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Diminished Advantage or Persistent Protection? A New Approach to Assess Immigrants' Mortality Advantages Over Time

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Abstract

Much research has debated on whether immigrants' health advantages over natives decline with their duration in the destination. Most such research relies on (pooled) cross-sectional data and uses years since immigration as a proxy for duration of residence, leading to the challenge of distilling the duration effect from the confounding cohort-of-arrival and age-of-arrival effects. Existent longitudinal studies tend to use self-rated health as the outcome, thus subject to the criticism that the changes observed may reflect shifts in immigrants' awareness of health problems. We shed light on the debate by examining how immigrants' mortality risk, a relatively unambiguous measure that is tied to poor health, changes over time compared to natives', using the National Health Interview Survey 1992–2009 with linked mortality data through 2011 (n=875,306). The analysis shows that U.S. immigrants enjoy a survival advantage over the native-born, and that this advantage has persisted or amplified during the 20 years of observation. Moreover, the persistence of this advantage is observed for all immigrants, regardless of their race, gender, or when they began to live in the United States. As far as mortality is concerned, this study provides unequivocal evidence that the health protection of immigrant status is stable and long-lasting.

Keywords

Immigrant health advantage; Mortality disparities by nativity; Duration of residence; Gender; Race

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Despite immigrants' lower socioeconomic status and less access to health care (Derose, et al., 2009; Park & Myers, 2010), they tend to have better health in many aspects, including mortality, heart and circulatory disease, obesity, and smoking status, than the native-born of their destinations (e.g., Cunningham, et al., 2008; Lariscy, et al., 2015; Singh & Hiatt, 2006). This is known as the "immigrant health advantage" (e.g., Markides & Eschbach, 2005; Riosmena, et al., 2017). This advantage is nevertheless argued to decrease along immigrants' length of stay in the United States (Akresh, 2007; Lara, et al., 2005; Lopez-Gonzalez, et al., 2005). Researchers have attributed the declined health advantage to immigrants'

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unhealthy assimilation to the diet, smoking habit, and other health behaviors of the native-born (Abraido-Lanza, et al., 2005; Finch, et al., 2001; Kimbro, 2009) and exposure to racial discrimination and other negative environmental experiences (Carrasquillo, et al., 2000; Hunter, 2000; Leclere, et al., 1994).

Most studies addressing immigrants' diminishing health advantage use (pooled) cross-sectional data and compare immigrants with varying lengths of time in the destination country to infer the existence of unhealthy assimilation (Antecol & Bedard, 2006; Cho, et al., 2004). In such data, immigrants' duration of residence is exactly the survey year minus the arrival year or the age at the survey minus the age of arrival. Therefore, researchers often suffer from identification problems trying to address all these factors. In most cases, they inevitably confound immigrants' length of stay with the cohort or age of arrival. Because immigrants arriving at various time periods may differ in selectivity due to shifts in the origin's sociodemographic conditions and policy changes in the destination, the cohort of arrival could explain why immigrants of varying durations of stay exhibit differing extents of health advantage in cross-sectional data. Similarly, immigrants arriving in childhood and adulthood likely migrate for different reasons, with those migrating for work more selective health-wise than those for family reasons (Gubernskaya, 2015). Therefore, the health disparities observed at a single time point among those with varying durations of stay may reflect the age-based health selectivity, rather than the duration effect.

Given the difficulties cross-sectional analyses face, a handful of studies have started using longitudinal data that follow immigrants over time (Choi, 2012; Wakabayashi, 2010). Results from existing longitudinal analyses, however, are mixed regarding whether the immigrants' health converges with natives' over time. Gubernskaya (2015), for example, finds that immigrants' self-rated health declines at a greater rate compared to the native-born population's, whereas Lu and colleagues (2017) show that the foreign-born are able to maintain their health advantage. Moreover, prior studies either rely exclusively on an older population (Choi, 2012; Gubernskaya, 2015), in which immigrants may be especially few and selective, or use self-rated health as an outcome, which can reflect immigrants' changing perception of their health instead of their actual health (Jasso, et al., 2004; McDonald & Kennedy, 2004).

Built on the limited longitudinal research on the importance of duration of stay to immigrants' health, this study utilizes the National Health Interview Survey (NHIS) with linked mortality data to follow the survival status of a national adult sample for up to 19 years. Unlike previous research, we focus on shifts in immigrants' advantage in mortality, a measure fairly unambiguous compared to self-reported health conditions or self-rated health (Angel, 2006), over real time. Although mortality is conceptually different from health, it is reasonable to expect the health protection from immigrant status to lower mortality risk. In fact, research has shown immigrants' lower mortality than natives' (Arias, et al, 2010; Borrell & Lancet, 2012; Singh & Hiatt, 2006) and considered this gap as corroborating evidence for the immigrant health advantage (e.g., Angel, et al., 2010; Lariscy, et al., 2015). In this sense, examining how immigrants' advantage in mortality changes with their length of stay can shed light on the general knowledge concerning the durability of health protection for immigrants.

To uncover the effect of duration of residence on immigrants' mortality, we analyze the patterns and disparities in mortality risk over real time, while accounting for age-related mortality hazards. Because prior studies based on (pooled) cross-sectional data often divide immigrants by the number of years since immigration (YSI) and compare their health conditions (Antecol & Bedard, 2006; Cho, et al., 2004), we further break down the foreign-born by YSI group to show how these groups' mortality hazards evolve over time. By doing so, we can assess the extent to which differences among YSI groups indeed reflect shifts in immigrants' mortality risk relative to natives' over time. Finally, because immigrants of various races and ethnicities may assimilate at different paces and be exposed to differing levels of discrimination (Villarreal & Tamborini, 2018), their temporal mortality patterns are potentially diverse. Thus, we also examine long-term changes in mortality risk by immigrants' ethnoracial identity.

BACKGROUND

Immigrant Health and Mortality Advantages and Unhealthy Assimilation

Much research shows that compared to native-born counterparts, immigrants have better health conditions (e.g., Cunningham, et al., 2008; Markides & Coreil, 1986) and lower mortality rates (Arias, et al, 2010; Borrell & Lancet, 2012; Mehta, et al., 2016). These differences can be attributed to a combination of three factors. First, healthier individuals are more likely to self-select into migration (Akresh & Frank, 2008; Bosdriesz, et al., 2013; Guillot, et al., 2018). Second, immigrants' unique behavioral patterns and social capital help enhance their health (Blue & Fenelon, 2011; Eschbach, et al., 2004). Specifically, both immigrants' relatively favorable health behavior (e.g., low smoking rate) and tight social networks have protective effects on their health, leading to their lower mortality (e.g., Fenelon, 2013; Gallo, et al., 2009; Kimbro, 2009). Third, the "salmon bias"—that is, the bias caused by the likely returns of unhealthy immigrants to their origins—may explain immigrants' better health and lower mortality (e.g., Arenas, et al., 2015; Palloni & Ewbank, 2004). There is some evidence for the salmon bias, but many find it insufficient to fully explain immigrants' advantage in health or mortality (e.g., Elo, et al., 2004; Hummer, et al., 2007; Riosmena, et al., 2013).

Despite the abundant evidence on immigrants' health and morality advantages, some contend that such advantages are short-lived and appear mostly during the earlier part of an immigrant's time in the United States (Riosmena, et al., 2017). Immigrants with longer U.S. residence or greater acculturation to U.S. society have worse health and more illness risk factors than those with shorter residence or less acculturation (e.g., Hunt, et al., 2004; Lara, et al., 2005; Lopez-Gonzalez, et al., 2005). This phenomenon, often referred to as unhealthy assimilation (Antecol & Bedard, 2006), leads to the argument that the health protection for immigrants only exists in the short run, while assimilation to natives' unhealthy diet and behaviors (e.g., smoking) occurs in the medium to long run, ultimately eroding immigrants' health advantage (Cho, et al., 2004; Finch, et al., 2001). The other explanation for the declining health protection from immigrant status is the exposure to racial discrimination and other negative social, economic, and environmental experiences that differentially affect immigrants (Carrasquillo, et al., 2000; Finch & Vega, 2003). As immigrants' exposure to such negative forces increases with their length of stay, their health can be expected to deteriorate and converges with natives'.

To the extent poor health increases mortality risk, the unhealthy assimilation depicted in prior research should also erode immigrants' mortality advantage over time. Nevertheless, few researchers investigate whether immigrant mortality advantage dissipates as their length of stay extends. Instead, most studies rely on intergenerational comparisons. Such studies show that first-generation immigrants have lower mortality compared to their children and grandchildren (Elo, et al., 2004; Hummer, et al., 1999; Palloni & Arias, 2004) and that the immigrant mortality advantage over the native-born shrinks across generations (e.g., Eschbach, et al., 2007). This line of research, however, does not have a direct implication on how immigrant's mortality advantage may change within their own generation. As an exception, Angel and colleagues (2010) address within-generation shifts in mortality hazards using age of migration as a proxy for the length of stay. They find that among Mexican-origin immigrants age 65 and older, those who arrived after age 50 had lower mortality than those who came in childhood or midlife. But as we explain below, the findings based on age of migration do not necessarily imply unhealthy assimilation over the duration of residence, as they can be influenced by age-based health selection.

Counterarguments and Methodological Challenges

The argument of unhealthy assimilation is not without debate. Prior researchers have questioned this argument on both conceptual and methodological levels. Conceptually, although immigrants face an initial disadvantage in access to health care (Laroche, 2000; Leclere, et al., 1994; McDonald & Kennedy, 2004), especially if they are undocumented (Hacker, et al., 2015), with time they could experience changes in legal status, expansion of local ties, and improved knowledge of destination language and resources. In turn, immigrants are likely to have increased opportunities to receive preventative health checks, diagnoses, and medical treatments as their stay lengthens, which should widen their health or mortality advantage over the native-born. Immigrants are also likely to experience economic assimilation to the native-born, which offsets their early disadvantages in income, employment, and living environments (Borjas, 1995; Duleep & Regets, 2002; Hu, 2000; Schoeni, 1997; Villarreal & Tamborini, 2018; Zheng & Yu, 2022). Considering the potential growth of immigrants' resources and access over time, some researchers suggest that the finding of immigrants' shrinking health advantage may result from how prior studies measure health. Immigrants' improved health care access with longer time in residence may increase the diagnoses of pre-existing conditions (e.g., Jasso, et al., 2004; McDonald & Kennedy, 2004), which could lead to worse self-rated health, an outcome variable widely used in studies about unhealthy assimilation (Cho, et al., 2004; Hamilton, et al., 2015). If, despite their self-perception, immigrants in reality would become increasingly healthier than natives the longer they stay in the host country, then we should find their mortality advantage—which is unaffected by their subjective views—to persist and even expand with time.

Methodologically, most studies supporting the argument of unhealthy assimilation, which renders the competing hypothesis that immigrants' survival advantage will diminish with their time of stay, rely on cross-sectional or pooled cross-sectional data (Antecol & Bedard, 2006; Cho, et al., 2004). Such studies generally use retrospective information on the number of years since immigration to measure duration of residence and test how immigrants' health varies across the values of this indicator. In any given survey year, however, the effect of duration of residence on health could capture the impact of compositional differences among immigrants who arrive in a particular year (i.e., cohort-of-arrival effect) and the impact of the age at which immigrants arrive (i.e., age-of-arrival effect), as the duration is a function of both. The specific relationships can be expressed as follows:

1. duration of residence = year of survey − cohort of arrival
2. duration of residence = age at survey − age of arrival

Because both age and survey year are potentially relevant to individuals' health and should be controlled for (in the case when data from multiple survey years are used), any attempt to simultaneously address duration of residence and cohort or age of arrival with cross-sectional or pooled cross-sectional data naturally suffers from identification problems.

Separating the effect of duration of stay from that of cohort of arrival is crucial because there are at least three reasons to expect differences in characteristics, including health endowment and mortality risk, among immigrant cohorts arriving in different time periods. First, the health distribution in the sending countries may change over time (Lu, et al., 2017). For example, health endowment has generally improved across cohorts in less industrialized countries due to the improving living standard, nutrition, and health care. As a result, the cohorts of immigrants arriving in more recent decades may be heathier. Second, there could be shifts in the migration selection process. As enhanced living standards in the sending countries increase the opportunity cost of immigration, especially for those who are relatively well off, more recent immigrant cohorts may disproportionally consist of individuals from lower socioeconomic backgrounds. Third, changes in legal and social environments in the destination, such as implementation of anti-immigrant laws, may also amplify (or reduce) the cost of immigration (Hamilton, et al., 2015). Within the United States, the shifts in immigrants' destination states over time further add time-related variation in the cost of immigration (Massey, 2008), as states differ in their policies and treatments of immigrants. The changing cost is likely to alter the composition of incoming immigrants (by legal status, education, etc.) and to accelerate or decelerate existent immigrants' rate of returning to their origins, both of which can cause disparities in health and mortality risk across immigrant arrival cohorts.

Due to the concern of confounding cohort-of-arrival effect, studies using data from multiple survey years have tried to control for this factor and survey year simultaneously and estimate the net effect of duration of residence in the destination (e.g., Antecol & Bedard, 2006). Some researchers find no negative relationship between immigrants' length of stay and health for all immigrants (Lu, et al., 2017) or among Black immigrants (Hamilton & Hummer, 2011), while others report downward health assimilation (Antecol & Bedard, 2006; Cho, et al., 2004; Hamilton, et al., 2015), after controlling for cohort of arrival. This line of research has also produced some perplexing cohort-of-arrival patterns. For example, despite the nutrition transition and obesity epidemic in the origins and rising obesity and overweight prevalence rates among immigrants over time in the United States, recent Hispanic immigrants have lower body mass index than those who immigrated in 1980 or before (Antecol & Bedard, 2006, Table 5 and 6). But at the same time, recent immigrant cohorts are more likely to report poorer health, worse physical conditions, and more activity limitations than earlier ones (Antecol & Bedard, 2006, Table 3 and 4). These conflicting findings cannot be explained by selection; it is unlikely that increasing selectivity over time filters out Hispanic immigrants with higher body mass index but does not remove those with poorer health. Even more puzzling, Hamilton and colleagues (2015, Table 3 and 4) use the same analytic strategy and find recent Hispanic immigrants are actually less likely to report poor health than early immigrants. Although these discrepancies can potentially come from different data (NHIS data in Antecol & Bedard, 2006, March Current Population Survey data in Hamilton, et al., 2015), they also possibly result from the instability in the model estimates due to the collinearity among cohort of arrival, years since immigration, and survey year.

Relatively few cross-sectional studies have recognized that the duration-of-residence effect can also be confounded with the age-of-arrival effect. Younger immigrants are likely a less selective group compared to older immigrants. Whereas child immigrants tend to be brought by their parents, young adult immigrants move primarily for personal aspiration and job opportunities, the pursuit of which requires them to be relatively healthy. Even elderly immigrants, who tend to move for family unification, must be healthy enough to migrate. Consistent with this age-based health selection, previous studies show that at the same baseline age (e.g., age 50), immigrants who migrated during childhood or adolescence have worse health than those who migrated in young adulthood or later life (Choi, 2012; Gubernskaya, 2015). Because the same studies also find the former to experience a slower health decline since the baseline age than the latter, it is unlikely that the longer duration of stay and greater extent of unhealthy assimilation or exposure to discrimination explain child immigrants' worse health at the baseline age. Had we only had the health patterns at the baseline age, as in the case of cross-sectional analyses, we could have erroneously taken the worse health for those migrated at an earlier age as evidence for immigrants' declining health advantage. Alternatively, we would suffer from collinearity and identification problems in attempt to simultaneously account for age, age of arrival, and duration of stay in the models.

An Alternative Approach

The foregoing discussion explains the identification challenges in using (pooled) cross-sectional data to capture the variation in health along immigrants' duration of residence. Even if the identification problems can be solved, cross-sectional analyses do not directly observe how within-individual health conditions or mortality hazards change over elapsed time. A conceptually clearer and methodologically cleaner approach is to utilize longitudinal data and track both immigrants and natives' health or mortality over real time. This approach can also bypass the two aforementioned identification problems inherent to (pooled) cross-sectional estimates.

A limited number of studies have exploited longitudinal data to examine U.S. immigrant health trajectories. Gubernskaya (2015) uses 1992–2008 Health and Retirement Study to model the self-rated health trajectories since age 50. She shows that foreign-born people report better health than native-born ones at age 50, but some foreign-born groups, such as Hispanics and those who migrated at older ages, experience steeper health declines since age 50 than the native-born. Lu and colleagues (2017) utilize the 1996, 2001, 2004, and 2008 panels of Survey of Income and Program Participation, with a follow-up period of 2–4 years for each panel. Contrary to Gubernskaya (2015), they find that immigrants maintain their self-rated health advantage over natives during the short follow-up period. Lu and colleagues also show that Latin American and Asian immigrants are particularly likely to sustain their health advantage.

Although the aforementioned studies have substantially improved prior analyses with (pooled) cross-sectional data, their mixed results call for further investigations. Moreover, both studies rely on a subjective measure of health. As discussed earlier, immigrants' duration of stay may affect their perceived health status due to improved health care access and screening. Gubernskaya's (2015) finding of certain immigrant groups' greater declines in self-rated health than natives' could reflect this change in perception. Although Lu and others' study shows that immigrants' self-rated health is largely stable, their follow-up period of 2–4 years might be too short for immigrants to experience improved health care access and heightened awareness of health problems. Self-rated health is also problematic because different ethnic and nativity groups, who have differing cultures and reference groups, may assess their health using diverse criteria (Kimbro, et al., 2012; Finch, et al., 2002).

Compared to self-rated health, mortality risk is far less ambiguous and is not subject to the same criticism. Taking advantage of surveys with mortality follow-up data, a handful of studies have investigated how elderly immigrants' subsequent mortality depends on their age at migration (Angel, et al., 2010; Choi, 2012). Those who migrated in older age are found to have lower subsequent mortality than those who migrated in childhood or midlife. Although this finding can be a joint product of age-of-arrival effect and duration effect, the fact that health behaviors barely explain the mortality differences among those who migrated at varying ages suggest the differences are more likely due to age-based migration selection than unhealthy assimilation (Angel, et al., 2010, Table 2). In any case, none of the prior studies of mortality risk directly test whether immigrants' survival advantage over the native-born changes over real time.

To add evidence on the durability of health protection for immigrants, we utilize an unusually large dataset that contains a general adult population and a sizable number of immigrants. This dataset tracks respondents' mortality status for a long period of time, allowing us to examine changes in immigrants' survival advantage and avoid the reporting bias inherent to subjective health measures. Instead of comparing subsequent mortality among immigrants with different ages of migration (Angel, et al., 2010), which may capture both age-of-arrival and duration effects, or comparing natives and immigrants at each age (Gubernskaya, 2015), which may confound the duration effect with life course patterns, we investigate mortality disparities over elapsed time (time passed since the survey interview), while accounting for age-related survival patterns. If unhealthy assimilation indeed takes place, we should observe convergence in mortality risk between immigrants and natives along elapsed time regardless of how many years the immigrants have been in the United States prior to the survey.

METHODS

Data and Participants

For the analysis, we used the IPUMS NHIS from 1992–2009 with linked mortality records through the year 2011 (https://nhis.ipums.org/nhis/) (Blewett, et al., 2018). The NHIS is an annual, cross-sectional, multistage probability sample survey of the non-institutionalized civilian U.S. population conducted by the National Center for Health Statistics. The NHIS began to measure nativity in 1989, but it lacked detailed information about Asian heritages until 1992, which leads us to restrict the sample to data from that year onward. Different from other national surveys on immigration that either focus on one specific immigrant group or have small samples, the NHIS contains a large sample and immigrants of diverse origins. We can therefore compare immigrants with different ethnoracial identities. The survey data are linked to death records in the National Death Index (NDI) through probabilistic record-matching methods, which use 13 criteria to ascertain the vital status of each respondent.[1] At the time of data analysis, death records at quarter-year intervals from the NHIS 1992–2009 surveys were available through the end of 2011.

We pooled the NHIS respondents from 1992 to 2009 and restricted the sample to individuals who were 26–85 years old at the time of survey.[2] Setting the lower bound of age at 26 ensures most respondents finish education. Within this sample, 92% had eligible mortality records (n=922,193).[3] Having a wider age range than various previous studies (e.g., Angel, et al., 2010; Gubernskaya, 2015), we are able to observe immigrants before they reach an older age, when a larger proportion of them may return to their country of origin for health reasons. Of course, examining mortality risk for a general adult population has the potential downside of capturing more deaths from causes independent of health (e.g., accidents), as such causes are relatively common among young people. However, we conducted an additional analysis limiting the data to respondents or person-years over age 50 and found similar results. We therefore think that the benefits of using a sample of general adult population outweigh the drawbacks.

Our analysis compares four foreign-born populations—non-Hispanic Whites, non-Hispanic Blacks, non-Hispanic Asians, and Hispanics—with their native-born co-ethnics. Non-

[1]The National Center for Health Statistics links the NHIS survey records to the NDI records using the following identifying information in both records: social security number, first name, middle initial, last name, father's surname, month of birth, day of birth, year of birth, state of birth, state of residence, sex, race, and marital status. The NHIS participants are ineligible for the linkage if the submission records did not meet the minimum data requirements. Therefore, it is possible that some NHIS participants may have died and filed death certificates, but the death records were not linked due to the missing information in the NHIS records. Throughout the paper we refer to those without linked death records for any reason, including the scenario just described, as those "without eligible mortality records." The issue of missing record matches may be potentially more serious for the foreign-born compared with the native-born due to return migration and undocumented migrants' missing social security numbers. The robustness check presented later nevertheless helps address this issue. We discuss how the check helps in the conclusions and footnote 10.
[2]The NHIS top coded age at survey at age 85 from 1997 forward. To be consistent, we top coded age at age 85 for waves 1992–1996.
[3]83,863 respondents are without eligible mortality records (i.e., without eligible NDI linkage).

Hispanic Asians include Chinese, Filipinos, and Asian Indians. We excluded other Asian ethnic groups because such groups were either very small or disproportionately foreign- or native-born in the NHIS data. Hispanics include those originated from Mexico and other Latin American countries. After dropping individuals in other racial groups (3.7% of the sample with eligible mortality records; n=34,145), and those with missing data on covariates (1.0%; n=9,419), the analytic sample consists of 748,106 native-born individuals, among whom 590,833, 105,525, 2,863, and 48,885 are Whites, Blacks, Asians, and Hispanics, respectively; and 130,523 foreign-born individuals, among whom 28,467, 9,803, 15,196, and 77,057 are Whites, Blacks, Asians, and Hispanics, respectively. Although only 1% of the eligible sample has missing values on the covariates, we conducted a separate analysis that incorporated those with invalid values (by adding an “unknown” category to the covariates). The results were virtually unchanged.

To compare immigrants’ mortality risk to native-born people’s over elapsed time, we reshaped the data set to a person-year format, which starts from the year of interview and ends in the year of respondents’ death or year 2011, whichever is earlier. The NHIS supplies information for the time of birth, interview, and death by quarter year, allowing us to compute the time exposed to mortality risk (i.e., elapsed time) since each respondent was interviewed. We measured the duration of exposure by year, instead of quarter year, to avoid generating an unnecessarily large dataset that is computationally difficult to handle. For the respondents who died during the observed period, the duration of exposure is a time-varying measure of the number of years from their interview time to each subsequent calendar year until their death. For the surviving respondents, we calculated their time-varying durations through 2011, the last time point with mortality status in our data. After the transformation to the person-year format, our analytic sample contains 9,870,755 observations in total.

Measurements

The outcome of interest is mortality status. By December 31, 2011, 125,531 of the NHIS respondents died, among whom 115,345 were natives (15.4% of natives) and 10,186 were immigrants (7.8% of immigrants). Because the NHIS data are linked to mortality records, we can determine the exact elapsed time since the survey year during which a death occurred. We coded the mortality status as 1 if a respondent died in that year and otherwise as 0.

For the main predictor, nativity status, we measured it in three different ways. The first and simplest is a binary indicator that distinguishes native-born from foreign-born individuals based on self-reports. For the second measure, we similarly included a category for natives but further divided foreign-born respondents into four groups according to their YSI, an indicator often used in prior research to infer the process of unhealthy assimilation. The NHIS asked the foreign born to select whether they had been in the United States for (1) 0–4, (2) 5–9, (3) 10–15, or (4) over 15 years. Because the survey did not distinguish among those who have immigrated more than 15 years ago, we could not create a time-varying measure to indicate the precise amount of time an immigrant respondent had been in the United States. Therefore, instead of the exact length of stay in the country, our analysis focuses on how respondents’ mortality hazards change along the time elapsed since the survey. At the same time, we compare the time-based shifts among different YSI groups to gauge the extent to which the group differences indeed reflect the process of unhealthy assimilation. In our sample, there are 14,263 individuals in the 0–4 YSI group, 18,870 in the 5–9 YSI group, 19,236 in the 10–14 YSI group, 75,725 in the 15+ YSI group, and 2,429 with undetermined YSI (1.9% of immigrants). We kept the immigrants with undetermined YSI in the analysis to maximize the sample size but excluded them from the models specifically addressing differences between YSI groups.

Because immigrants of different ethnoracial identities may vary in their selectivity and legal-status composition, which have implications for their health and mortality, we also investigate whether changes in immigrants' survival advantage are contingent on their race or ethnicity. For this purpose, we constructed a third variable to differentiate the immigrants by race/ethnicity. The resulting measure had five categories: natives, non-Hispanic White immigrants, non-Hispanic Black immigrants, non-Hispanic Asian immigrants, and Hispanic immigrants. In some of the models, we also divided the native-born into the same 4 ethnoracial groups to compare immigrants with their co-ethnics.

To account for differences in characteristics between native-born and foreign-born respondents, we introduced gender, age at the survey, education, poverty status, and marital status in the models.[4] The NHIS recorded gender as binary (women vs. men), so we measured it accordingly. Age at the survey was centered at the grand mean. Education was measured in four categories: less than high school, high school degree, some college, and college degree or more. We used three categories to indicate poverty status: above the U.S. Census Bureau's poverty threshold, below the poverty threshold, and unknown poverty status.[5] Marital status consists of five categories: married, widowed, divorced, separated, and never married.

Analytic Strategy

We employed discrete-time survival analysis (logistic regression), treating elapsed time, ranging from 0 to 19 years, either as 20 duration-interval-specific dummy variables or a continuous variable. The overall findings are similar either way, although a continuous variable for elapsed time produces a smoother trend. For the sake of the length of tables, we present the findings from models using a continuous elapsed-time variable in the main text and those based on 20 elapsed-time dummy variables in Appendix. A logistic regression coefficient indicates the logarithm of the odds of a given group (e.g., immigrants) experiencing the outcome over the odds of the reference group (e.g., natives), thus representing the relative risk of the dependent variable associated with the covariate. This regression coefficient can be referred to as log odds coefficient or log odds ratio. The key variables of interest in the survival analysis are the interactions between the three nativity-

[4]Although immigrants' legal status can affect their access to health care (Hacker, et al. 2015), the NHIS did not ask about this status. The survey did ask about citizenship status from 1998 forward, but we cannot infer the legal status for non-citizens, who could be permanent residents, legal temporary migrants, or undocumented migrants. The differentiation of immigrants by race/ethnicity in our analysis is likely to capture some of the impact of legal status, as immigrants from different regions vary considerably in their documentation status. We discuss more about the implications of the inability to control for legal status in the conclusions.

[5]We did not include income in the models due to a considerable proportion of missing values (31%). The combination of education and poverty status, however, should approximate respondents' socioeconomic status fairly well.

status measures and elapsed time. With natives as the reference group, positive coefficients for the interactions indicate the immigrant survival advantage diminishes over elapsed time, while negative coefficients indicate an extended health advantage, on a *relative* scale.[6] All models were adjusted for age at the survey and the interaction between nativity status and age at the survey to account for possible confounding life-course mortality patterns and potential native-immigrant differences in such patterns. Other individual characteristics (e.g., gender, race, education, poverty status, and marital status) were added to take into consideration nativity differences in these compositions. Survey year dummies were also included to control for temporal trends in mortality.

In addition to presenting results in log odds coefficients, we also calculated predicted hazard probabilities over elapsed time from the survival analysis. In the calculation all the categorical variables were set to be the reference groups and continuous variables were at the grand means. In the case of predicted hazard probabilities, a widening gap (*difference*) in the probabilities between the immigrants and natives over elapsed time indicates an extended immigrant survival advantage based on an *absolute* scale, while a narrowing gap indicates a diminished immigrant health advantage.[7] The patterns based on log odds ratios, which indicate how immigrants' chances of dying relative to natives, and those based on *differences* in predicted hazards, which demonstrate the absolute gap in mortality risk by nativity, may not always be consistent. The choice of using the relative or absolute scale to interpret an interaction between covariates (nativity and elapsed time in this paper) has been debated and discussed in the epidemiological literature since the 1970s (Brown, 1986; Rothman, et al., 1986; Walter & Holford, 1978). Some social scientists have called for using the absolute, instead of relative, scale to test the temporal changes in the social inequalities of health (Mehta, et al., 2019). But given that the appropriate scale to examine immigrant health advantage is not clear-cut from the literature, we follow the guideline from prior studies to present findings on both scales (Harper & Lynch, 2005; Vandenbroucke, et al., 2007; VanderWeele & Knol, 2014).

RESULTS

Table 1 shows the nativity/race/ethnicity compositions of the sample and other basic descriptive statistics. Among immigrants, 2.9 % died in both the 0–4 and 5–9 YSI groups by the end of 2011, whereas 3.9% in the 10–14 YSI group and 10.9% in the 15+ YSI group died. Among the native-born, 15.4% died between the survey year and 2011. These numbers appear to suggest that immigrants have a survival advantage, and their survival advantage diminishes along the duration of residence. But the differences among YSI groups could also reflect the effects of age (the mean age of survey increases from 37.9 to 50.5 across these four YSI groups) and cohort of arrival. A better way to identify the duration of residence effect is comparing immigrants' mortality risk to the native-born population's over elapsed time.

[6]By design, logistic regression forces covariates to operate multiplicatively because additivity on a logarithmic scale implies multiplicativity on the untransformed scale (Mehta, et al., 2019). The coefficient of an interaction term between two covariates on a logarithmic scale implies whether the odds ratio for one covariate differs across levels of the other covariate on the untransformed scale.

[7]The difference (not ratio) in the hazard probability measures the absolute risk of the dependent variable associated with the covariate.

Immigrant Survival Advantage over Elapsed Time

Table 2 presents the log odds coefficients from the discrete-time survival analysis using alternative indicators of nativity status. Starting from Model 1, being foreign-born was associated with a 19% ((1-exp(−0.215))*100) reduction in the odds of death at time 0 (i.e., year of the survey). This survival advantage has amplified with each elapsed year, although both natives' and immigrants' odds of death have increased with time. Model 2 includes the interaction between being foreign-born and age at survey. The nonsignificant coefficient (0.001) suggests that foreign-born individuals' survival advantage has persisted over the life course. More importantly, adding this interaction barely alters the coefficient estimate of the interaction between being foreign-born and time. Thus, immigrants' increasing survival advantage over time cannot be explained by the health disparities by nativity at each age.

Because odds are not straightforward to interpret, we converted odds to hazard probabilities. Table 3 and Figure 1A display these probabilities over elapsed time by nativity status. Foreign-born people had a 0.04 percentage-point lower probability of death than native-born respondents' in the beginning of the observation period (year of survey) and a 0.47 percentage-point lower probability by year 19. Table 3 also shows the ratios of various immigrant groups' hazard probabilities to natives' at time 0 and time 19. These ratios are similar to the log odds ratios in Table 2 in that they indicate immigrant-native mortality disparities on a relative scale, although hazard probability ratios are more intuitively understandable. Foreign-born individuals' hazard probability was about 19% lower in the year of survey (time 0) and 34% lower 19 years later. Thus, regardless of whether we rely on differences (an absolute measure) or ratios (a relative measure) of hazard probabilities, foreign-born individuals' survival advantage has persisted and expanded throughout the 20 years of observation.

Model 3 of Table 2 compares various YSI groups with the native-born. All the YSI groups had lower odds of death than natives and their survival advantages have persisted or grown over elapsed time. Figure 1B illustrates the predicted hazard probabilities for the various groups over elapsed time. The figure similarly shows that the survival advantages of all four YSI groups, especially the 0–4 YSI and 5–9 YSI groups, over natives have increased over time. For example, the 0–4 YSI group's mortality hazard probability was 0.08 percentage points lower than that of the native-born in the year of survey. The former's probability became 0.74 percentage points lower after 19 years have elapsed (Table 3). The 15+ YSI group's hazard probability has also changed from 0.05 percentage points lower to 0.39 percentage points lower than natives' during the 20-year period. If we instead look at the ratio of hazard probabilities, the pattern is similar: The 15+ YSI group's hazard probability has changed from 79% to 72% of natives' during the 20 years of observation.

Although the mortality hazard probabilities for the 10–14 YSI and 15+ YSI groups are higher than those for the 0–4 YSI and 5–9 YSI groups, the differences do not necessarily indicate the existence of unhealthy assimilation. If the mortality gap between, say, the 10–14 YSI group and the 0–4 YSI group, indeed results from the former's unhealthy assimilation during their extra 10 years in the United States, the survival advantage of 0–4 YSI group compared to the native-born should have shrunk by the time they have been in the United States for 10 and more years. By the same token, the survival advantages of the 10–14 and

15+ YSI groups should have continued to shrink starting from year 0. Rather than unhealthy assimilation, the differing hazard probabilities among the YSI groups most likely reflect influences of factors other than duration of residence, such as the age and cohort of arrival. Because the differences in mortality hazards are not linearly correlated to the length of YSI, we suspect the cohort-of-arrival effect may contribute more to the YSI-related pattern. Those in the YSI groups that arrived at the U.S. in earlier periods might have had worse health than later comers upon arrival.

Racial and Gender Heterogeneities

Table 4 presents the racial and gender heterogeneities in the immigrant survival advantage over natives. According to Model 1, White immigrants had lower log odds of death compared to natives and other immigrants in the year of the survey, but their survival advantage compared to natives has narrowed over elapsed time even though it is not statistically significant. In contrast, Black, Asian, and Hispanic immigrants' survival advantages over natives have either remained or grown over time. Figure 2 displays the predicted hazard probabilities from Model 1. The figure shows that the gap in hazard probabilities between natives and immigrants, an absolute measure of immigrant survival advantage, has widened for all immigrant groups. For White immigrants, the difference between them and natives has increased from 0.11 percentage points to 0.55 percentage points during the 20 years, and the differences have grown more for other immigrant groups (Table 3). However, based on the ratio of hazard probabilities, a relative measure, White immigrants' advantage appears to have shrunk slightly, with the hazard probability increasing from 52% to 61% of the native-born's (Table 3). This is not the case for other immigrant groups, whose survival advantages have amplified even with ratios of hazard probabilities. It is important to note that over-time comparisons using a relative scale—based on log odds ratios or hazard probability ratios—could be less meaningful than those on an absolute scale. When the hazard probability at the baseline is substantially lower than subsequent years, the change over time can make a small difference on the absolute scale but be artificially large on the relative scale (Mehta, et al., 2019).

Model 2 and 3 of Table 4 present the results by gender, race/ethnicity, and nativity. Based on the log odds estimates, immigrants' survival advantage has expanded over time for all subgroups but White and Black women, for whom it has either significantly or non-significantly narrowed. But as we explained in the preceding paragraph, it is more important to examine the difference in hazard probability, an absolute measure. Figure 3 presents the corresponding graphs with hazard probabilities. The figure shows that in the absolute sense, the immigrant survival advantage over natives has amplified for all subgroups, especially Black and Asian men and Asian and Hispanic women. In comparison with other immigrants, the magnitude of increase in survival advantage is smallest for White male immigrants.

Table 5 compares the mortality advantages of immigrants to their native-born co-ethnics by gender. The overall findings are consistent with Table 4, although the significance level varies perhaps due to the small sample size of some native-born co-ethnics (e.g., Asians). The coefficients of the three-way interactions of nativity, time, and race/ethnicity in Model 1 suggest that the magnitude in which the immigrant survival advantage grows with time could be greater among Black and Asian men. Among women, White and Black immigrants' survival advantages over their native-born counterparts have hardly changed over elapsed time, but Asian and Hispanic immigrants' have strengthened, although the coefficient is nonsignificant for Asians. The predicted hazard probabilities calculated from models in Table 5, not presented here, reveal similar patterns.

Overall, our results indicate that on the absolute scale, the immigrant survival advantage over natives has increased over the observation period for all gender and racial groups, especially Black men, Asian men and women, and Hispanic women. Even on the relative scale, the advantage has persisted or magnified for most immigrant subgroups, especially compared to their native-born co-ethnics. In general, the over-time increase in the survival advantage is more pronounced for non-White than White immigrants, and this is more the case for men. Perhaps non-White immigrants, who tend to be from less developed countries, need to have overcome more obstacles to immigrate than White immigrants. The former may therefore be more selective based on health or health behaviors, leading to their greater survival advantages. This differential health selection might be more likely for men than women, as men more commonly immigrate for work, which requires relatively robust health.

Robustness Checks

To be certain about the persistence of immigrant survival advantage, we first checked the robustness of the findings by using different model specifications. Model 1 in Appendix Table A1 uses elapsed time as the time metric but measures it with a set of dummies. The overall results are very similar to Model 1 in Table 2. Model 2 uses attained age (time-varying years of age in each year since the survey) as the time metric, while including the interaction between attained age and foreign-born status to account for nativity disparities in life-course mortality patterns. Changes in immigrants' survival advantage over time are still indicated by the interactions between elapsed time and foreign-born status in this model. Since attained age is highly correlated with elapsed time, the main effect of elapsed time is omitted in Model 2. Findings from the model point to the same conclusion: immigrants' odds of death have become increasingly lower than those of the native born (from 19% lower to 40% lower) along the elapsed time.[8]

Second, we checked for the possibility of salmon bias, which may cause overestimation of immigrants' health advantage, because return migrants tend to be less healthy than those who remain in the United States. The NHIS does not include information on whether a migrant has returned to the country of origin. The dataset nevertheless informs us about the respondents without eligible death records (i.e., without eligible NDI linkage); 47,161 natives and 15,169 immigrants had no such records.[9] We included these immigrants in a sensitivity analysis with a bold assumption that they are all return migrants. Although this assumption may not be accurate, it sets up an upper bound for the estimate of the impact of salmon bias. We created hypothetical scenarios in which varying proportions of these

[8] 19% = 1 − exp(−0.902+0.692); 40% = 1 − exp(−0.902+0.391).

[9] The sum of the two numbers is smaller than 83,863, the number listed in footnote 3, as this sum excludes respondents with missing data on any covariates.

migrants died by 2011, the end of our mortality follow-up data. According to Table 1, 15.4% of natives and 7.8% of immigrants among those with eligible death records died by 2011. In the hypothetical scenarios, the immigrants without eligible mortality records were set to be equally likely (15%), twice more likely (30%), and over three times more likely (50%) than natives to have died by 2011. In other words, we assumed these immigrants to be 2–7 times more likely to die than the immigrants with eligible mortality records. As shown in Appendix Table A2, immigrants' health advantage would have persisted along the elapsed time in these extreme scenarios except when 50% of them are assumed to have died by 2011. Under such a scenario, the odds of death for immigrants compared to natives would have increased along elapsed time, implying a decline in the former's survival advantage. Nevertheless, the likelihood that a half of the immigrants with missing mortality records had returned to their home countries and died is very low. Based on this additional analysis, we think that the salmon bias is unlikely to fully account for the persistent immigrant survival advantage along the length of stay.

CONCLUSIONS

Much research has debated on whether immigrants' health advantage over natives declines with their duration in the destination. Most such research faces the challenge of distinguishing the influences of multiple time-related factors, including age, survey year, the time period of arrival, and the age of arrival, from the effect of duration of stay on immigrants' health, due to their use of (pooled) cross-sectional data. Existing longitudinal studies are similarly limited partly because of their reliance on self-reported health as the outcome variable. Because poor health generally adds mortality risk, and because mortality is an unambiguous measure that has long been used to assess immigrants' health advantage (e.g., Angel, et al., 2010; Choi, 2012), we shed light on the debate on the durability of this advantage by examining how immigrants' mortality risk compared to natives' change over real time. The analysis has shown that U.S. immigrants enjoy a survival advantage over the native-born. This advantage, when assessed on the absolute scale, is enduring and ever-growing for all immigrants, regardless of their race, gender, or number of years since arrival. Even on the relative scale, the survival advantage is persistent over time for nearly all immigrant subgroups. Thus, to the extent mortality is tied to health, this study provides unequivocal evidence that the health protection of immigrant status is stable and long-lasting, with no sign of waning after two decades.

Our results suggest that immigrants' initially greater health endowment and better health behaviors, along with increased economic assimilation and improved access to health care with time, ultimately offset any unhealthy assimilation and amplify their survival advantage over natives in the long run. Even after considering the higher likelihood that unhealthy immigrants will return to their countries of origin (the salmon bias), immigrants' survival advantage generally remains over time. Despite our robust findings, we are unable to examine the specific mechanisms behind immigrants' enduring and oftentimes increasing survival advantage, given that we have no time-varying information other than mortality. The fact that immigrants of various races and ethnicities, including White immigrants, who tend to be more assimilated upon arrival and rely less on immigrant community resources, universally experience persistent mortality protection leads us to suspect that conditions shared by *all* immigrants, such as the health-based selection, may be primarily responsible for their lasting survival advantage. Regardless of the mechanisms, this research suggests that as far as mortality risk is concerned, the argument of negative acculturation and its tolls on immigrant health might be exaggerated. Nevertheless, future studies should collect detailed longitudinal data on immigrants' experiences and behaviors over the duration of their stay to better understand how immigrants manage to maintain their survival advantage over time.

Findings from this study also help explain the inconsistent conclusions regarding long-term changes in immigrants' health advantages in the existing literature. As we have argued, the health discrepancies between different YSI groups in cross-sectional observations could in large part reflect the disparities between immigrant cohorts who arrive in the destination at different time points. Different arrival cohorts are likely to have differing health endowment and selection due to the time-varying conditions in both their origins and destinations. The cohorts could also vary in their compositions of the sending countries and geographic destinations within the United States. All these factors could cause immigrants' long-term health trajectories and mortality risk to differ by their cohort of arrival. We have shown in this study that the relationship between health and years of stay inferred by various YSI groups' mortality hazards does not need to be consistent with the pattern of change in mortality risk that respondents have experienced over time. Our finding that the magnitude of immigrants' survival advantage is not linearly associated with YSI also suggests that health and mortality differences among YSI groups likely reflect heterogeneity across arrival cohorts, as this heterogeneity could be shaped by factors not linearly correlated with time (e.g., law changes). Overall, our research highlights the need to be more cautious in interpreting findings regarding disparities among immigrant groups with different lengths of stay in the host country.

Although this study focuses on U.S. immigrants, its results may have implications for our understanding of migrant health elsewhere. Some longitudinal studies have found that immigrants' self-assessed health declines with their duration in Australia (e.g., Chiswick, et al., 2008) and declines more than the native-born population in Canada (Newbold, 2005; Setia, et al., 2012). These countries differ from the United States in population health (with the U.S. population being less healthy), immigrants' origins, health care systems, and labor market opportunities, making it difficult to draw a direct comparison between these studies and ours. Nonetheless, our findings suggest the importance to replicate the pattern of unhealthy assimilation found elsewhere using more unambiguous outcomes (e.g., mortality). Our research design that tracks shifts in immigrants' survival advantage over real time, instead of age or age of arrival, can also be useful for studies in other countries.

Despite this study's contribution to the knowledge of immigrants' long-term health trajectories, it has a few limitations. First, because the NHIS data lump together all those who migrated more than 15 years ago, and a large proportion of immigrants belong to this group, we are unable to more precisely distinguish immigrants based on their year or age of arrival. Consequently, we cannot say conclusively why the various YSI groups demonstrate different extents of relative survival advantage over the 20 years of observation; we only know that the duration of stay alone is unlikely to explain the group differences.

Second, although using the occurrence of death as the outcome variable helps avoid self-reporting bias, which can easily be affected by immigrants' acculturation and medical assess, mortality does not capture all aspects of health. It is possible that among the survivors, immigrants suffer more from chronic illnesses, disabilities, or other serious physical limitations, than their native-born counterparts. Given immigrants' greater language barriers and typically worse access to health care, however, their chances of surviving severe illnesses should be worse than natives'. If so, we would be more likely to find the native-born who have lived through the 20-year period to have more major health problems than their foreign-born counterparts.

Third, because our analysis relies on linked mortality data from administrative records, the results could be biased if immigrants' and natives' deaths are documented with different levels of accuracy. Indeed, we find that a larger proportion of immigrants have no eligible mortality records, compared to the native-born. Such a discrepancy may be due to some immigrants' return to their countries of origin, the difficulty of linking undocumented immigrants' records, or immigrants' less accurate filing of death certificates. In any case, our additional analysis has shown that even the foreign-born without linked death records had similar or considerably higher mortality hazards than native-born individuals', immigrants' long-term survival advantage over natives generally remains.

Fourth, our data lack information that would allow us to further investigate heterogeneity among immigrants. Specifically, we do not know each immigrant's legal status, making it impossible to tell whether the immigrant survival advantage varies by legal status. However, we have shown that immigrants from all ethnoracial groups, who likely vary in the proportion with undocumented status, have enjoyed a lasting survival advantage over the native-born, and the differences between immigrant groups are relatively small (Figure 2). Thus, although a change from undocumented to documented legal status after some years of U.S. residence could be one potential explanation for the widening survival gap between immigrants and natives, we do not think accounting for legal status would alter our overall results.[10]

Aside from contributing to the debate on the durability of immigrants' health advantage over time, our study adds to the general knowledge of mortality disparities across sociodemographic groups. Mortality research has long documented the pattern where Blacks, a group with high mortality, converge in survival rates with Whites, who on the whole have lower mortality, with increases in age (known as the Black-White mortality crossover) and attributed this pattern to mortality selection (e.g., Manton & Stallard, 1981; Johnson, 2000). That is, because members of higher-mortality groups die at faster rates, the survivors in such groups become increasingly selective with age, enabling them to close the mortality gap with the low-mortality group at the aggregate level.[11] In contrast

[10]The legal status could also matter if most undocumented immigrants were not matched in the mortality records. But as our robustness check shows, even if all those without linked mortality records were mostly undocumented and had an unusually high mortality rate due to their lack of access to health care, it would hardly affect our argument about immigrants' persistent survival advantage.

[11]Because the group-level pattern has to do with mortality selection, once we account for this selection, we can still find cumulative disadvantage with age for individuals from higher-mortality groups—i.e., a widening gap in mortality risk between them and otherwise-similar people from lower-mortality groups (Zheng, 2020).

to the pattern just described, we have found the native-born, a higher-mortality group, to increasingly fall behind immigrants, a lower-mortality rate group, in survival chances over time. It is possible that the widening gap is due to the greater heterogeneity of the foreign-born population compared to the native-born population; if the former's health distribution is more bimodal than the latter's, then the death of unhealthy individuals could boost the former's average survival rate more, even though the latter has a larger number of deaths. It is also possible that immigrants experience proportionally much greater increases in socioeconomic resources and access to health care than natives over time, and the greater health protection from these increases ultimately offsets the mortality selection effect in shaping the nativity gap in mortality over time. While it is beyond the scope of the paper to examine the exact mechanisms behind the widening mortality gap between immigrants and the native-born over time, our study demonstrates a different way in which mortality disparities between population subgroups evolves and calls for research on conditions that may counteract the influence of differential mortality selection.

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Appendix

Appendix

Appendix Table A1.

Coefficient estimates from various model specifications of survival analysis

	Model 1		Model 2	
	Logistic model (elapsed time as time metric)		Logistic model (attained age of time metric)	
Attained age			0.092 ***	(0.000)
Foreign-born	−0.112 *	(0.056)	−0.902 ***	(0.055)
Foreign-born * Attained age			−0.001	(0.001)
Elapsed time				
1	0.931 ***	(0.021)		
2	1.069 ***	(0.020)		
3	1.147 ***	(0.021)		
4	1.226 ***	(0.021)		
5	1.348 ***	(0.021)		
6	1.422 ***	(0.021)		
7	1.517 ***	(0.021)		
8	1.593 ***	(0.021)		
9	1.675 ***	(0.021)		
10	1.777 ***	(0.022)		
11	1.849 ***	(0.023)		

	Model 1		**Model 2**	
	Logistic model (elapsed time as time metric)		**Logistic model (attained age of time metric)**	
12	1.919 ***	(0.023)		
13	1.981 ***	(0.023)		
14	2.078 ***	(0.024)		
15	2.150 ***	(0.025)		
16	2.239 ***	(0.026)		
17	2.296 ***	(0.028)		
18	2.387 ***	(0.032)		
19	2.467 ***	(0.040)		
Foreign-born * Elapsed time				
1	−0.147 *	(0.068)	0.692 ***	(0.064)
2	−0.094	(0.066)	0.793 ***	(0.063)
3	−0.121	(0.067)	0.745 ***	(0.064)
4	−0.154 *	(0.067)	0.695 ***	(0.064)
5	−0.124	(0.067)	0.752 ***	(0.064)
6	−0.192 **	(0.068)	0.665 ***	(0.065)
7	−0.184 **	(0.069)	0.675 ***	(0.065)
8	−0.243 ***	(0.070)	0.601 ***	(0.067)
9	−0.233 ***	(0.071)	0.601 ***	(0.068)
10	−0.178 *	(0.071)	0.666 ***	(0.068)
11	−0.260 ***	(0.074)	0.567 ***	(0.071)
12	−0.252 ***	(0.076)	0.554 ***	(0.073)
13	−0.192 *	(0.078)	0.588 ***	(0.075)
14	−0.256 **	(0.083)	0.531 ***	(0.079)
15	−0.420 ***	(0.089)	0.349 ***	(0.085)
16	−0.198 *	(0.087)	0.570 ***	(0.083)
17	−0.162	(0.096)	0.574 ***	(0.092)
18	−0.268 *	(0.114)	0.470 ***	(0.109)
19	−0.337 *	(0.153)	0.391 **	(0.148)
Age at Survey	0.091 ***	(0.000)		
Foreign-born × Age at Survey	0.001	(0.001)		
Constant	−6.848 ***	(0.022)	−5.419 ***	(0.012)
N	9,870,755		9,870,755	
Likelihood Ratio Test	248153.04		244988.47	
Pseudo R2	0.185		0.182	

* p<0.05

** p<0.01

*** p<0.001.

Standard errors in parentheses

Notes: All models include race, gender, education, poverty status, marital status, and survey year dummies.

Appendix Table A2.

Coefficient estimates from discrete time survival analysis by different mortality scenarios among immigrants with ineligible death information.

	Scenario 1		Scenario 2		Scenario 3	
	(15% of immigrants with ineligible death information died)		(30% of immigrants with ineligible death information died)		(50% of immigrants with ineligible death information died)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Years Since Immigration (ref: native born)						
0–4 YSI	−0.429***	(0.094)	−0.444***	(0.092)	−0.443***	(0.089)
5–9 YSI	−0.314***	(0.082)	−0.327***	(0.080)	−0.373***	(0.078)
10–14 YSI	−0.151*	(0.070)	−0.166*	(0.068)	−0.244***	(0.067)
15+ YSI	−0.139***	(0.030)	−0.116***	(0.029)	−0.090**	(0.029)
Time	0.099***	(0.001)	0.099***	(0.001)	0.099***	(0.001)
0–4 YSI × Time	−0.007	(0.009)	0.007	(0.009)	0.023**	(0.008)
5–9 YSI × Time	−0.015	(0.008)	0.002	(0.008)	0.022**	(0.007)
10–14 YSI × Time	−0.003	(0.007)	0.010	(0.007)	0.033***	(0.006)
15+ YSI × Time	−0.007**	(0.002)	0.001	(0.002)	0.008***	(0.002)
Age at Survey	0.091***	(0.001)	0.091***	(0.001)	0.091***	(0.001)
0–4 YSI × Age at Survey	−0.020***	(0.003)	−0.024***	(0.003)	−0.030***	(0.003)
5–9 YSI × Age at Survey	−0.013***	(0.002)	−0.018***	(0.002)	−0.023***	(0.002)
10–14 YSI × Age at Survey	−0.016***	(0.002)	−0.019***	(0.002)	−0.025***	(0.002)
15+ YSI × Age at Survey	−0.003***	(0.001)	−0.006***	(0.001)	−0.009***	(0.001)
Constant	−6.133***	(0.014)	−6.127***	(0.014)	−6.118***	(0.014)
N	9,884,808		9,884,808		9,884,808	
Likelihood Ratio Test	244025.03		243390.71		242698.08	
Pseudo R2	0.181		0.180		0.179	

* p<0.05

** p<0.01

*** p<0.001.

Standard errors in parentheses

Notes: All models include race, gender, education, poverty status, marital status, and survey year dummies.

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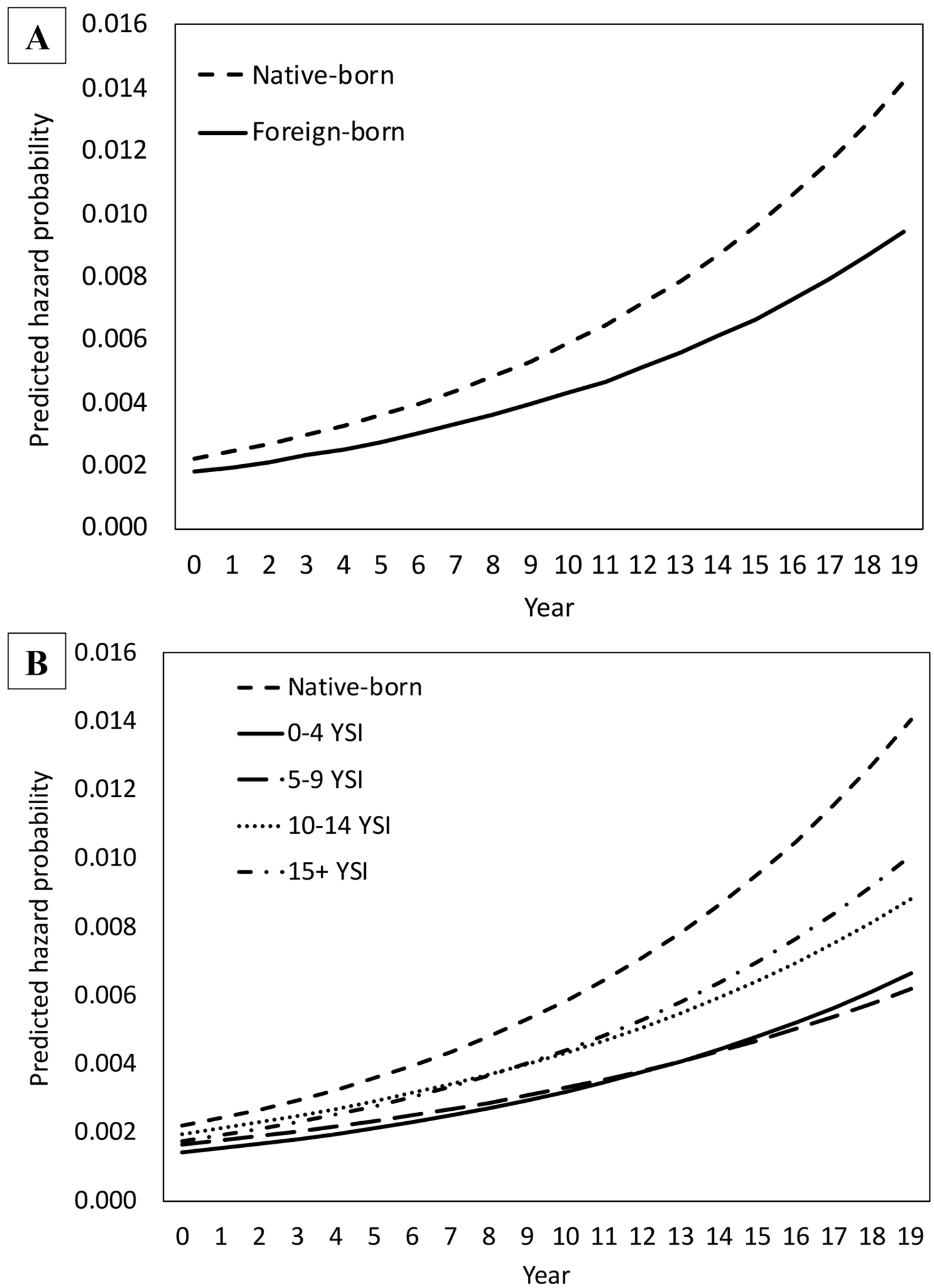

Figure 1.
Predicted hazard probabilities over elapsed time since the survey by nativity and YSI

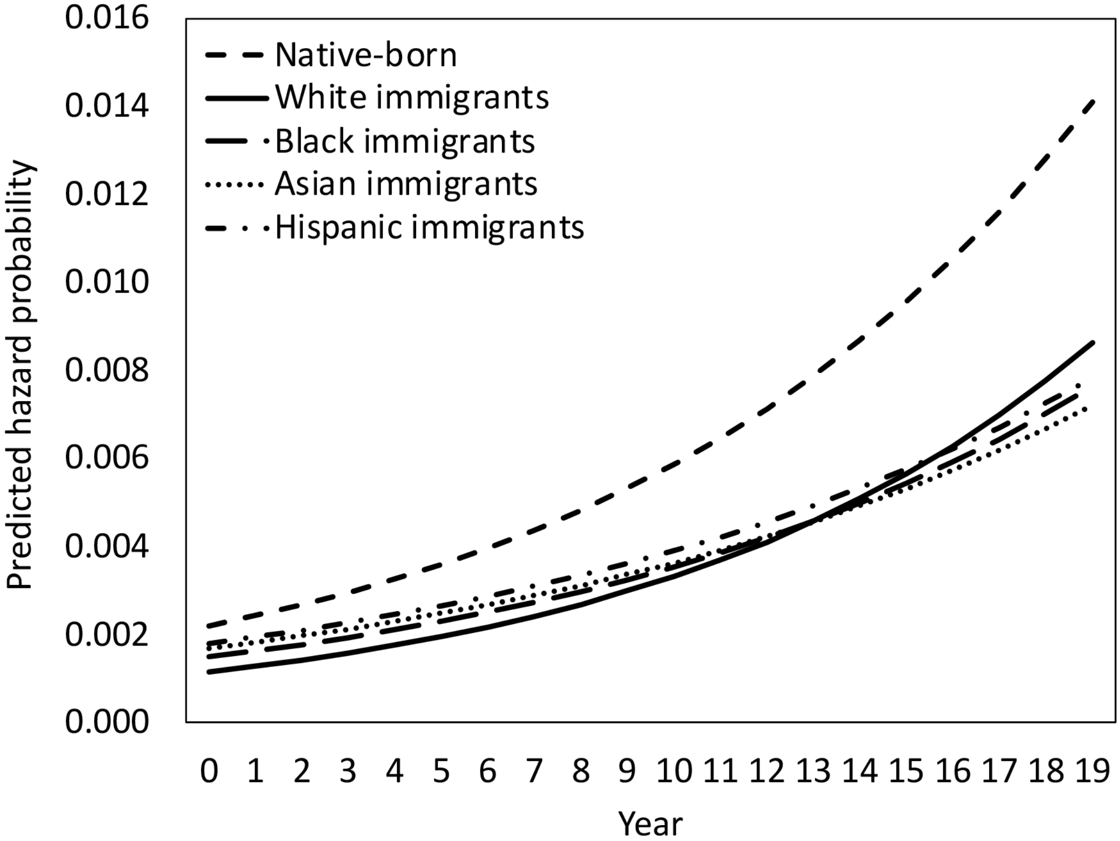

Figure 2.
Predicted hazard probabilities over elapsed time by nativity and race/ethnicity

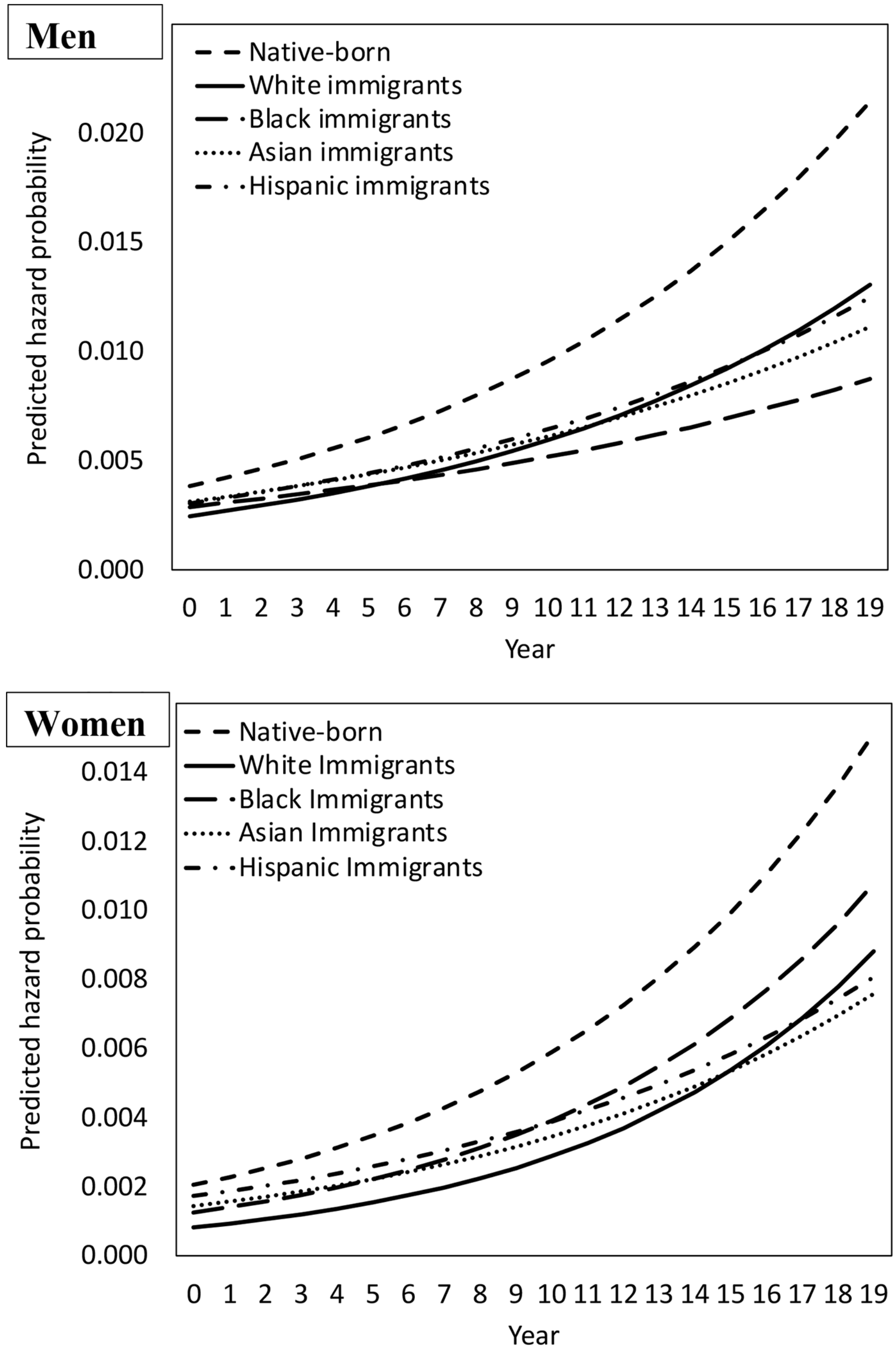

Figure 3.
Predicted hazard probabilities over elapsed time of various immigrant racial groups and the native-born population by gender

Table 1.

Descriptive statistics.

	Native-born	Foreign-born	0–4 YSI	5–9 YSI	10–14 YSI	15+ YSI
N. of sample	748,106	130,523	14,263	18,870	19,236	75,725
N. of death	115,345	10,186	416	543	754	8,277
% of death	15.4%	7.8%	2.9%	2.9%	3.9%	10.9%
Men	47.0%	47.6%	47.3%	47.2%	48.5%	47.4%
Non-Hispanic White	79.0%	21.8%	19.3%	14.6%	12.6%	26.6%
Non-Hispanic Black	14.1%	7.5%	7.1%	8.3%	8.2%	7.2%
Non-Hispanic Asian	0.4%	11.6%	16.9%	14.2%	13.5%	9.6%
Hispanic	6.5%	59.0%	56.7%	62.9%	65.7%	56.6%
Age at survey	49.6	45.6	37.9	38.1	39.5	50.5
Education						
Less than high school	15.0%	37.9%	36.3%	40.2%	42.6%	36.4%
High school degree	35.2%	24.3%	21.2%	23.3%	23.9%	25.1%
Any college	25.7%	16.5%	12.3%	14.2%	14.3%	18.6%
College degree or more	24.1%	21.2%	30.1%	22.3%	19.3%	19.9%
Poverty						
Above poverty threshold	76.2%	65.5%	55.1%	61.8%	64.3%	69.5%
Below poverty threshold	7.4%	15.6%	23.8%	20.5%	18.4%	12.2%
Unknown poverty status	16.4%	19.0%	21.1%	17.7%	17.3%	18.3%
Marital status						
Married	65.9%	71.5%	72.6%	73.2%	74.3%	70.1%
Widowed	8.2%	5.7%	2.8%	2.5%	2.8%	7.8%
Divorced	11.3%	7.0%	3.7%	4.5%	5.2%	8.7%
Separated	2.5%	3.8%	3.3%	4.1%	4.6%	3.7%
Never married	12.3%	12.0%	17.7%	15.7%	13.0%	9.7%

Table 2.

Coefficient estimates from discrete time survival analysis on immigrant survival advantage.

	Model 1		Model 2		Model 3	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Nativity						
Foreign-born	−0.215***	(0.020)	−0.215***	(0.027)		
Time	0.098***	(0.001)	0.098***	(0.001)	0.098***	(0.001)
Foreign-born × Time	−0.011***	(0.002)	−0.011***	(0.002)		
Years Since Immigration (ref: native born)						
0–4 YSI					−0.440***	(0.097)
5–9 YSI					−0.291***	(0.084)
10–14 YSI					−0.115	(0.072)
15+ YSI					−0.231***	(0.032)
0–4 YSI × Time					−0.017	(0.010)
5–9 YSI × Time					−0.028**	(0.009)
10–14 YSI × Time					−0.019*	(0.007)
15+ YSI × Time					−0.005*	(0.002)
Age at Survey	0.091***	(0.001)	0.091***	(0.001)	0.091***	(0.001)
Foreign-born × Age at Survey			0.001	(0.001)		
0–4 YSI × Age at Survey					−0.014***	(0.003)
5–9 YSI × Age at Survey					−0.009***	(0.003)
10–14 YSI × Age at Survey					−0.011***	(0.002)
15+ YSI × Age at Survey					0.001	(0.001)
Constant	−6.121***	(0.014)	−6.121***	(0.014)	−6.122***	(0.014)
N	9,870,755		9,870,755		9,844,455	
Likelihood Ratio Test	244842.99		244842.99		244626.53	
Pseudo R2	0.182		0.182		0.182	

* $p<0.05$

** $p<0.01$

*** $p<0.001$.

Standard errors in parentheses

Notes: All models include race, gender, education, poverty status, marital status, and survey year dummies.

Table 3.

Predicted hazard probabilities

	Table 2, Model 2		Table 2, Model 3				Table 4, Model 1			
	Figure 1A		Figure 1B				Figure 2			
Elapsed time	**Native-born**	**Foreign-born**	**0–4 YSI**	**5–9 YSI**	**10–14 YSI**	**15+ YSI**	**White**	**Black**	**Asian**	**Hispanic**
0	0.0022	0.0018	0.0014	0.0016	0.0020	0.0017	0.0011	0.0015	0.0017	0.0018
1	0.0024	0.0019	0.0015	0.0018	0.0021	0.0019	0.0013	0.0016	0.0018	0.0019
2	0.0027	0.0021	0.0017	0.0019	0.0023	0.0021	0.0014	0.0018	0.0020	0.0021
3	0.0029	0.0023	0.0018	0.0020	0.0025	0.0023	0.0016	0.0019	0.0021	0.0023
4	0.0032	0.0025	0.0020	0.0022	0.0027	0.0025	0.0018	0.0021	0.0023	0.0024
5	0.0036	0.0027	0.0021	0.0023	0.0029	0.0028	0.0020	0.0023	0.0025	0.0026
6	0.0039	0.0030	0.0023	0.0025	0.0031	0.0030	0.0022	0.0025	0.0027	0.0029
7	0.0044	0.0033	0.0025	0.0027	0.0034	0.0033	0.0024	0.0027	0.0029	0.0031
8	0.0048	0.0036	0.0027	0.0029	0.0037	0.0036	0.0027	0.0030	0.0031	0.0033
9	0.0053	0.0039	0.0029	0.0031	0.0040	0.0040	0.0030	0.0032	0.0034	0.0036
10	0.0058	0.0042	0.0032	0.0033	0.0043	0.0044	0.0033	0.0035	0.0036	0.0039
11	0.0064	0.0046	0.0035	0.0035	0.0047	0.0048	0.0037	0.0038	0.0039	0.0042
12	0.0071	0.0051	0.0038	0.0038	0.0051	0.0053	0.0041	0.0042	0.0042	0.0046
13	0.0078	0.0055	0.0041	0.0041	0.0055	0.0058	0.0046	0.0046	0.0046	0.0049
14	0.0086	0.0060	0.0044	0.0044	0.0059	0.0064	0.0051	0.0050	0.0049	0.0053
15	0.0095	0.0066	0.0048	0.0047	0.0064	0.0070	0.0056	0.0054	0.0053	0.0057
16	0.0105	0.0072	0.0052	0.0050	0.0070	0.0076	0.0063	0.0059	0.0057	0.0062
17	0.0116	0.0078	0.0056	0.0054	0.0075	0.0084	0.0070	0.0064	0.0062	0.0067
18	0.0127	0.0085	0.0061	0.0058	0.0081	0.0092	0.0078	0.0070	0.0067	0.0072
19	0.0140	0.0093	0.0066	0.0062	0.0088	0.0101	0.0086	0.0076	0.0072	0.0078
Gap at time 0 between immigrants and natives										
Difference		−0.0004	−0.0008	−0.0006	−0.0002	−0.0005	−0.0011	−0.0007	−0.0005	−0.0004
Ratio		81%	64%	75%	89%	79%	52%	68%	77%	82%

Gap at time 19 between immigrants and natives

	Table 2, Model 2		Table 2, Model 3				Table 4, Model 1			
	Figure 1A		Figure 1B				Figure 2			
Elapsed time	**Native-born**	**Foreign-born**	**0–4 YSI**	**5–9 YSI**	**10–14 YSI**	**15+ YSI**	**White**	**Black**	**Asian**	**Hispanic**
Difference		−0.0047	−0.0074	−0.0079	−0.0052	−0.0039	−0.0055	−0.0065	−0.0069	−0.0063
Ratio		66%	47%	44%	63%	72%	61%	54%	51%	56%

Table 4.

Coefficient estimates from discrete time survival analysis on immigrant survival advantage by race and gender compared to native-born population.

	Model 1 (all)		Model 2 (men)		Model 3 (women)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Immigrant racial group (ref: native born)						
White	−0.653***	(0.052)	−0.448***	(0.067)	−0.901***	(0.081)
Black	−0.389***	(0.095)	−0.288*	(0.129)	−0.484***	(0.141)
Asian	−0.266***	(0.080)	−0.209*	(0.104)	−0.359**	(0.125)
Hispanic	−0.204***	(0.032)	−0.231***	(0.043)	−0.173***	(0.049)
Time	0.098***	(0.001)	0.091***	(0.001)	0.106***	(0.001)
White × Time	0.008	(0.004)	−0.003	(0.005)	0.019**	(0.005)
Black × Time	−0.012	(0.009)	−0.033*	(0.013)	0.007	(0.012)
Asian × Time	−0.022**	(0.007)	−0.024*	(0.010)	−0.018	(0.011)
Hispanic × Time	−0.021***	(0.003)	−0.017***	(0.005)	−0.024***	(0.005)
Age at Survey	0.091***	(0.000)	0.091***	(0.000)	0.091***	(0.000)
White × Age at Survey	0.014***	(0.001)	0.009***	(0.002)	0.020***	(0.002)
Black × Age at Survey	−0.003	(0.003)	0.000	(0.004)	−0.007	(0.004)
Asian × Age at Survey	−0.011***	(0.003)	−0.012***	(0.003)	−0.009*	(0.004)
Hispanic × Age at Survey	−0.006***	(0.001)	−0.007***	(0.001)	−0.006***	(0.001)
Constant	−6.117***	(0.014)	−5.552***	(0.019)	−6.188***	(0.020)
N	9,870,755		4,615,448		5,255,307	
Likelihood Ratio Test	244729.41		115150.24		129219.60	
Pseudo R2	0.182		0.172		0.191	

* p<0.05

** p<0.01

*** p<0.001.

Standard errors in parentheses

Notes: All models include education, poverty status, marital status, and survey year dummies.

Table 5.

Coefficient estimates from discrete time survival analysis on immigrant survival advantage by race and gender compared to native-born co-ethnics.

	Model 1 (men)		**Model 2 (women)**	
	Coefficient	**SE**	**Coefficient**	**SE**
Nativity				
Foreign-born	−0.134**	(0.050)	−0.289***	(0.053)
Race (ref: White)				
Black	0.192***	(0.022)	0.229***	(0.021)
Asian	−0.523**	(0.203)	−0.328	(0.205)
Hispanic	−0.088*	(0.038)	−0.177***	(0.042)
Foreign-born × Black	−0.273*	(0.115)	−0.564***	(0.125)
Foreign-born × Asian	0.287	(0.224)	0.065	(0.231)
Foreign-born × Hispanic	−0.063	(0.067)	0.167**	(0.069)
Time	0.093***	(0.001)	0.109***	(0.001)
Foreign-born × Time	−0.013**	(0.005)	0.001	(0.005)
Black × Time	−0.008***	(0.003)	−0.017***	(0.002)
Asian × Time	0.005	(0.023)	0.010	(0.023)
Hispanic × Time	−0.007	(0.004)	−0.003	(0.005)
Foreign-born × Time × Black	−0.015	(0.014)	0.024	(0.013)
Foreign-born × Time × Asian	−0.013	(0.026)	−0.027	(0.026)
Foreign-born × Time × Hispanic	0.005	(0.008)	−0.021**	(0.008)
Age at Survey	0.091***	(0.000)	0.091***	(0.000)
Foreign-born × Age at Survey	−0.002*	(0.001)	0.002	(0.001)
Constant	−5.575***	(0.019)	−6.213***	(0.020)
N	4,615,448		5,255,307	
Likelihood Ratio Test	115293.09		129328.99	
Pseudo R2	0.173		0.191	

* $p<0.05$

** $p<0.01$

*** $p<0.001$.

Standard errors in parentheses

Notes: All models include education, poverty status, marital status, and survey year dummies.