biomedical improvements may add to lower rates of chronic disease for many years after migration. Third, cancers and other conditions (stroke, e.g.) that are associated with childhood deprivation and unfavorable hygienic conditions might be higher in immigrant populations. "Hence, immigrants will initially experience a lower overall mortality than the host population. Their mortality may remain lower for many years, depending on the time they take to adopt a western lifestyle. After decades their mortality from ischaemic heart disease may catch up with that of the host population while their elevated risk from stroke and stomach cancer is likely to persist" (Razum and Twardella 2002).

Of course, every theory is not without its caveats and exceptions. First, immigrants trade-off relative poverty in impoverished host countries for similar positions in high-income countries. Thus, if the effects of income inequality on health are in fact real (Wilkinson 1996), they may experience health declines from relative deprivation. Additionally, minority status, stress from acculturation (Finch and Vega 2003), discrimination (Finch 2000), and persistent poverty (Aber, Bennett, Conley, and Li 1996) may all contribute to overall health declines over time. However, none of these explanations speaks much to the notion that native cultures may be protective of health given that they may reflect healthier social arrangements and dense networks of familial and kin relationships—all of which are known to be salutary (Berkman 1995; Berkman and Syme 1979). As such, the maintenance of cultural ties and distinct language patterns (Vega 1994), in addition to residence with other co-ethnic immigrants(Eschbach et al. 2004; Finch, Boardman, Kolody, and Vega 2000)—may all contribute to a healthy living environment that inures immigrants from long-term health threats. That is, there may be factors through which immigrants are able to maintain the health advantages that come with low levels of chronic disease risk factors, large levels of social support and integration, and the relative decline in rates of infectious disease.

RESEARCH QUESTIONS

Much of the literature on the epidemiological paradox, thus far, has chosen to focus on protective aspects of native culture, artifactual explanations, and/or selection processes, and fewer have considered both a theoretically nuanced approach with a focus on latent[1] health patterns as culprits in the generally observed health declines over time and across immigrant generations. As such, our intent is to test two relatively ignored aspects of this theory. First, that exposure to higher rates of infectious disease is evident among new immigrants and second, that culturally protective markers (such as language) will indicate the presence of culturally-embedded practices that will be correlated with better health. Our hypotheses are as follows:

- Hypothesis 1: Recent immigrants will experience superior overall health, superior cardiovascular health, but inferior health from exposure to infectious disease.
- Hypothesis 2: These trends will be weakened (and absent for the case of infectious disease markers) when comparing native-born Latino populations with the Anglo population.
- Hypothesis 3: Markers of the maintenance of native culture—Spanish-speaking in this case—will be independently protective of immigrant health.
- Hypothesis 4: Some of these health advantages will be due to lower levels of engagement in risky health-behaviors such as lower rates of smoking among recent immigrants.

[1] We refer to "latent" measures of health as objective health states that may or may not have resulted in, and subsequently been diagnosed as a particular disease, but rather, serve as current asymptomatic indicators of risk for future disease. The specific latent health measures used in this study consist of several biological markers of allostatic load that are collected from clinical examinations and laboratory analyses of blood and urine in the NHANES III.

DATA & METHODS

Data. To test our hypothesis, we utilize data from the National Health and Nutrition Examination Survey III (NHANES III). The NHANES III, conducted between 1988 and 1994, is a nationally representative sample of the civilian, non- institutionalized household population and collects information on topics such as cardiovascular disease, diabetes, mental health, physical activity, nutritional status, physical functioning, risk behaviors, obesity, and respiratory disease. The full survey sample includes 33,994 persons aged 2 months and over, from households across the U.S. Because of the growth in the elderly population, the NHANES III has no upper limit on the age of respondents, unlike previous surveys in the NHANES series. Furthermore, home examinations were introduced for the very young as well as adults who were too frail to visit the NHANES mobile examination center. The unique feature of the NHANES is its combination of survey interviews, physical examinations from a mobile examination center, and laboratory analyses of blood and urine samples. This combination allows for monitoring of health conditions that were previously undiagnosed or unknown to survey respondents.
Although NHANES III includes an oversample of both Blacks and Mexican-Americans, throughout our analyses, we restrict our sample to Non-Hispanic Whites and Mexican-Americans eighteen years old and above. This restriction leaves us a sample of 12,330 adults.

Outcomes of Interest. We have two sets of outcomes of interests: 1) subjective health status and 2) allostatic load measures that are created from biological markers collected in the NHANES laboratory component.

Subjective health status includes self-rated health and physician rated health. Both are numeric indicators of five levels: poor, fair, good, very good, and excellent health, with poor health status reflecting the lowest rank of one and excellent health status reflecting the highest rank of five. We use self-rated health as a base of comparison for the other models. Measures of self-rated health have been validated by a number of studies. Most of these studies find that a poor self-rating of health has predictive value for future mortality above and beyond clinical assessments (Benyamini and Idler 1999; Idler 1997). However, the validity of using self-rated health, especially for the purpose of this study, relies on the consistency of interpretation and response across our subgroups of interest. To be specific, if Latino immigrants do not interpret and/or respond to a given health measure the same way as more acculturated Latinos or White respondents, then observed differences between these groups on this measure may be artifactual (see, e.g., (Finch 2002). Hence, we also use physician rated health, a measure that is less likely to exhibit this bias, as a base of comparison.

Interpretive inconsistencies aside, self-rated health and physician rated health only accurately reflect the physical and emotional well-being of an individual to the extent that the maladies and illnesses have progressed to such a stage to make it perceptible to the individual. Because it may take many years for risk factors to reach such a point that it would manifest itself, both self-rated health and physician rated health may not be able to capture the increasing health risk of Mexican immigrants as they adopt to the Western lifestyle.

In order to measure the level of health risk factors that may not be apparent to physicians or to the individuals themselves, we rely on the concept of *allostatic load.* Allostatic load is conceptualized as the cumulative evidence of physiological "wear and tear" that can accumulate over time as biological regulatory systems are called on to respond to life experiences (McEwen 1998). This total is postulated to impact significantly on health and longevity and can be measured even before more apparent symptoms of high-risk levels appear.

For our allostatic load (AL) measures, we follow the strategy validated by the McArthur Studies of Successful Aging and simply sum the counts of binary biomarkers, which represent high risk (i.e. highest risk quartile) scores on various biomarkers that make up each index (Seeman et al. 2001). We have three different components measure of allostic load: cardiovascular AL, metabolic AL, and inflammatory response AL. Each AL measure attempts to capture the function of disparate organ systems and their functioning. Cardiovascular AL captures risk-factors for heart disease and mortality using typical markers such as blood pressure, heart rate, and the waist-to-hip ratio while metabolic AL captures risk factors for heart disease and stroke with measures of cholesterol, plasma glucose, and glycated hemoglobin. Each of these component measures range from 0-4 indicating individuals with zero risk-factors in the highest risk quartile to those with all markers exceeding the highest risk quartile. Inflammatory response allostatic load captures dysregulated functioning of the immune and inflammatory systems and is made up of two biomarkers, creating a score ranging from 0-2. Finally, our total allostatic load (TAL) measure is constructed by summing all 3 allostatic load components to capture the overall amount of system dys-regulation and bodily wear and tear (See Table 3). The TAL score ranges from 0-10.

Control Variables. Table 1 provides descriptive statistics of our sample as a whole and by race/nativity. Race/nativity represents our key variable set of interest. It is composed of 4 categories: non-Hispanic White, U.S. born Mexican-Americans, foreign- born Mexican-Americans who have lived in the U.S. for less than 12 years, and foreign-born Mexican-Americans who have lived in the U.S. for 12 years or more [2].

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[2] Note that the non-Hispanic White category includes both the U.S. and foreign-born. Only 5% of non-Hispanic Whites were foreign-born.

We account for the different distributions of socio-demographic variables across Whites and Mexican-Americans by including a set of control variables. These variables include gender, age, years of education, an income-to-poverty ratio based on income, marital status, labor force status, and primary language used for the interview (English or Spanish).

For the most part, these variables represent the conventional set of controls. However, the income-to-poverty ratio construct merits further explanation. The income-to-poverty ratio is a continuous measure of family financial strength. It is the ratio of family income to a family's poverty threshold, based on family size and composition. A ratio at or below 1.00 indicates that the respondent is a member of a family that is at or below the official poverty threshold while a ratio greater than 1.00 indicates that the individual is a member of a family that is above the poverty threshold.

Methods. For each outcome, two standard ordinary least squares models were conducted.[3] The first and second regression models for each outcome are identical except for the addition of one variable, interview language, in the second model. Here, we are using interview language as an additional proxy for acculturation and assume that Mexican immigrants who prefer to have their interviews/exams conducted in their native tongue are less acculturated and less likely to have adopted the lifestyle of their host country. In keeping with our theory, we expect to see those who had their interviews conducted in Spanish to exhibit a health advantage. Additionally, we expect to see the inclusion of this additional acculturation proxy to reduce the health advantage of Mexican immigrants compared to Whites. In addition, we specify models that both exclude, and then include a set of dummy variables for smoking status (never, current, and former).

[3] We accounted for the design effects inherent in the NHANES III multistage and over-sampling strategy in all our regression models by using survey-specific estimators in Stata v. 8 (svyreg).

RESULTS

We begin by looking at the characteristics of the NHANES III sub-sample. Our sample consists of 12,330 Latino(a) and non-Hispanic White adults. While our sample is split fairly evenly between these two populations, approximately 20% of the Latinos are US born, 8.5% are recent immigrants (in the U.S. less than 12 years), 8.5% are long-term immigrants, and just under 4% are of indeterminate immigration status[4]. The mean age of our sample is just under 49 years and the mean education is approximately 10.63 years. In addition, there is a clear socio-economic gradient such as those with more time in the United States have a higher income-to-poverty ratio (i.e., a higher socio-economic status) and non-Hispanic Whites have a ratio nearly one-third higher than even native-born Latinos. While just under 21% of native-born Latinos conducted their survey in Spanish, more than two-thirds of long-term immigrants and 91% of recent immigrants used Spanish for the survey. Finally, there is a similar gradient for smoking such that more long-term immigrants and Anglos have higher propensities for smoking than do recent immigrants and native-born Latinos, respectively.

These health patterns are basically replicated for the whole host of outcome variables that we specify (see Table 2), with the exception of self-rated health, which actually works in the opposite direction. However, given the differential distribution of socio-demographics across these sub-populations, we turn now to our multivariate regression models presented in Tables 4 and 5 to more accurately assess health differences across duration in the United States, nativity, and race/ethnicity. Our models of self-rated health in Table 4 present a bit of an anomaly, albeit an expected; that is, recent immigrants (<12 years in the U.S.) actually rate themselves in poorer

[4] Our division of recent and long-term immigrants at 12 years of duration in the U.S. is largely sample-driven in order to maintain comparable numbers between these categories to maximize comparisons. However, the models are largely insensitive to the use of more than one cut-point and indicate a general monotonic relationship for the number of years in the U.S. and each of the outcomes.

health than all the other sub-groups. However, this has been demonstrated in several other studies and is largely an artifact of language and/or translation differences (Angel and Guarnaccia 1989; Finch 2002); that is, self-rated health among Latinos, particularly recent immigrants, may not have the same predictive validity for mortality that this measure does in other sub-populations (Finch 2002).

The models of physician-rated health begin to exhibit patterns of an immigrant advantage that are commonly observed in other studies. That is, while native-born Mexicans have similar health to non-Hispanic Whites, long-term immigrants exhibit a significant health advantage while recent immigrants exhibit an even larger health advantage over non-Hispanic Whites. This relationship, although partially accounted for by language, persists net of the inclusion of a variable for language of interview. The inclusion of Spanish indicates that Spanish speakers are rated as significantly healthier than English speakers, even net of duration/nativity. Physician-rated health is the only outcome for which speaking Spanish yields a statistically significant relationship, however. For all cases of allostatic load (cardiovascular, metabolic, inflammatory response, and total), native-born Mexicans are less healthy than non-Hispanic Whites. In addition, recent immigrants are healthier along the dimensions of cardiovascular AL, metabolic AL (although not significant net of Spanish-language), and total allostatic load. However, recent immigrants are predicted to have similar levels of inflammatory response markers as non-Hispanic Whites. And while the patterns for long-term immigrants are fairly inconsistent across the models, they are predicted to have similar levels of health across each of the domains as non-Hispanic Whites.

To summarize, native-born Mexicans are less healthy with respect to the objective biomarkers across the board, while recent immigrants are healthier than non-Hispanic Whites for virtually all of the objective health indicators (biomarkers and physician-rated health) other than inflammatory response. These general patterns do not persist when a control-variable for smoking status is added to the models in Table 5. For example, controlling for smoking eliminates the less favorable metabolic and inflammatory response measurements observed among native-born Mexicans relative to non-Hispanic Whites. In addition, adding smoking status eliminates the health advantage exhibited by recent immigrants relative to non-Hispanic Whites for metabolic response and accounts for a small portion of the effect in cardiovascular and total allostatic load measures. And finally, net of smoking, Spanish-language usage is no longer protective of physician-rated health[5].

DISCUSSION AND CONCLUSIONS

From our results, we are able to draw the following conclusions that were hypothesized. First, as expected, recent immigrants are healthier across virtually all domains of health—physician ratings and all biological markers of allostatic load—except for inflammatory response. On the other hand, our hypotheses suggested that inflammatory response markers among recent immigrants would actually be higher than non-Hispanic Whites, but this was not the case. In fact, it appears that inflammatory response markers are incredibly similar among these two population groups. Second, our hypotheses suggested similar trends, although weakened for long-term Mexican immigrants and native-born Mexican-Americans. However, while there was an observed, statistically significant, positive relationship for physician-rated health among long-term immigrants, there was no similar health advantage observed for the biological markers. On the contrary, native-born Mexican-Americans exhibited inferior health to non-Hispanic Whites

[5] It is worth reiterating that there is little variation in Spanish-language speaking among recent immigrants as more than 90% of all recent immigrants spoke Spanish in the interview. This is a less of a problem for long-term immigrants of whom just over two-thirds of respondents spoke Spanish.

for all biological domains but not for physician-rated health. Thus, in short, while the advantage was weakened among long-term immigrants—it actually reverses itself and becomes a disadvantage among the native-born of Mexican descent.

Third, we hypothesized a protective effect for Spanish-language usage that was not borne out by any of the models except for physician-rated health—and this relationship was explained by the inclusion of a smoking variable. Fourth, it appears that, as hypothesized, a non-trivial proportion of the recent immigrant advantage is due to lower rates of smoking.

The "Oliver Twist Theory" presented above provides a more comprehensive framework that subsumes a large core of research under a single theory of immigrant adaptation and health changes. This theory posits that immigrants from less-developed countries to relatively socio-economically advantaged countries will at first exhibit health advantages that decline over adaptation to native culture patterns of chronic disease risk-behavior profiles. The evidence presented here demonstrates several things; first, recent immigrants are advantaged with respect to several of these indicators that cannot be attributed to data or artifactual errors and second, this advantage is diminished among more long-term immigrants. However, this advantage may not be entirely due to selection processes since a comparison between immigrants and sending populations may not be appropriate due to improved hygienic and sanitary conditions, and smaller infectious disease rates in host populations. On the other hand, a childhood of deprivation and exposure to higher rates of infectious disease may have an effect on immigrants that is manifested in elevated rates for certain diseases such as stomach cancer and strokes. Our data provide no support that immigrants exhibit higher rates of exposure to infectious disease although this conclusion is largely based on several assumptions that we make about our indicators of this latent exposure to infectious disease. One, we are heavily reliant on the assumption that our measures are cumulative and represent long-term and not transient measures of inflammatory response. Two, we are assuming that elevated inflammatory response (C-reactive protein levels and serum albumin) are due to infectious disease exposure and not just due to smoking or the presence of current disease, for example. There is some indication, given that we are able to control for smoking in our models, that this is not the case. However, if these biomarkers for inflammatory response do a poor job of picking up life-course exposure to infectious disease, then we have not carried out an adequate test of this portion of the hypothesis. Clearly, further studies of objective health indicators are needed to confirm the negative findings presented here. From our findings, it might be the case that recent immigrant advantages are overwhelmed by higher levels of inflammatory response risk-profiles among non-Hispanic Whites that are due to (unidentified) poorer lifestyle behaviors (i.e. that inflammatory response is not a good marker for life-course exposure to infectious disease) or that immigrants are selective with respect to childhood exposures.

Finally, there is strong evidence that some of the observed advantages are due to lower risk-behavior engagement among recent immigrants. That is, some of the advantaged health effect is explained away by the addition of smoking into our models. A fuller range of health-behaviors in our models (diet, exercise, drinking, drug use, e.g.) may help to further explain these perceived advantages.

One limitation of this study is our inability to distinguish between what we are defining as duration effects from cohort effects. That is, we are assuming that those who have been in the US longer have been exposed to more native culture and have engaged in the acculturative process for a longer period of time, rather than this measure simply reflecting differences between immigrant cohorts. This will be a difficult limitation to overcome, short of using rare, longitudinal studies of immigrant communities and their rates of behavioral change in accordance with their exposure to American culture and Americans.

A second limitation relates to our inability to partition out duration effects from exposure or marginalization effects. That is, as individuals acculturate and adopt poorer health-behaviors, they also tend to increase their socio-economic status and increase their exposure to members of native cultures, factors that are associated with both better and worse health, respectively. Thus, while better English skills might lead to better employment opportunities, it might also lead to higher rates of acculturative stress and discrimination. Thus, untangling the life-course experiences of disparate individuals in a cross-sectional survey becomes daunting.

To summarize, the "Oliver Twist" theory has much to offer our understanding of immigrant health advantages coupled with duration and generational declines in health. It offers a much more cohesive and comprehensive description of the disparate processes involved in health changes among immigrant populations. Although this study represents a step in the right direction, in terms of attempts to empirically test relatively ignored portions of this theory, there is clearly much room for research that both tests this theory and attempts to establish new theories of immigrant health.

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Table 1. Descriptive Statistics

Variable	Total Sample		Nonhispanic White		US Born Mexican		Foreign Born Mexican: Less than 12 Years in US		Foreign Born Mexican: 12 or More Years in US	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
N	12,330	100.0	7,420	60.19	2,418	19.62	996	8.49	1,047	8.08
Female	6,461	52.40	4,003	53.95	1,277	52.81	452	45.38	506	48.33
ETHNICITY / LENGTH IN US										
Non-Hispanic White	7,420	60.19								
US Born Mexican	2,418	19.62								
Foreign Born Mexican: Less than 12 Years in US	1,047	8.49								
Foreign Born Mexican: 12 or More Years in US	996	8.08								
Foreign Born Mexican: Years in US missing	446	3.62								
Age (Mean)	48.96		54.41		42.78		30.09		46.52	
EDUCATION										
Years of Education (Mean)	10.63		7.56		12.04		7.48		9.94	
MARITAL STATUS										
Never Married	1,956	15.88	950	12.81	508	21.03	284	28.57	104	9.96
Married	7,913	64.24	4,703	63.42	1,496	61.92	647	65.09	775	74.23
Other Marital Status	2,449	19.88	1,763	23.77	412	17.05	63	6.34	165	15.80
ECONOMIC STATUS										
Poverty Income Ratio (Mean)	2.56		3.10		2.06		1.13		1.43	
Unemployed	630	5.11	290	3.91	150	6.20	89	8.94	56	5.35
Employed	6,463	52.42	3,750	0.54	1,320	54.59	632	63.45	540	51.58
Not in Labor Force	5,237	42.47	3,380	45.55	948	39.21	275	27.61	451	43.08
LANGUAGE										
Spanish	2,475	20.13	2	0.03	503	20.88	905	91.14	755	72.32
SMOKING STATUS										
Never Smoked	6,170	50.04	3,373	45.46	1,319	54.55	633	63.55	570	54.44
Previously Smoked	3,355	27.21	2,316	31.21	554	22.91	130	13.05	266	25.41
Currently Smoking	2,805	22.75	1,731	23.33	545	22.54	233	23.39	211	20.15

Table 2. Health Distribution

Variable	Total Sample		Nonhispanic White		US Born Mexican		Foreign Born Mexican: Less than 12 Years in US		Foreign Born Mexican: 12 or More Years in US	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
N	12,330		7,420		2,418		996		1,047	
SELF-RATED HEALTH										
Poor	593	4.81	333	4.49	118	4.88	31	3.11	78	7.45
Fair	2,487	20.19	1,085	14.64	535	22.13	358	35.94	367	35.05
Good	4,360	35.39	2,393	32.28	964	39.87	425	42.67	405	38.68
Very Good	3,008	24.41	2,227	30.04	484	20.02	110	11.04	118	11.27
Excellent	1,873	15.20	1,375	18.55	317	13.11	72	7.23	79	7.55
PHYSICIAN RATED HEALTH										
Poor	176	1.52	128	1.85	26	1.13	3	0.32	15	1.50
Fair	1, 027	8.86	726	10.49	159	6.92	19	2.00	93	9.28
Good	3,053	26.35	1,906	27.54	624	27.14	156	16.44	240	23.95
Very Good	2,654	22.91	1,650	23.84	557	24.23	148	15.60	232	23.15
Excellent	4,675	40.35	2,510	36.27	933	40.58	623	65.65	422	42.12
ALLOSTATIC LOAD										
Cardiovascular Risk Count										
0	4,518	40.67	2,505	37.75	864	39.24	588	64.26	370	38.42
1	3,364	30.28	2,078	31.32	649	29.47	208	22.73	311	32.29
2	1,981	17.83	1,263	19.04	410	18.62	77	8.42	179	18.59
3	1,011	9.10	639	9.63	228	10.35	34	3.72	86	8.93
4	234	2.11	150	2.26	51	2.32	8	0.87	17	1.77
Metabolic Risk Count										
0	4,138	38.72	2,445	37.96	767	36.93	443	51.69	346	36.00
1	3,515	32.89	2,152	33.41	671	32.31	287	33.49	294	30.59
2	1,868	17.48	1,166	18.10	366	17.62	88	10.27	178	18.52
3	983	9.20	565	8.77	235	11.31	34	3.97	124	12.90
4	183	1.71	113	1.75	38	1.83	5	0.58	19	1.98
Inflammatory Response Risk Count										
0	7,931	68.37	4,740	68.06	1,555	67.05	701	76.44	638	64.19
1	2,788	24.03	1,710	24.55	563	24.28	163	17.78	268	26.96
2	881	7.59	514	7.38	201	8.67	53	5.78	88	8.85

Table 3. Component Measures of Allostatic Load.

	Description	Measurement
1. *Cardiovascular*	*Sub-Index*	*Count: 0-4*
Systolic Blood Pressure	Heart Disease/Hypertension Risk	(average of 3 measurements)
Diastolic Blood Pressure	Heart Disease/Hypertension Risk	(average of 3)
Heart/Pulse Rate	60-second radial heart rate	(beats/min)
Waist-to-Hip Ratio	Metabolism/Adipose Tissue Deposition	(0.51-2.09)
2. *Metabolic*	*Sub-Index*	*Count: 0-4*
Total Cholesterol	Metabolic Imbalance	(mmol/L)
HDL Cholesterol	Heart Disease Risk Factor	(mmol/L)
Plasma Glucose	Glucose Metabolism	(mmol/L)
Glycosylated Hemogolobin	Integrated Measure of glucose metabolism over time	(%)
3. *Inflammatory Response*	*Sub-Index*	*Count: 0-2*
C-reactive protein	Injury/Infection/Inflammation	(mg/dL)
Serum Albumin	Protein Absorption	(g/L)
4. *Total Allostatic Load*	*Total Index*	*Count: 0-10*
Cardiovascular		0-4
Metabolic		0-4
Inflammatory Response		0-2

Note: Highest risk quartiles are used to create binary indicators of risk for each component measure of the allostatic load indexes; the highest risk quartile is represented by observed values above the 75^{th} percentile for all measures except: HDL cholesterol and serum albmin—for which the highest risk is represented by values below the 25^{th} percentile.

Table 4. Model Results.

	Self Rated Health		Physician Rated Health		Cardiovascular		Metabolic		Inflammatory Response		Total Allostatic Load	
	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang
U.S. Born Mexican	-0.172**	-0.161**	0.038	0.022	0.150**	0.149**	0.130**	0.135**	0.075*	0.077*	0.422**	0.425**
Foreign Born Mexican: Less than 12 Years in U.S.	-0.373**	-0.302**	0.478**	0.360**	-0.232**	-0.235**	-0.104**	-0.036	-0.004	0.008	-0.345**	-0.285*
Foreign Born Mexican: 12 or More Years in U.S.	-0.202**	-0.148*	0.341**	0.257*	-0.072	-0.075	-0.002	0.052	0.036	0.046	-0.019	0.030
Foreign Born Mexican: Years in U.S. Missing	-0.288**	-0.234**	0.214	0.122	-0.089	-0.092	0.065	0.113	-0.037	-0.029	-0.095	-0.055
Age	-0.010**	-0.010**	-0.023**	-0.023**	0.022**	0.022**	0.020**	0.020**	0.005**	0.005**	0.047**	0.047**
Years of Education	0.073**	0.073**	0.037**	0.038**	-0.018**	-0.018**	-0.032**	-0.033**	-0.009**	-0.009**	-0.063**	-0.064**
Married	0.055	0.054	0.110*	0.112*	0.073	0.072	0.099**	0.097**	0.038	0.038	0.177**	0.175*
Other Marital Status	0.083	0.080	0.042	0.042	0.014	0.015	0.057	0.058	0.035	0.035	0.077	0.079
Female	0.000	0.001	0.058*	0.058*	-0.424**	-0.425**	-0.373**	-0.374**	0.186**	0.187**	-0.644**	-0.645**
Poverty to Income Ratio	0.088**	0.088**	0.063**	0.063**	-0.013	-0.013	-0.018	-0.018*	-0.006	-0.006	-0.030	-0.030
Employed	0.116	0.116	0.043	0.044	-0.038	-0.039	0.061	0.060	-0.145**	-0.146**	-0.118	-0.122
Not in Labor Force	-0.081	-0.081	-0.118	-0.118	0.022	0.021	0.118	0.117	-0.045	-0.045	0.126	0.125
Spanish		-0.081		0.139*		0.004		-0.078		-0.012		-0.070
N	11060	11039	10442	10422	10037	10019	9664	9643	10446	10426	8926	8909

* significant at 5%; ** significant at 1%

Table 5. Model Results with Smoking.

	Self Rated Health		Physician Rated Health		Cardiovascular		Metabolic		Inflammatory Response		Total Allostatic Load	
	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang	w/o Lang	w/Lang
U.S. Born Mexican	-0.219**	-0.205**	0.011	-0.003	0.154**	0.152**	0.148**	0.152**	0.084*	0.086*	0.457**	0.458**
Foreign Born Mexican: Less than 12 Years in U.S.	-0.471**	-0.377**	0.422**	0.316**	-0.222**	-0.230**	-0.064	-0.007	0.014	0.022	-0.267**	-0.228*
Foreign Born Mexican: 12 or More Years in U.S.	-0.288**	-0.216**	0.291*	0.217	-0.064	-0.070	0.034	0.080	0.052	0.059	0.050	0.084
Foreign Born Mexican: Years in U.S. Missing	-0.374**	-0.302**	0.164	0.082	-0.081	-0.087	0.099	0.139	-0.020	-0.015	-0.028	-0.003
Previous Smoker	-0.121**	-0.121**	-0.047	-0.045	0.054	0.053	0.060	0.059	0.023	0.023	0.153*	0.151*
Current Smoker	-0.299**	-0.300**	-0.174**	-0.170**	0.026	0.024	0.116**	0.114**	0.056*	0.055*	0.221**	0.216**
Age	-0.011**	-0.011**	-0.024**	-0.024**	0.022**	0.022**	0.021**	0.021**	0.005**	0.005**	0.047**	0.047**
Years of Education	0.066**	0.065**	0.033**	0.034**	-0.018**	-0.018**	-0.029**	-0.030**	-0.008*	-0.008**	-0.057**	-0.058**
Married	0.104*	0.102*	0.138**	0.139**	0.066	0.066	0.084*	0.083*	0.029	0.029	0.147*	0.146*
Other Marital Status	0.144*	0.141*	0.078	0.078	0.007	0.009	0.037	0.038	0.023	0.024	0.037	0.039
Female	-0.030	-0.029	0.043	0.044	-0.417**	-0.417**	-0.359**	-0.360**	0.192**	0.192**	-0.612**	-0.614**
Poverty to Income Ratio	0.084**	0.084**	0.061**	0.061**	-0.013	-0.013	-0.017	-0.017	-0.005	-0.005	-0.028	-0.028
Employed	0.091	0.091	0.030	0.030	-0.036	-0.037	0.069	0.068	-0.141**	-0.141**	-0.105	-0.108
Not in Labor Force	-0.114	-0.115	-0.137	-0.137	0.024	0.023	0.126	0.125	-0.039	-0.040	0.139	0.137
Spanish		-0.107		0.126		0.008		-0.066		-0.008		-0.048
N	11060	11039	10442	10422	10037	10019	9664	9643	10446	10426	8926	8909