Does life in the U.S. take a toll on health? Duration of residence and birthweight among six decades of immigrants

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Abstract—

We use the 1998-2009 National Health Interview Survey to systematically investigate cohort differences in low birthweight among U.S.-born children of mothers arriving in the U.S. between 1955-2009 and giving birth between 1980-2009, cohort-adjusted patterns in low birthweight by maternal duration of residence in the U.S., and cohort-adjusted patterns in low birthweight by maternal duration of residence stratified by age at arrival and region of origin. These analyses are necessary for understanding immigrant women’s health trajectories, as proxied by their infants’ birthweight, and for understanding how living in the U.S. affects health more generally. We found a consistent deterioration in infant health with successive immigrant cohorts, a curvilinear association between duration and low birthweight controlling for cohort effects, that Asians benefit more than Hispanics from migrating to the U.S., and that low birthweight decreases with duration among women who came to the U.S. as adults but increases with duration among those who came as children. The findings underscore the need to disaggregate immigrant groups when studying post-migration trajectories and provide additional evidence that early life exposures are a key to understanding why the U.S. lags other developed nations in health.
Introduction

Despite having the highest per capita healthcare expenditures in the world, the U.S. ranks poorly on most health indicators compared to other developed countries. The U.S. disadvantage spans the lifecourse, from infant mortality to life expectancy at older ages (United Nations 2011), and is not limited to mortality. Differences in morbidity are also apparent across the lifecourse, from very young ages through late adulthood, at least compared to England (Martinson, Teitler and Reichman 2011). The most obvious potential explanations—namely, smoking, stress, inequality, health insurance and health care, violence, and diet—have not gone far in explaining the persistent and generalized U.S. health disadvantages (National Research Council 2010; Banks et al. 2006; Martinson, Teitler and Reichman 2011), leading to speculation that there is something generally intrinsic or “toxic” about living in the United States.

Immigrants provide a valuable lens through which to learn about how living in the United States affects residents’ health. Research on immigrant health suggests that migrating to the U.S., even from low-income countries with poor quality healthcare systems, takes a toll on one’s health. When they land on U.S. soil, the health of immigrants is better than that of U.S.-born individuals of the same race/ethnicity. However, the immigrant health advantage appears to erode over time (e.g., Antecol and Bedard 2006; Cho et al. 2004; Day et al. 2006; Goel et al. 2004; Uretsky and Mathiesen 2007). Because immigrants arrive at different ages, come from different countries, are of different ethnicities, come with different levels of human capital, and have different durations of residence, their experiences can help us understand how living in the United States affects health. That is, the considerable heterogeneity of the immigrant population provides a useful lever for learning about “for whom” and “under what circumstances” exposure
to the U.S. has detrimental effects on health—questions that cannot be easily answered from studies of U.S. natives or from cross-national comparisons.

Despite considerable interest in immigrant health and the production of a large body of theoretical and empirical research over recent decades, credible estimates of the effects of duration of residence in the U.S. on immigrant health have yet to be produced. The existing literature has, almost without exception, failed to account for differences in health endowments of immigrants arriving in different time periods (cohort effects), which could seriously bias estimated duration effects.

In this paper, we investigate how a highly salient measure of immigrant health—low birthweight of children born in the U.S. to immigrant mothers—has varied across arrival cohorts, is associated with duration of residence adjusting for cohort differences, and varies by region of origin and age at arrival. All three analyses are critical for moving the research on immigrant health trajectories forward. Additionally, the region-of-origin and age-at-arrival analyses exploit important variations in immigrant experiences to help us learn about U.S. health disadvantages more generally.

We focus on birthweight for substantive and practical reasons. The substantive reasons are that: (1) Native/immigrant differences in birth outcomes mirror those in adult health; specifically, birthweight-related outcomes of foreign-born mothers are uniformly more favorable than those of native-born mothers of the same race or ethnicity (e.g., Cho and Hummer 2001; David and Collins 1997; Landale, Oropesa and Gorman 1999; Landale, Oropesa, Llanes and Gorman 1999; Singh and Yu 1996). (2) Some of the key behaviors thought to be affected by immigrant acculturation (e.g. diet and smoking) are important predictors of birthweight (Reichman 2005). (3) The maternal-child link is potentially important for understanding patterns
in immigrant health across generations. (4) The share of children in the U.S. born to immigrant mothers is large, with one quarter of births in the U.S. in 2008 taking place to women born outside of the 50 U.S. states or DC (Martin et al. 2010). The practical reasons are that: (1) Birthweight is a widely-used and readily-available index of infant health that is strongly associated with subsequent morbidity (Reichman 2005). (2) Maternal reports of birthweight are highly accurate, even retrospectively after many years (McCormick and Brooks-Gunn 1999; O’Sullivan, Pearce and Parker 2000). (3) Because retrospective reports are reliable, information obtained from mothers about the birthweight of their children going back to when those children were born can be used, in conjunction with the mothers’ years of arrival, to construct long duration time series using available nationally-representative data.

**Background**

**Immigrant Health Trajectories**

As indicated earlier, most existing studies of immigrant health trajectories have found negative associations between duration of residence and health; specifically, the longer individuals live in the U.S., the worse their health. There is some evidence of similar associations in Canada (McDonald & Kennedy 2004; Newbold 2005) and Australia (Chiswick, Lee and Miller 2008; Julian and Easthope 1996). However, Jasso et al. (2004) found evidence of a curvilinear association, suggesting improvements in health soon after arrival to the U.S. followed by steady deterioration after about five years. A handful of studies have investigated associations between mothers’ duration of residence and the birth outcomes of their U.S.-born infants. Most have found evidence of worse outcomes with longer duration (e.g., Ceballos and Palloni 2010; Landale, Oropesa and Gorman 2000), although a recent article based on data from three national birth cohort studies and using more refined duration intervals than the other studies found
curvilinear patterns in birthweight akin to those found by Jasso for adult health (Teitler, Hutto and Reichman 2012).

The dominant explanation for the purported decline in immigrant health by duration is acculturation, which has been characterized in much of the empirical literature using measures of language acquisition, generational status, and age of arrival, all of which are highly associated with duration of residence in the host country. While acculturation theory was much more nuanced in its original theoretical formulation (see Lara et al. 2005; Portes and Rumbaut 2001), the empirical literature often distills the concept into one of gradual acceptance of the new culture as the protective effects of the country of origin dissipate over time. That is, the process is assumed to be monotonic and assimilative in nature. Acculturation is thought to operate primarily through individuals’ health behaviors, particularly drug use, alcohol abuse, cigarette smoking, and unhealthful dietary patterns (see Lara et al. 2005). Specifically, the longer immigrants reside in the U.S., the more likely they are to engage in those behaviors, which in turn compromise their health.

There is evidence that immigrants’ age at arrival is associated with health-related outcomes, including cognitive development (Glick et al. 2009) and obesity (Kaushal 2009; Roshania et al. 2008), as well as outcomes that may affect health, such as language proficiency (Bleakley and Chin 2010). There is also strong evidence that decisions about whether to engage in health-related behaviors (including those related to birth outcomes, such as smoking) are made during adolescence (Elders et al. 1994; Kandel et al. 1998). The critical period for take-up of smoking appears to be narrow and a fairly universal phenomenon (World Bank 1999). If health-related behaviors are driving associations between duration in the U.S. and health, then we
would expect immigrants who came to the U.S. during or prior to adolescence to be most negatively affected by duration in the U.S.

Changes in behaviors are not the only processes that can potentially shape immigrants’ health trajectories. Exposures to discrimination or other potentially health-compromising social stressors could also take a toll on immigrants’ health (Nazroo 2001; Singh and Siahpush 2002; Reijneveld 1998; Uretsky and Mathiesen, 2007). However, health could also be favorably affected by migrating to the U.S. if the move leads to economic opportunities and better access to high-quality healthcare. Thus, factors such as race/ethnicity, education, and circumstances surrounding the decision to migrate, all which are associated with place of origin, may moderate duration effects on health.

Cohort effects

All of the above-mentioned studies of immigrant health trajectories are based on cross-sectional data, leaving open the possibility that observed associations between duration in the U.S. and health could be driven (or partly suppressed) by patterns in health selectivity of immigrants arriving to the U.S. over time, since duration in the U.S. is a function of year of arrival. For example, if the health of new entrants to the U.S. declines over successive immigration cohorts and this pattern is not accounted for, estimated duration effects of U.S. residence would be positively biased (i.e., increased duration would appear to improve health). Conversely, if the health of new entrants to the U.S. improves over time, estimated duration effects that do not account for this trend would be negatively biased. To properly estimate the effects of duration of residence in the U.S. on health, it is necessary to account for year-of-arrival effects.
The extent to which the health of immigrants varies by cohort represents a significant knowledge gap, as does the extent to which differences across cohorts explain associations between immigrant duration of residence and health. Jasso et al. (2004) found that self-rated health among immigrants who came to the U.S. in 1991 was better than that among immigrants who arrived in 1996, and Antecol and Bedard (2006) found some evidence of worsening health, particularly among women, across four recent cohorts of immigrants. Hamilton and Hummer (2011) found no clear pattern across immigration cohorts for blacks. These findings suggest that, overall, immigrants have become less positively selected on the basis of health over time; however, they are based on too few data points and from observation periods too short to allow for general inferences to be made. For this reason, the findings from these studies cannot be used to ascertain the extent to which cohort effects bias estimates of immigrant health trajectories. Disentangling duration and cohort effects on immigrant health requires repeated cross-sectional data over a large period of time with granular duration and year-of-arrival intervals.

*Age effects*

Age is an important potential source of confounding when estimating the effects of duration, as the duration and age are perfectly collinear. The association between maternal age and low birthweight has a distinct “U” shape, with high rates among teenagers and older mothers and low rates among women in their 20s and early 30s (Reichman 2005; Reichman and Pagnini 1997). Thus, age is likely to confound estimated effects of duration of U.S. residence on low birthweight, unless age is controlled for or observations are confined to the middle “healthy” age range.

*Period effects*
It is important to consider whether observed differences in health (in our case, low birthweight) across immigrant cohorts reflect secular changes in the U.S. as a whole. If that is the case, observed cohort differences could reflect a more general and less immigrant-specific trend. As can be seen in Figure 1, which documents rates of low birthweight in the U.S. from 1950–2009 (compiled from U.S. natality data), the trend has remained quite flat. The rates have fluctuated only within a narrow corridor of about 7–8 percent over 60 years, despite many changes over the period that would be expected to affect rates of low birthweight over time, such as: (1) tremendous changes in cigarette smoking, which increased until around 1960 and halved over the following 40 years (Burns et al. 1997); (2) increased use of assisted reproductive technology, which has increased the rate of multiple birth (a risk factor for low birthweight) (Martin, Hamilton and Osterman 2012); (3) increased rates of intervention and delivery of infants prior to term in cases of poor fetal growth (Joseph, Demissie and Kramer 2002); and (4) substantial changes in the sociodemographic composition of the population as a whole and of births in particular (Congressional Research Service 2011; Livingston and Cohn 2010). The remarkable stability of the trend in low birthweight despite these major forces suggests that period effects are unlikely to bias our estimated cohort and duration effects on low birthweight.

Our contribution

In this paper, we systematically investigate (1) cohort differences in low birthweight among children born to immigrant mothers arriving in the U.S. between 1955 and 2009, using fine-grained duration and year-of-arrival intervals; (2) patterns in low birthweight by maternal duration of residence in the U.S., controlling for cohort differences; and (3) patterns in low birthweight by maternal duration of residence stratified by age at arrival and region of origin, also controlling for cohort differences. All of these analyses are necessary for ascertaining the
extent to which life in the U.S. takes a toll on immigrant women’s health, as measured by their infants’ birthweight. The analyses stratified by age at arrival and place of origin also represent important steps for determining how living in the United States affects health.

Data

We use the 1998 to 2009 waves of the National Health Interview Survey (NHIS) to investigate the relationships between maternal duration of residence in the United States, year of arrival, and low birthweight. The NHIS is the largest household health survey in the U.S. and is widely used to monitor national health trends. The restricted version of the NHIS is used for the analyses in this study because it includes the actual year of arrival of the mother, in contrast to the public use version which includes this variable only in 5 year intervals and is top-coded at 15 years or more in the U.S. Using all available years of the restricted NHIS that include the requisite analysis variables provides us with a unique and invaluable data source for disentangling effects of duration of residence in the U.S. from those of year of arrival. Because 1998 was the first year that the NHIS asked about year of arrival and the year of birth was available only for (randomly-selected) children under age 18 residing with their mothers at the time of their interviews, our analysis sample of 21,700 mothers consists of women who came to the U.S. between 1955 and 2009 and gave birth in the U.S. between 1980 and 2009. Table 1 shows sample sizes by 5-year arrival intervals, rounded to the nearest 100 to conform to institutional protocols governing the presentation of sensitive data. The NHIS uses a multistage probability sample; consequently, all figures and analyses have been weighted accordingly using the svy commands in Stata SE 11.

We focus on low birthweight (< 2500 grams, or about 5.5 pounds) as the outcome. Low birthweight is a widely used, well-measured, and reliably-reported marker of poor health at birth.
It is the second leading cause of infant mortality in the U.S. after birth defects and is associated with long-term health and developmental problems among infants who survive (Reichman, 2005). As indicated earlier, maternal retrospective reports of their children’s birthweight—which we use for our analyses—are known to be reliable, even after many years.

Most of the results presented in this paper are based on the mother’s actual year of arrival collapsed into 5-year-arrival bands in order to comply with the NHIS and institutional restrictions regulating the presentation of data based on small cell sizes. However, analyses conducted using narrower intervals (and even individual years) produced results highly consistent with those using the 5-year intervals.

Duration of residence in the U.S. is calculated by subtracting the mother’s year of arrival in the U.S. from the year of the focal child’s birth. Births that took place before the mother came to the U.S. are not included in the sample. Because only the years (and not months) of arrival and birth are available, our duration measures, which are expressed in single (whole number) years, actually encompass 24-month duration periods. For example, women who gave birth 12 months plus 1 day after arriving, those who gave birth 36 months less one day after arriving, and those with arrival-to-birth intervals within that range would all be coded as having lived in the U.S. for 2 years at the time of the birth (that is, having a two year difference between arrival and the birth). In our graphical analyses, following Teitler, Hutto and Reichman (2012), we use the following duration categories: 0–2, 3–5, 6–10, 11–15, and 16+ years. In our regression analyses, we include single year duration measures, omitting the 1-year category (which represents the most recent arrivers, who had been in the U.S. 0 to 24 months when they gave birth to the focal child).

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1 Since the calculation of duration of residence in the U.S. is based on calendar year of immigration and calendar year of birth, the range of exposure to the U.S. captured by each of our 1-year duration of residence variables is
Analyses

The first two questions we address in this paper are: (1) To what extent has low birthweight of immigrants changed across arrival cohorts over the past 50 years? (2) To what extent does low birthweight vary by duration of residence in the U.S.? To answer the first question, we compute rates of low birthweight for 5-year arrival cohorts within specific duration intervals. To answer the second question, we estimate cohort-adjusted duration effects using logistic regression to estimate low birthweight as a function of both the number of years the mother had been in the U.S. at the time of the birth and her year-of-arrival cohort (as 5-year interval dummy variables and, in alternative specifications, as a continuous variable). We also control for maternal age (less than 20, 20–34, or 35+ years). We then graphically display the fitted 2nd order polynomial curve corresponding to the logit coefficients.

In our third set of analyses, we stratify by age at arrival and by region. Specifically, we conduct separate analyses for mothers who arrived in the U.S. as minors (< 18 years old) and as adults (over age 18), and for two region-of-origin groups for whom sample sizes are sufficient: (1) mothers from Mexico, Central, South America, and the Caribbean, and (2) mothers from Asia, Southeast Asia, and the Indian subcontinent. For ease of exposition, we refer to the former as “Hispanics” and the latter as “Asians,” recognizing that these terms do not accurately characterize all individuals from those areas. Finally, although sometimes considered foreign-born in research on immigrant health, island-born Puerto Ricans, who are U.S. residents, are not included in the Hispanic group.

Results

greater than one year. To illustrate, a birth in 1999 to a mother who arrived in 1998 would be coded as having resided in the U.S. for one year. This could be a mother who arrived on December 31st 1998 and gave birth on January 1st 1999 (so arrived in the U.S. 1 day before giving birth), but could also be a mother who arrived January 1st 1998 and gave birth on December 31st, 1999 (so in the U.S. 2 years before giving birth). Thus, each 1-year duration of residence variable represents the median potential exposure to the U.S. within a 24 month period.
Cohort effects

Both official statistics and the survey data from the NHIS demonstrate that there have been important changes over time in the characteristics of immigrants arriving to the United States. Figures 2 and 3 present data from various U.S. government reports (see table notes) on the composition of legal immigrants to the U.S., by world region, from 1950 to 2010. With the exception of a peak in the number of legal immigrants from Mexico between 1988 and 1992, coinciding with the Legally Authorized Worker and Specialized Agricultural Worker amnesty programs under the Road to the Immigration Reform and Control Act, the proportions of immigrants to the U.S. from Asia, all Spanish speaking countries, and Europe have remained fairly stable since the 1970s (Figure 2). The proportion has increased notably only for immigrants from Africa, but this group remains small in comparison to other sending regions.

Most of the major regional compositional changes of new immigrants occurred from 1950 to 1975, during which there were large increases in the numbers from Spanish speaking and Asian countries (Figure 3). The absolute numbers of immigrants from Europe and Canada have remained relatively stable since the 1950s, but as the total number of immigrants has risen, their proportional representation has diminished substantially.

Data on country or region of origin in our NHIS analysis sample (immigrant women giving birth in the U.S. between 1980 and 2009) confirm the relative stability of proportions from various sending areas. However, the NHIS data (which may include undocumented immigrants) suggest that the share from Mexico, Central America, and South America has been substantially larger among immigrant women giving birth in the U.S. than among legal immigrants to the U.S. as a whole—60–65 percent (Figure 4) compared to approximately 40 percent per year (Figure 3).
The relative stability in the regional composition of immigrants over the recent past does not mean that the composition of immigrants has otherwise remained the same. We find in our NHIS sample that cohorts have become much less educated over time; 94 percent of immigrant mothers in the 1955–1960 arrival cohort had a high school education (assessed at the time of the NHIS interview), compared to 57 percent of those in the 2005–2009 cohort (Figure 5). Since education and health are strongly intertwined, the decreasing level of education among immigrants—if not accounted for—is likely to confound estimated effects of duration of residence in the U.S. on birth outcomes. The same could be true for any other compositional changes among immigrants that are related to health. Education is particularly difficult to account for in studies of immigrant health trajectories that do not focus on one particular sending country because educational systems vary across sending countries and equivalencies are difficult to assess, and because reporting on educational attainment in surveys with U.S.-based educational response choices may vary by region of origin. Additionally, and more specific to the NHIS and our study, some mothers may have arrived prior to having completed their education. The most direct and expedient way to account for all observed and unobserved compositional differences when investigating the effects of duration of residence on health is to control for cohort, which is the approach we follow.

In Figure 6, we present rates of low birthweight among U.S.-born children of immigrants over successive immigration cohorts. We focus on mothers in specific duration intervals to purge duration effects from actual cohort differences. What is notable from this figure is that there has been a consistent deterioration in infant health with successive immigrant cohorts. That is, rates of low birthweight steadily increased over the 50-year observation period. For example, among women giving birth 1–2 years after arrival to the U.S., the rate of low birthweight was 9.6
percent for the 2005–2009 cohort, compared to 7.6 percent for the 1985–1990 cohort. A similar pattern is apparent within almost all of the other duration categories. The exception is for mothers giving birth 16 years or more after coming to the U.S., for whom rates of low birthweight were substantially lower among the last cohort (1985–1990) than among the previous cohorts. However, that “reversal” is likely to be an artifact of women in the last cohort being constrained to the beginning of the 16+ duration interval whereas those in earlier arrival cohorts were not. To the extent that there are detrimental duration effects among long-term residents (which is not inconsistent with what we find later in this paper), the censored composition of this group would suppress rates of low birthweight. Relative risk analyses (not shown) confirm that year-of-arrival effects are large and highly significant. Specifically, we find that the risk of delivering a low birthweight infant increased by 1.1 percent per year, controlling for duration of U.S. residence in single year increments. At the aggregate level, the percentage point increase in low birthweight, controlling for duration, was .10. That is, children of immigrants who were low birthweight increased by approximately 1 percentage point every 10 years during the latter half of the 20th century and first decade of the 21st century.

Effects of duration in U.S.

To estimate the effects of duration of residence in the U.S. on low birthweight, we estimate logistic regressions of low birthweight on 14 single-year duration indicator variables plus an indicator for living in the U.S. 16 years or more, with less than 1 year in the U.S. as the reference category. We control for the eleven 5-year arrival cohorts in Table 1 using indicator variables for 10 of those cohorts and the other serving as the reference category, and for maternal ages at the time of the birth of less than 20 and greater than 34 years, with 20–34 years as the reference category. In addition to the model for the overall sample, we estimate corresponding
models that alternatively restrict the sample to Hispanic mothers (defined earlier as being from Mexico, Central and South America, or the Caribbean); Asian mothers (defined earlier as being from China, Southeast Asia, or the Indian subcontinent); mothers that arrived prior to age 18; and mothers that arrived at age 18 or older. We then estimate and plot a quadratic regression curve of the logistic regression coefficients of the duration indicator variables to visually display the pattern of associations between low birthweight and duration of residence in the U.S. controlling for cohort effects and maternal age. The graphical results are presented in Figures 7a–e and the full regression results upon which the five figures are based are included in Appendix Table 1.

Our full-sample analysis reveals a pattern similar to that found by Teitler, Hutto and Reichman (2012) based on three national datasets (ECLS-B, ECLS-K, and Fragile Families), but not accounting for cohort effects. Specifically, there appears to be a curvilinear association between duration in the U.S. and low birthweight (Figure 7a). The logged odds that immigrant women give birth to low a birthweight infant decreases over the first 11 years in the U.S. and subsequently increases. The odds of having a low birthweight baby 11 years after arriving are almost half ($e^{-0.49} = .61$) the odds for women giving birth less than 2 years after arrival. Even after being in the U.S. 16 or more years, the rate of low birthweight, conditional on maternal age and arrival cohort, is no worse that it was than upon arrival (logit coefficient = -.13). Every duration coefficient (i.e., the log odds of low birthweight for a given duration relative to being in the U.S. less than 2 years) is negative, and most are statistically significant at $p < .05$ or close to significant. As an alternative specification, we restricted the sample to women ages 20–34 – the range within which age effects on low birthweight are very small – rather than controlling for maternal age and the results were substantively unchanged (not shown).
Figures 7b and 7c (and the corresponding models in Appendix Table 1) show the duration coefficients for Hispanic- and Asian-origin mothers, respectively. While the regression-fitted curvilinear trend is less pronounced for these subgroups than for the full sample, it still appears that there are beneficial effects of duration over the first 9–11 years which subsequently taper off. As for the full sample, the rates of low birthweight after 15 years are no greater than they were upon arrival.

An important and striking difference revealed by the stratified analyses is that the apparent health benefits accruing from additional years in the U.S. are particularly large for Asian immigrants, for whom the logit coefficients for duration are approximately 4 times larger than those for Hispanics. This is a particularly noteworthy finding as most studies on immigrant health have focused on Hispanics (often Mexicans), possibly providing a negatively-skewed view of immigrant health trajectories in the U.S. That said, stratifying by region reduces the analysis sample sizes significantly, and as a consequence, the duration estimates are not statistically significant in the model for Hispanics. For Asians, many of the duration coefficients are statistically significant as a result of their relatively high magnitudes. Finally, it is important to point out that the much larger coefficients for Asians reflect a large decline in rates of low birthweight between the first and second years in the U.S. Were we to use a combined 1–2 year duration interval as the reference category, the difference in the magnitude of coefficients between the two regional groups would be largely erased.

The last two figures (7d and 7e) show results from models stratified by maternal age at arrival. As discussed earlier, there are theoretical reasons to expect that duration effects would be different for immigrants who come to the U.S. before or during the particularly impressionable adolescent years than for those who come after they have already reached adulthood and may
have already established lifelong health-related habits. It is also possible that selectivity on the 
basis of health is very different for adults (who make the decision to migrate) than children (who 
passively accompany their parents or other adults) and that the effect of exposure to the U.S. 
depends on the individual’s health endowment.

The results presented in Figures 7d and 7e (and in the corresponding models in Appendix 
Table 1) demonstrate that the health trajectories are, in fact, distinctly different for the two age-
at-arrival groups in a manner that is consistent with acculturation theory and with what is known 
about critical periods for the formation of health behaviors. While the likelihood of having a low 
birthweight infant decreases with duration among women who came to the U.S. as adults, the 
likelihood of low birthweight increases with duration among those who came to the U.S. as 
children (all but one coefficient is positive though most are not statistically significant due to the 
greatly reduced sample size). Immigrants coming to the U.S. as children account for most of the 
long-exposure sample (i.e., women having births more than 10 years after arriving) and those 
arriving as adults account for most of the short-exposure sample (i.e., women having births fewer 
than 10 years after arriving). The fact that the associations are divergent for the two groups 
explains the U-shaped association between duration and low birthweight observed in the full 
sample. That is, the initial decline in low birthweight reflects the experience of women who 
arrived in the U.S. during their prime reproductive years and gave birth soon afterward, while the 
increase after 10 years in the U.S. reflects the experiences of those who arrived at much younger 
ages.

As an alternative specification, we re-estimated all of the regression analyses using a 
continuous measure of year of arrival (rather than 5-year cohorts) and the results were
substantively unchanged, suggesting that—at least over the past 50 years—the declining levels of immigrants’ human capital can be thought of as a gradual and persistent phenomenon.

Discussion

A fair amount of scholarly work over recent decades has focused on documenting and attempting to explain health declines of immigrants to the U.S., within and across generations. This research has been based on the notion that the acculturation process erodes immigrants’ initial health advantages over time. The literature to date can be characterized as having three fundamental limitations – not having taken into account variations in health across arrival cohorts, using very broad duration intervals (which is what are available in most relevant datasets), and failing to account for important interactions. Accounting for cohort effects is critical because year of arrival is a linear function of duration of residence and because there have been profound changes in the composition of immigrants over time. We found a pronounced and consistent deterioration in infant health with successive immigrant cohorts between 1955 and 2009. Using broad and fixed duration intervals can conceal complex non-linear associations between duration and health. We found that the use of fine-grained duration intervals (even single years) paints a nuanced picture of the associations between duration and low birthweight. Not allowing for associations to vary across groups can mask substantial heterogeneity of effects within the immigrant population. In addressing all three of these limitations, we found evidence of a nonlinear association between duration of residence in the U.S. and low birthweight that appears to reflect two very different processes—improvements in health with duration among immigrants who came to the U.S. as adults and deteriorations in health with duration among those who arrived as children. We also found differential duration effects by place of origin for the two largest broad groups of immigrants in the U.S. In particular,
Asian immigrants appear to benefit more than Hispanic immigrants, in terms of health, after arriving to the U.S.

The divergent results for the two age-at-arrival groups allow us to pinpoint a clearly identifiable group for which health erosion with duration in the United States takes place—those who came to the U.S. as minors (sometimes referred to as generation 1.5). These findings are consistent with any the following scenarios: Adults making decisions to come to the U.S. likely do so with the expectation of improving their circumstances and a strong motivation to take advantage of new opportunities. They are primed to benefit from increased opportunities and resources, and at the same time, relatively protected from commercial and social pressures to engage in health-compromising behaviors (e.g., smoking, substance use, poor diet, sedentary lifestyle), having already established their health habits. Immigrant youth, who come to the U.S. with their parents or other adults, are less likely to be as highly motivated to benefit from the migration experience. They also arrive at a stage in the lifecourse at which they are more likely to succumb to influences to engage in health-compromising behaviors. Finally, it is possible that children are particularly vulnerable to health compromising social and physical environments that may exist in the United States.

The finding that Asians experience larger gains to being in the U.S. than Hispanics is noteworthy and novel, as Asian immigrants are an understudied group despite their growing numerical representation in the U.S. Among legal immigrants, Asians now outnumber Hispanics. The bulk of research on immigrant health to date has focused on Hispanics. Our finding of region-of-origin differences in duration effects underscores the need for more studies of Asian immigrant health trajectories and the underlying processes.
This study focused on one indicator of health, infant birthweight, which represents a substantively important outcome and allowed us to create a nationally-representative dataset with substantial variation in year of arrival, duration of U.S. residence, maternal age at birth, age at arrival, and region of origin—all of which were necessary for accomplishing the aims of this study. That said, it is important to point out that the results based on this outcome cannot necessarily be generalized to other aspects of physical or mental health. It is possible that duration of residence in the U.S. is associated with benefits to reproductive health but with decrements to other measures of health, although there is no reason to expect that would be the case. It is also possible that the effects of duration are different for men than for women, particularly since women may be more connected to healthcare services in their reproductive years. Finally, in terms of birthweight itself, it is not possible to explore the specific etiologies (preterm birth, intrauterine growth retardation) behind the observed duration effects with available nationally-representative data.

In addition to addressing questions about our primary focus—immigrant health—the findings from this study have implications for the vexing observation that the health of Americans compares unfavorably to that of residents of most other developed countries. The fact that the health of immigrants who come as adults does not appear to deteriorate by virtue of being in the U.S., but that the health of those who come as children does seem to erode over time, suggests that child immigrants are less favorably selected on health and therefore less resilient to health compromising exposures or that U.S. health disadvantages are embedded early in the life course. The latter is consistent with recent findings by Martinson, Teitler and Reichman (2011) that U.S. health disadvantages (at least compared to England) are as pronounced in childhood as later in life.
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Table 1. Sample Sizes of Immigrant Mothers Giving Birth in the U.S., NHIS 1998–2009, by Arrival Cohort

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<thead>
<tr>
<th>Arrival cohort</th>
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</tr>
<tr>
<td>1960–1964</td>
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<td>1600</td>
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<tr>
<td>2005–2009</td>
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</table>
Figure 1. Percent Low Birthweight in the United States, 1950–2009


Note: Missing data covering the late 1960s and early 1970s were interpolated.
Figure 2. Proportion of Legal Immigrants to U.S. by Region of Origin and Year of Arrival

Figure 3. Legal Immigrant Inflows to the U.S. by Region of Origin and Year of Arrival

Sources: See notes to Figure 2.
Figure 4. Regional Composition of Immigrant Arrival Cohorts over Time, NHIS Sample of Immigrant Women Who Gave Birth in the U.S. between 1980 and 2009

Source: Authors’ calculations
Figure 5. Percent with High School Education by Arrival Cohort, NHIS Sample of Immigrant Women Who Gave Birth in the U.S. between 1980 and 2009

Source: Authors’ calculations
Figure 6. Low Birthweight by Immigrant Cohort Within Duration Intervals, All Immigrant Mothers

![Graph showing low birthweight by immigrant cohort within duration intervals, all immigrant mothers.](image-url)
Figure 7a. Estimated Effects of Duration of U.S. Residence on Low Birthweight Among All Immigrant Mothers, Controlling for Year of Arrival and Maternal Age at Time of Birth

Note: Derived from estimates in column (a) of Appendix Table 1.
Figure 7b. Estimated Effects of Duration of U.S. Residence on Low Birthweight Among Hispanic Mothers, Controlling for Year of Arrival and Maternal Age at Time of Birth

Notes: Note: Derived from estimates in column (b) of Appendix Table 1. As explained in the text, Hispanics include mothers from Mexico, Central and South America, or the Caribbean.
Figure 7c. Estimated Effects of Duration of U.S. Residence on Low Birthweight Among Asians, Controlling for Year of Arrival and Maternal Age at Time of Birth

Notes: Derived from estimates in column (c) of Appendix Table 1. As explained in the text, Asians include mothers from China, Southeast Asia, or the Indian subcontinent.
Figure 7d. Estimated Effects of Duration of U.S. Residence on Low Birthweight Among Mothers Who Arrived at Ages < 18 Years, Controlling for Year of Arrival and Maternal Age at Time of Birth

Note: Derived from estimates in column (d) of Appendix Table 1.
Figure 7e. Estimated Effects of Duration of U.S. Residence on Low Birthweight Among Mothers Who Arrived at Ages 18+ Years, Controlling for Year of Arrival and Maternal Age at Time of Birth

-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Log Odds (reference group = 1 year)

Note: Derived from estimates in column (e) of Appendix Table 1.
### Appendix Table 1. Multivariate Estimates of the Effects of Duration of U.S. Residence, Year of Arrival, and Maternal Age on Low Birthweight

<table>
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<th>Years in U.S. (1 omitted)</th>
<th>All (a)</th>
<th>Hispanics (b)</th>
<th>Asians (c)</th>
<th>Arrived &lt;18 (d)</th>
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### Year of Arrival (1955-60 omitted)

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### Mother's age at time of birth (20-34 omitted)

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<th>Asians (c)</th>
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### N (rounded)

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<th>Asians (c)</th>
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Notes: Figures are logit coefficients and standard errors that were used to derive figures 7a-e. **p<0.01, ***p<0.05, *p<0.10. As explained in the text, Hispanics include mothers from Mexico, Central and South America, or the Caribbean and Asians include mothers from Asia, Southeast Asia, or the Indian subcontinent.