

# **Methodology, Assumptions, and Inputs for the 2017 National Population Projections**

**September 2018**

## **Erratum Note:**

The 2017 National Population Projections were revised after their original release date to correct an error in infant mortality rates. The files were removed from the website on August 1, 2018 and an erratum note posted. The error incorrectly calculated infant mortality rates, which erroneously caused an increase in the number of deaths projected in the total population. Correcting the error in infant mortality results in a decrease in the number of deaths and a slight increase in the total projected population in the revised series. The error did not affect the other two components of population change in the projections series (fertility and migration). Major demographic trends, such as an aging population and an increase in racial and ethnic diversity, remain unchanged.

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## Introduction

The U.S. Census Bureau produces projections of the resident population using a cohort-component method and assumptions about demographic components of change (future trends in births, deaths, and net international migration). Projections are updated periodically to incorporate revised assumptions about anticipated trends and updated data for these components. This can result in differences between series in the projected population, both in terms of number and in distribution across characteristics. This document describes the methodology, assumptions, and inputs used to produce the 2017 National Population Projections.

## Methods

The projections were produced using a cohort-component method beginning with an estimated base population for July 1, 2016.<sup>1</sup> In this method, the components of population change are projected separately for each birth cohort (persons born in a given year) based on past trends. For each year, 2017 to 2060, the population is advanced one year of age using the projected age-specific survival rates and levels of net international migration for that year. A new birth cohort is added to the population by applying the projected age-specific fertility rates to the female population. Births, adjusted for infant mortality and net international migration, form the new population under one year of age. In its simplest form, the cohort component method is expressed as:

### Equation 1.

$$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + M_{t-1,t}$$

Where:

$P_t$  = population at time t;

$P_{t-1}$  = population at time t-1;

$B_{t-1,t}$  = births in the interval from time t-1 to time t;

$D_{t-1,t}$  = deaths in the interval from time t-1 to time t; and

$M_{t-1,t}$  = net migration in the interval from time t-1 to time t

Projections produced through the cohort component method are driven by assumptions regarding each of the components of change. In order to project a population forward in this manner, separate projections of fertility, mortality, and net international migration are required to serve as inputs into the cohort component model, as is an original base population to project forward. The assumptions and methodologies used to create each input for the 2017 National Population Projections are described in detail in the sections that follow.

## Base Population

The 2017 National Population Projections are of the resident population by age, sex, race, Hispanic origin, and nativity. The base population for the 2017 National Population Projections derives from the Census Bureau's Vintage 2016 Estimates of the resident population on July 1, 2016. These

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<sup>1</sup> The base population derives from the Census Bureau's Vintage 2016 Population Estimates, which are based on the 2010 Census (U.S. Census Bureau, 2016).

estimates are by age (0 to 99, 100+), sex, race (31 groups), and Hispanic origin, but do not include any detail on nativity. Producing population projections by nativity requires a base population that is distributed across this characteristic. The 2016 American Community Survey (ACS) was used to add nativity by calculating the proportion native for each age, sex, race, and Hispanic origin group and applying those proportions to the Vintage 2016 estimates. Rounded values were used to create the native population, which was then subtracted from the Vintage 2016 estimate to create the foreign-born population.

Additionally, rates of emigration for the foreign-born in this series are assumed to vary depending on the length of time that has passed since arrival in the United States. For this reason, the foreign-born in the base population must also be divided by year-of-entry cohort. This is added to the foreign-born population using data from the 2016 single-year ACS. A year-of-entry distribution by age, sex, race, and Hispanic origin ranging from 0 to 10+ years since arrival in the U.S. was calculated and applied to the foreign-born base population. The results were then rounded within each age, sex, race, and Hispanic origin cohort so that the previous totals were maintained.

### **Fertility and Mortality Denominators**

The denominators used to calculate the fertility and mortality rates were derived from the intercensal estimates for the years 1990 to 2009, and the Vintage 2016 population estimates for 2010 to 2015. To create a consistent time series of estimates by the required characteristics, we had to adjust for changes in the way that race has been measured in vital records and in the population data from 1989 to the present. Intercensal estimates were available only by four races prior to 2000 (White, Black, Asian or Pacific Islander (API), and American Indian or Alaska Native (AIAN)). For the period from 2000 to 2015, estimates were produced for a total of 31 race groups consistent with the revised OMB standards for data on race and ethnicity (Office of Management and Budget, 1997). Similarly, records of birth and death registrations contain race reported in the four groups for all years of the time series, 1989 through 2015, and in the 31 race groups for select states and years starting in the early 2000s. To maintain continuity of the population estimates across the time series, and consistency between the population estimates and vital records, bridged race population estimates were used for 2000 to 2015.<sup>2</sup>

The Census Bureau's population estimates do not distribute the population on the basis of nativity. To calculate population estimates by nativity, we applied proportions of native and foreign-born populations within age, race, and Hispanic origin groups from the 1990 and 2000 Decennial Censuses and the 2001 to 2015 single-year ACS files to the estimates for those years.<sup>3</sup> Annual estimates of the resident population by nativity were not available for the period from 1991 to 1999. To create population estimates by nativity for these years, the proportion of the native population was linearly interpolated between the 1990 and 2000 censuses. Computed proportions were then applied to the population estimates to fill in the missing values.

After these adjustments, we have final denominators which consist of population estimates by age, sex, race, Hispanic origin, and nativity from 1990 to 2015.

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<sup>2</sup> Bridged race estimates are those where multiple-race responses are converted back to the single-race categories consistent with the 1977 Office of Management and Budget standards for data on race and ethnicity.

<sup>3</sup> The universe represented by the ACS varies across years. For instance, in the years 2000 to 2004, data are available only for areas with populations greater than 250,000, whereas in the years 2005 and beyond, data are available for populations in excess of 65,000. For detailed descriptions of the ACS data, see <http://www.census.gov/acs/www/>.

## Fertility

### Data

Age-specific fertility rates were estimated and projected for women aged 14 to 54 in six nativity, race, and Hispanic origin groups. These rates are based on birth registration data compiled by the National Center for Health Statistics (NCHS) in conjunction with data from the Census Bureau's Intercensal Estimates, Decennial Censuses, and the ACS.

Birth registration data from NCHS for the years 1990 to 2014 were used as the numerators in our fertility rates. These data contain demographic information about the mother, including her race, age at the time of delivery, Hispanic origin, and country of birth.

For 2015 and 2016, final birth data from NCHS were not available at the time of production, however, a preliminary total number of births for 2015 was available. To incorporate the most recent trends in fertility in the time series for the 2017 National Population Projections, proportions of births by maternal age, race, Hispanic origin, and nativity from 2014 were applied to the total number of births given for 2015. Births for 2016 were estimated from the projection of the fertility measures, which is discussed in further detail below.

The denominators discussed in the previous section are used to calculate both fertility and mortality measures. To calculate fertility rates, however, we only use the population estimates of women aged 14 to 54.

### Fertility Rates

Age-specific fertility rates were calculated and projected based on six nativity, race, and Hispanic origin groups. To account for the nativity of the mother, a dichotomous variable was used to differentiate native mothers, those born in the United States or in U.S territories, from those born elsewhere. Births to non-residents were excluded from the series.<sup>4</sup>

Groups displaying similar fertility rates and trends throughout the time series were aggregated. For the purposes of these projections, rates were produced for three foreign-born groups and three native groups.

Foreign-Born	Native
Hispanic	Asian or Pacific Islander
Non-Hispanic Asian or Pacific Islander	White
Non-Hispanic other races	Other races (includes Black and AIAN)

*Note: Native groups include both Hispanic and non-Hispanic mothers.*

**Age-specific fertility rates** are calculated by dividing the number of births to mothers in a specific age group over a certain time period by the total number of women in that age group at the same time period (equation 2).

### Equation 2.

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<sup>4</sup> Non-residents are defined as persons whose reported state of residence is *not* one of the 50 states or the District of Columbia.

$$ASFR_{x,t} = \frac{Births_{x,t}}{FP_{x,t}}$$

Where:

$ASFR_{x,t}$  = age-specific fertility rate at age x and time t;

$Births_{x,t}$  = number of births to mothers age x at time t (provided by NCHS); and

$FP_{x,t}$  = the female population age x at time t (provided by Census Bureau population estimates).<sup>5</sup>

### Fertility Projections

For the 2017 National Population Projections, age-specific fertility rates were projected to 2060 by assuming linear convergence in the year 2100 of the age-specific fertility rates of all six nativity, race, and Hispanic origin groups. The 2100 convergence point is the average age-specific fertility rates of the native White population for the years 2004 to 2015<sup>6</sup>. After calculating the average age-specific fertility rates of the native White population for the years 2004 to 2015, we interpolate age-specific fertility rates from 2015 to 2100 by age, race, Hispanic origin, and nativity. The projected age-specific fertility rates are then multiplied by the population of women at each age, race, Hispanic origin, and nativity group to calculate the projected number of births from 2016 to 2060 (equation 3).

### Equation 3.

$$B_t = ASFR_{x,t} \times FP_{x,t}$$

Where:

$B_t$  = births at time t;

$ASFR_{x,t}$  = age-specific fertility rate age x and time t; and

$FP_{x,t}$  = the female population age x and time t.

Figure 1 shows the age-specific fertility rates for each of the six nativity, race, and Hispanic origin groups in 2017. In that year, foreign-born Hispanics had higher fertility rates in the young adult ages compared with the other groups, while foreign-born other race women who were non-Hispanic had the highest rates in the older ages. Asian or Pacific Islander women had the lowest age-specific fertility rates in ages less than 20 in 2017.

Figure 2 shows the projected age-specific fertility rates for 2060. As expected, there is less variation in the age distribution of the fertility rates across the groups in 2060. In the younger ages, rates for foreign-born Hispanics remain slightly higher, and rates for Asian or Pacific Islander women

<sup>5</sup> More detail on both the numerators and denominators can be found throughout pages 3-4.

<sup>6</sup> Both Hispanic and non-Hispanic White are included in this.

slightly lower than the other groups. However, for ages 35 and older, rates are relatively similar across all of the groups.

### Assigning Race, Hispanic Origin, Sex, and Nativity to Projected Births

The number of births each year is determined by applying projected fertility rates to each year's projected female population. Race and Hispanic origin were assigned to projected births based on the race of the mother, the racial composition of men in the projected population, and the racial and ethnic distribution of women and men with children under 18 years old in the household from the 2010 census.

Distributions of race reported by parents of children under 18 in the census data were used to assign race and Hispanic origin to each birth. This method and the underlying data have been described in previous work in population estimates and projections (e.g., Guarneri and Dick 2012, Hollmann and Kingkade 2005, Smith and Jones 2003, U.S. Census Bureau 2010). The current application of this method is referred to as the "Kid Link Method."

The Kid Link Method uses information on the relationship to the householder to define children as biological sons and daughters of the householder, and parents as persons who are the householder, spouse of the householder, or unmarried partner of the householder. Distributions of race and Hispanic origin for children under 18 are derived from a series of cross-tabulations of the reported race of the child for every race and Hispanic origin combination of parents. The result is a series of child race and Hispanic origin proportions for every combination of parents' race and Hispanic origin. These are referred to as Kid Link Proportions. Race and Hispanic origin are assigned to births by multiplying the births by the respective child race proportions for that parental race-origin combination.

Records in the census where there is only one parent in the household are included in the kid link proportions, while records with same-sex parents are not. In the case of a single parent household, the parent is assumed to be a biological parent. Since the intent is to provide a comparable measure to the parents' records on the birth certificate that can be used to examine the relationship between biological parents' race and Hispanic origin with the race and Hispanic origin reported for children, the same assumption cannot be true for both partners in a same-sex household.

For the projections, the method for allocating births by race and Hispanic origin must be modified somewhat because births are projected by the race and Hispanic origin of the mother, but do not include information on the race and Hispanic origin of the father. To address this limitation, a pool of potential fathers was created from the projected male population based on the race and Hispanic origin composition of fathers relative to that of the entire male population in the 2010 census.

The potential fathers were linked to mothers by age – each age of mother category has a specified age range for potential fathers based on 2010 census data. The age range was generated by calculating the mean age of fathers for mothers from the census data, then adding and subtracting one standard deviation from the mean age to create the age range for each age of mother category. Once prospective fathers were linked to the mothers, race and Hispanic origin were assigned to each projected birth using the Kid Link proportions. Since the Kid Link proportions remain constant for all projected years, changes in the racial and Hispanic origin composition of the mothers and fathers drive changes in the racial and Hispanic origin composition of births over time.

Sex was assigned to projected births within each race and Hispanic origin group. The sex ratios (males per 100 females) of future births were set to equal the average of the sex ratios of births for the period from 2000 to 2014, within each of five race and Hispanic origin groups: (1) non-Hispanic

White, (2) non-Hispanic Black, (3) non-Hispanic American Indian or Alaska Native, (4) non-Hispanic Asian or Pacific Islander, and (5) Hispanic. All projected births are considered native.

## Mortality

### Data

Mortality rates were calculated from NCHS-compiled death registration data for 1989 to 2014. In conjunction with population estimates from 1989 to 2014 – discussed in the denominator section above – death data were used to produce a series of mortality rates by age, sex, race, Hispanic origin, and nativity. Death data include four categories of race (White, Black, American Indian or Alaska Native, and Asian or Pacific Islander), two categories for Hispanic origin (Hispanic and non-Hispanic), and two categories for nativity (native and foreign-born). Deaths to non-residents were excluded from the series.<sup>7</sup>

Due to concerns about the quality of race reporting in the death data over the time series, non-Hispanic race groups with similar mortality patterns were collapsed into two categories. As a result, mortality rates were produced for three race and Hispanic origin groups: (1) non-Hispanic White and Asian or Pacific Islander, (2) non-Hispanic Black and American Indian or Alaska Native, and (3) Hispanic (of any race). Nativity of the deceased was incorporated into this projection series by creating a dichotomous variable that distinguished deaths to native residents from deaths residents who were foreign-born. Native deaths are those to individuals born in the United States or in US territories, while foreign-born deaths are those to individuals born elsewhere.

### Mortality Projections

Mortality was projected in three steps:

- 1) Project life expectancy at birth ( $e_0$ ) by sex to the year 2100 to determine which model life tables will be used to project mortality rates.
- 2) Project mortality rates to the year 2100.
- 3) Create life tables for the years 2017 through 2060 using the projected mortality rates.

Life expectancy at birth ( $e_0$ ) was projected indirectly using the log of the complement of life expectancy at birth for the years 2000 through 2014. We assumed the upper limit for  $e_0$  to be 100, therefore, the complement was calculated as 100 minus  $e_0$  of a given year. The log of the complement of life expectancy at birth was projected to the year 2100 using linear extrapolation and was converted back to  $e_0$  giving us a life expectancy of 87 years for males and 91 years for females in 2100. Consequently, we selected the UN Model Life Tables with life expectancies at birth ( $e_0$ ) of 87 years for males and 91 years for females as the ultimate targets that we would use to project mortality rates.

To project the mortality rates, we merged the UN model life table rates with the 2014 mortality rates by sex and single year of age. We used the natural logs of the 2014 and target mortality rates to interpolate values for 2017 through 2060 that were then converted back to rates. This method produces a non-linear progression over time that places faster rates of change at the beginning of the period and very small rates of change toward the end of the period.

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<sup>7</sup> Non-residents are defined as persons whose reported state of residence is *not* one of the 50 states or the District of Columbia.

Complete life tables, including survivorship ratios, were then produced from the mortality rates for 2017 through 2060. The survivorship ratios from these life tables for ages 0-99 were applied to the population in the projections to calculate deaths (deaths for ages 1 and over are equal to the difference between the population alive at the start of a given time interval and survivors to the end of that interval). The survival ratio representing the population 100 years and older was split into single years of age and extended to age 115. Survivorship rates were linearly interpolated from age 100 to age 115, where the survivorship for age 115 was set to 0 under the assumption that no individuals in the projection survive beyond that age.

Table 1 shows estimates and projections of life expectancy at birth and at age 65 by sex, nativity, and race and Hispanic origin groups. For males and females, life expectancy at birth is lowest for people who are non-Hispanic Black and American Indian or Alaska Native, regardless of their nativity. The difference in life expectancy at birth is smaller among foreign-born race and Hispanic origin groups compared to the native race and Hispanic origin groups. Despite having the lowest projected life expectancies at birth from 2017 through 2060, people who are non-Hispanic Black and American Indian or Alaska Native are projected to experience a larger increase in life expectancy during this time than any of the other groups. Between 2017 and 2060, life expectancy at birth for the native non-Hispanic Black and American Indian or Alaska Native is anticipated to increase by about 10 years for males and 8 years for females. The projected increase in life expectancy is smaller for their foreign-born counterparts.

Foreign-born race and Hispanic origin groups had higher life expectancies at birth in 2017 compared to each of their native counterparts. Foreign-born White and Asian or Pacific Islanders, as well as foreign-born Hispanic females, are projected to have the highest life expectancies at birth throughout the projected period. In 2017 they were tied for the highest life expectancy at 85.5 years.

Figures 3-6 show mortality rates by age for the three race and Hispanic origin groups in 2017 and 2060. Mortality rates are generally projected to decline for all groups between 2017 and 2060, with some ages and groups experiencing more improvement than others. Overall, mortality rates start out lower for the foreign-born groups in 2017 for both males and females compared to their native peers.

## **Net International Migration**

The projections of net international migration for the 2017 National Population Projections consist of three components:

1. Foreign-born immigration
2. Foreign-born emigration
3. Net native migration

### **Foreign-Born Immigration**

Projections of foreign-born immigration were based on rates of emigration from sending countries. This approach shifts the perspective from the receiving nation to the source countries by incorporating information on the trends in population in sending countries. Sending countries were organized into regions and rates of emigration were calculated from annual estimates of foreign-born immigration and population estimates for the regions. Both sets of estimates are described below.

### ***Estimates and Projections of Population in Sending Countries: 1980-2060***

The Census Bureau produces estimates and projections of populations in other countries, which are compiled in the Census Bureau's International Data Base (IDB) and are available to the public via the Census Bureau's Web site ([www.census.gov](http://www.census.gov)). The IDB projections are available through 2050. To extend the series to 2060, we extrapolated the populations from 2050 to 2060 using a log model. The extrapolation was performed within country-of-birth groupings, which are described in the next section.

### ***Country of Birth Groupings***

The foreign-born immigration estimates and sending country population estimates and projections were categorized into six country-of-birth regions to maximize the diversity between regions and minimize the heterogeneity within region, while maintaining large enough aggregations to remain viable. These regions are:

1. Sub-Saharan Africa
2. Mexico
3. Latin America, Caribbean, South America
4. Europe, Canada, Oceania
5. Asia
6. Near East and North Africa

Estimates of the population for each region from 1980 to 2014 are presented in Figure 7. The populations of all regions grew between 1980 and 2014, though Asia and Africa grew substantially faster than the other regions. Asia had the largest population with over 4 billion in 2014.

### ***Estimates of Foreign-Born Immigration: 1980-2014***

Estimates of foreign-born immigration were developed using data from the 1990 and 2000 censuses and the 2001-2016 single-year ACS data files. Using ACS data, foreign-born immigration is measured as the foreign-born population who reported their year of entry to the United States as one year prior to the survey year. For example, if foreign-born respondents in the 2009 ACS reported their year of entry as 2008 then they would be counted in the 2008 estimate of foreign-born immigration.

Estimating immigration using decennial census data requires additional adjustments to account for death and emigration occurring within the decade. Because these data represent two time points that are ten years apart, and do not include information on immigrants who emigrate or die before the census date, there is an increased risk of excluding those who emigrate before the census date. For instance, immigrants who entered the United States in 1994 and then emigrated in 1998 would not be included in the 2000 Census. Omitting cases like this would produce downwardly biased estimates of immigration.

To account for emigration between censuses, the year-of-entry estimates for each year were adjusted using emigration rates. First, foreign-born immigration was estimated for the years 1991 to 2000 using the foreign-born population in the 2000 Census who reported a year of entry between 1990 and 1999. The estimates were produced by sex, race, and Hispanic origin. Next, each

annual estimate was adjusted for emigration by applying an emigration rate of 1.44 per thousand population to each year.<sup>8</sup> The same method was applied to 1990 Census data to develop estimates of foreign-born immigration between 1980 and 1989. Deaths that occurred to the foreign-born each year were estimated using the 1990 to 2000 survivorship ratios that were created to produce the mortality input. A substantial amount of the death records prior to 1990 do not include information regarding Hispanic origin. As a result, we use data from 1990 forward to produce the time series of death estimates. For the same reason, survivorship ratios for 1990, based on more complete reporting of Hispanic origin in death records, were used to generate immigration estimates for 1980 through 1989. For all other years, 1990 through 2000, the survivorship ratios for that same year are used.

Figure 8 shows the immigration estimates from 1980 to 2014 by region. Asia, the Near East and North Africa, and Sub-Saharan Africa show increasing levels of immigration to 2014, while Latin America and the Caribbean, as well the Europe, Canada, and Oceania region show downturns after 2000. Despite declining after 2000, immigration from Latin America and the Caribbean begins to increase after 2011. Immigration from Latin America and the Caribbean increases by about 131,000 between 2011 and 2014. Mexico shows a marked downturn in the 2000s, dropping from about 474,000 in 2004 to about 184,000 in 2014.

#### *Emigration Rates from Sending Countries (to the United States)*

Emigration rates for each of the six regions were calculated by dividing the number of immigrants to the United States by the estimated population in that region for the years 1980 through 2014. The emigration rates were projected into the future using a power function, a linear model that uses the natural log of the dependent variable (emigration rate) and the natural log of the independent variable (year) to estimate the intercept and coefficient (equation 4).

#### **Equation 4.**

$$\text{Log}_n(er) = a + b\text{Log}_n(n)$$

Where:

*er* = the emigration rate for year *n*

*n* = the year

*a* = the model intercept

*b* = the model coefficient

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<sup>8</sup> The emigration rate of 1.44 is the emigration rate for recent arrivals (e.g., those entering within the past 10 years) used for the Vintage 2013 estimates of foreign-born emigration. Emigration rates for the 1980s were calculated by Ahmed and Robinson (1994), but they were calculated only for arrivals before 1980. Earlier arrival cohorts are expected to have a lower rate of emigration than the more recent arrivals for which we are producing estimates, so we chose to use more current data on the emigration of recent immigrants.

Figures 9a and 9b shows estimated and projected rates of emigration for each sending region. The rate patterns are very similar to the immigration patterns. Mexico's emigration rates were the highest, ranging from 7 per 1,000 population in 1990 to a little over 1 per 1,000 in 2014 with the model projecting a relatively flat trajectory that stays slightly above 2.5 per 1,000.

The rates for Latin America and the Caribbean range from 1.4 per 1,000 population in 1980 to about 0.72 per 1,000 in 2014. The model projects rates to decline from about .59 per 1,000 in 2017 to about .53 in 2060.

Rates in the other regions were generally under 0.2 per 1,000 population, though the Europe, Canada, Oceania region jumped to about 0.4 per 1,000 in 1999. Europe's rates are projected to increase from .26 per 1,000 population in 2017 to .32 per 1,000 in 2060. The other three groups (Asia, Sub-Saharan Africa, and Near East and North Africa) are projected to have very stable rates between 0.1 and 0.17 per 1,000 population.

### *Foreign-Born Immigration Projections*

Projected immigrants to the United States were calculated for each year by multiplying the projected emigration rate from the sending countries by the projected population in the sending countries within each region. Figure 10 presents the projections of foreign-born immigration within each of the six regions.

The total number of foreign-born immigrants is projected to be 1.88 million in 2060. In 2060, just over 500,000 immigrants are projected to come from Asian countries and about 400,000 are projected to come from Mexico. More than 300,000 are projected to come from Latin America, the Caribbean, and the South America region in 2060 while another 250,000 are projected to come from Europe, Canada, and Oceania. Immigrants from sub-Saharan Africa are projected to increase the most, rising from 93,000 in 2017 to over 250,000 in 2060, surpassing immigration from Europe, Canada, and Oceania. Immigrants from the Near East and North Africa are projected to increase to about 100,000 in 2060.

The foreign-born immigration projections were distributed by age, sex, race, and Hispanic origin using the distributions of characteristics of immigrants within each of the six country of birth groupings from the 2008-2012 ACS. These distributions were held constant in all years of the projections, meaning that the projections of foreign-born immigration do not account for potential variations in the composition of the population within the sending countries. Because of this, any changes in the demographic characteristics of foreign-born immigrants to the United States over time are the result of shifts in the sending countries from which the immigrants originate. For instance, a projected increase in the share of immigrants arriving from Asia would be associated with a rise in foreign-born immigrants in the Asian race group.

Figure 11 shows the race and Hispanic origin distribution of projected foreign-born immigrants. Hispanics are projected to remain the largest immigrant group, although their share of the immigrant population decreases from about 39 percent in 2017 to less than 34 percent in 2060. The proportion of immigrants that are non-Hispanic Asian is also projected to decrease slightly from almost 30 percent in 2017 to about 27 percent in 2060. The projected share of immigrants

who are non-Hispanic White and other non-Hispanic race groups is expected to remain relatively stable from 2017 to 2060. The proportion of immigrants who are non-Hispanic Black is projected to increase substantially from nearly 10 percent in 2017 to more than 16 percent in 2060.

### Foreign-Born Emigration Rates

We calculated projections of foreign-born emigration by first calculating emigration rates using ACS data and then applying these rates to the foreign-born population annually.

### Emigration Rates from the United States (to Abroad)

Foreign-born emigration rates were estimated using a residual method. The residual method uses information on mortality and immigration to account for cohort change in the foreign-born population between two survey or census years. The residual method assumes that a decline in the foreign-born population between two given years (the residual difference after accounting for mortality and immigration) is due to emigration. The general formula for a residual estimate is shown in equation 5.

#### **Equation 5.**

$$E_{x,x+y,t_1,t_2} = \sum_{i=0}^y [(P_{x+i,t_1} \times S_{x+i,t_1,t_2}) - P_{x+(i+z),t_2}]$$

Where:

$y$  = the range of the age group.

$z$  = the range of the time period.

$E_{x,x+y,t_1,t_2}$  = the foreign-born emigration residual for ages  $x$  to  $x + y$  between year  $t_1$  and year  $t_2$ , the difference between the sum of sex and age-specific expected populations, after accounting for annual survival in the residual period, and the estimated population in year  $t_2$ ;

$P_{x+i,t_1}$  = the estimate of the foreign-born population, age  $x + i$ , residing in the United States in year  $t_1$

$P_{x+(i+z),t_2}$  = the estimate of the foreign-born population, age  $x + (i + z)$ , who arrived in the United States prior to  $t_1$  residing in the United States at  $t_2$ .

$S_{x,t_1,t_2}$  = the annual survivorship ratio for the population age  $x$  between  $t_1$  and  $t_2$ .

Foreign-born population and immigration data came from the 2011-2015 ACS 1-year files. Annual survivorship ratios were calculated from NCHS data on foreign-born deaths by age, sex, race, and Hispanic origin. We divided the residual from equation 5 by number of “person years” for  $t_1$ - $t_2$  to

produce annualized emigration rates. Rates were calculated by age, sex, Hispanic origin, and arrival cohorts. Arrival cohorts are defined as (1) 'Recent Arrivals' who entered the United States 0 to 9 years prior to t1 and (2) 'Earlier Arrivals' who entered 10 or more years prior to t1. Sampling and non-sampling effects from the ACS data can bias the rates, in some cases producing negative rates. In order to minimize these effects, we calculate six rates using different survey years. Three of the six rates are based on two-year residual periods: 2011-2013, 2012-2014, and 2013-2015. Two of the rates have three-year periods: 2011-2014 and 2012-2015 and one rate has a four-year period: 2011-2015. We average the six rates to produce the final rate.

Table 2 presents the foreign-born emigration rates by age, sex, Hispanic origin, and arrival cohorts. Recently arrived Hispanic males have the highest emigration rates in the 0-4 year old age group and in age groups between 43 and 57 years, while recently arrived non-Hispanic males have the highest emigration rates in age groups between 15 through 42 years and 63 through 82 years. Recently arrived males overall tend to have higher emigration rates compared to their female counterparts.

### ***Foreign-Born Emigration Projections***

We applied the average of the six rates to all ages in the age groups of the annual foreign-born populations projected to be at risk of emigrating during the projection period. The population at risk is distributed by arrival cohort to the United States, age, sex, race, and Hispanic origin. Rates are applied to the population by Hispanic origin, sex, arrival cohort, and age group with the demographic characteristics of the population at risk determining the racial composition of the foreign-born emigrants.

### **Net Native Migration**

The net international migration of the native population includes natives emigrating out of the United States and those migrating between the United States and Puerto Rico. The estimates of native net emigration from the 2014 projections series by age, sex, race, and Hispanic origin were held constant for all years in the projections.

Puerto Rico net migration by age and sex was obtained from IDB projections for 2017 through 2050. This series was extended to 2060 using a regression model. Race and Hispanic origin were assigned to migrants using the distribution of these characteristics from the Vintage 2016 estimates of Puerto Rico. The Vintage 2016 values for Puerto Rico were not used because Puerto Rico is currently experiencing extremely high rates of emigration that are unlikely to be sustained over the projection horizon. Net migration from Puerto Rico is modeled in the IDB<sup>9</sup>.

### **Net International Migration**

Net international migration was calculated by summing the native and foreign-born net migration components by age, sex, race, and Hispanic origin. Figure 12 shows net international migration by race and Hispanic origin. Hispanic levels are the highest, between 350,000 and 400,000 across the projection period. Non-Hispanic Asian levels are the next highest, rising to nearly 320,000 in 2038 and slightly decreasing after. Non-Hispanic White levels are also projected to increase, rising from 211,000 in 2017 to 246,000 in 2060. The projected increase in non-Hispanic Black levels is the

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<sup>9</sup> For more information on the net migration calculations in the IDB, please visit <https://www.census.gov/population/international/>.

sharpest. They rise from 100,000 in 2017 to 211,000 in 2060. Finally, levels for other non-Hispanic race groups are projected to rise slightly, to about 18,000 in 2060.

Table 3 shows the distribution and sex ratios of the net international migrants by race and Hispanic origin from 2017 to 2060. The percent of net international migrants that are projected to be non-Hispanic White remained mostly constant through 2060. The percent non-Hispanic Black is projected to increase from 10.1 percent in 2017 to 18.4 percent in 2060, while the percent non-Hispanic Asian is projected to decrease from 29.9 percent in 2017 to 27.1 percent in 2060. Hispanics are projected to decrease from 37.2 percent of net international migrants in 2017 to 31.5 percent in 2060. The sex ratios indicate that Hispanic net international migrants are projected to be predominantly male until about 2050, while there are slightly more females than males for most of the non-Hispanic groups. The sex ratios for non-Hispanic other net international migrants tends to align most closely with that of Hispanic net international migrants until about 2050.

## **Population Projections**

The projected fertility rates, mortality rates, and international migration components described in this document were used to generate projections of the US resident population. These projections were created using the cohort-component method which adds or subtracts each component of population change to an initial population to project the population at a subsequent time. In this case, projections were created for the years 2017 to 2060 by nativity, age, sex, race, and Hispanic origin.

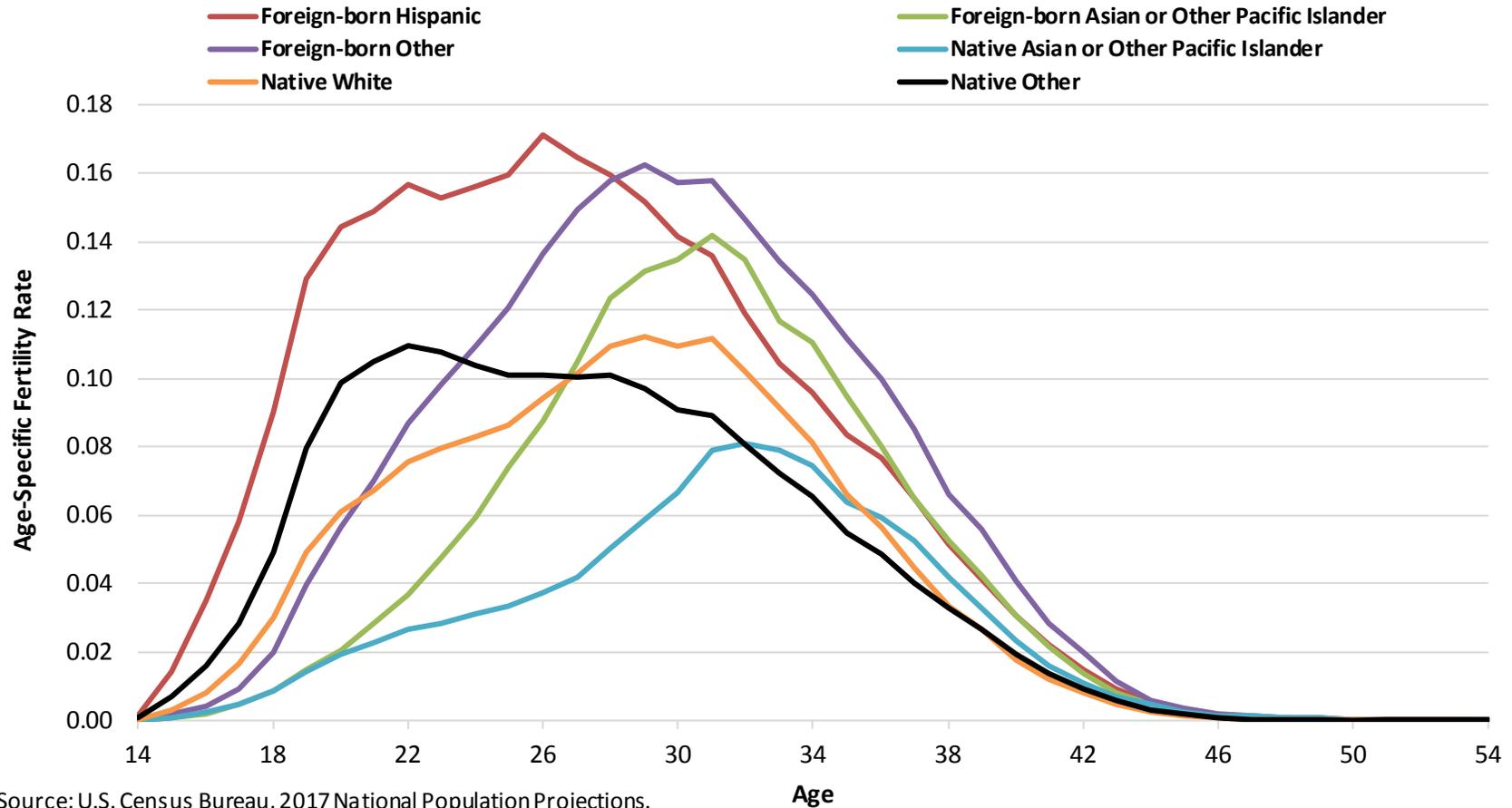
Projections of the resident population and components of change from the 2017 National Population Projections are available on the Census Bureau Web site at <https://www.census.gov/programs-surveys/popproj.html>.

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## Tables and Figures

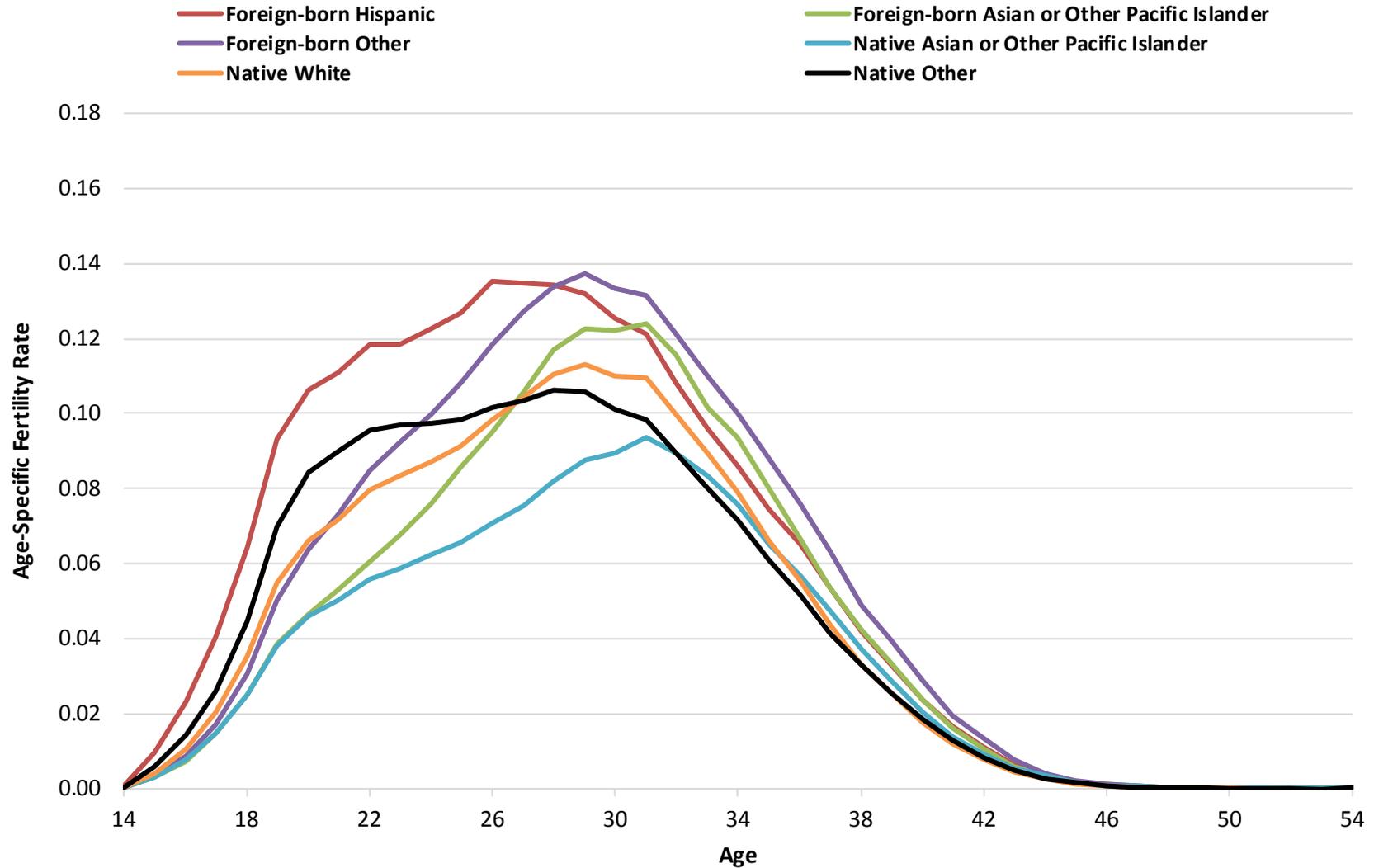
**Figure 1. Age-Specific Fertility Rates by Race and Hispanic Origin: 2017**



Source: U.S. Census Bureau, 2017 National Population Projections.

Note: The 'other' race group represents Black and American Indian or Alaska Native races.

**Figure 2. Age-Specific Fertility Rates by Race and Hispanic Origin: 2060**



Source: U.S. Census Bureau, 2017 National Population Projections.

Note: The 'other' race group represents Black and American Indian or Alaska Native races.

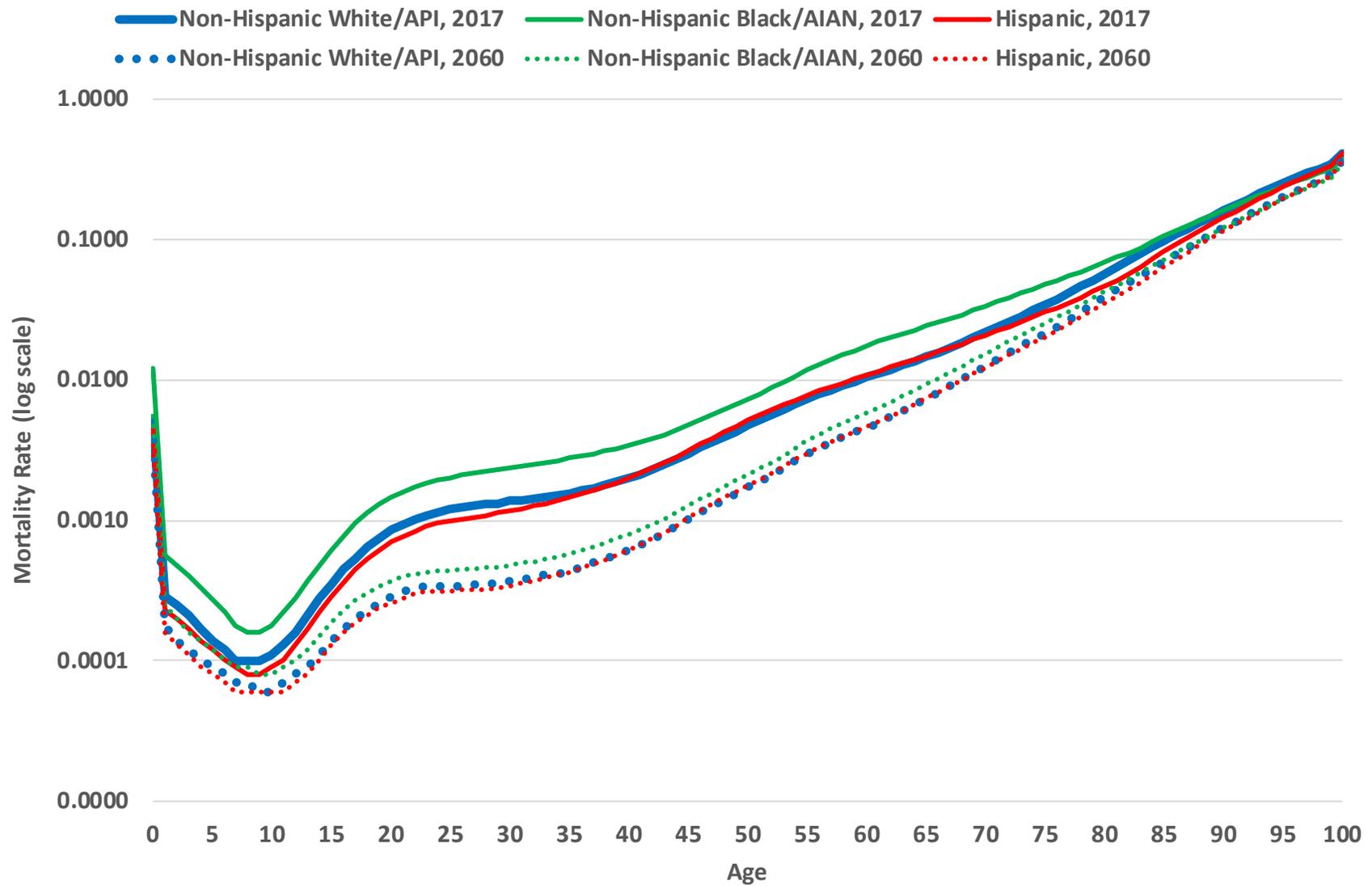
**Table 1. Life Expectancy at Birth and Age 65 by Nativity, Sex, Race, and Hispanic Origin: 2017 to 2060**

Year	Life Expectancy at Birth						Life Expectancy at Age 65					
	Male			Female			Male			Female		
	White/API	Black/AIAN	Hispanic	White/API	Black/AIAN	Hispanic	White/API	Black/AIAN	Hispanic	White/API	Black/AIAN	Hispanic
<b>Native-born</b>												
2017	77.3	72.1	78.2	81.9	78.0	83.3	18.4	16.4	19.4	20.9	19.5	22.1
2020	77.9	73.0	78.7	82.3	78.7	83.6	18.7	16.7	19.6	21.2	19.8	22.3
2030	79.6	75.8	80.4	83.7	80.9	84.8	19.4	17.8	20.2	22.0	20.9	22.9
2040	81.2	78.3	81.8	85.0	82.9	85.9	20.2	18.9	20.9	22.8	21.9	23.5
2050	82.6	80.5	83.1	86.1	84.6	86.8	20.9	20.0	21.5	23.5	22.9	24.1
2060	83.9	82.4	84.3	87.2	86.2	87.8	21.7	20.9	22.1	24.3	23.8	24.8
<b>Foreign-born</b>												
2017	81.6	80.6	81.2	85.5	84.8	85.5	20.9	20.6	20.6	23.2	23.4	23.3
2020	81.9	81.0	81.6	85.7	85.1	85.8	21.0	20.7	20.8	23.3	23.5	23.4
2030	82.9	82.2	82.6	86.4	86.0	86.5	21.5	21.3	21.3	23.8	24.0	23.9
2040	83.8	83.3	83.6	87.1	86.9	87.2	21.9	21.7	21.7	24.3	24.4	24.3
2050	84.6	84.3	84.4	87.8	87.7	87.9	22.3	22.2	22.2	24.7	24.9	24.8
2060	85.4	85.1	85.2	88.5	88.4	88.5	22.7	22.7	22.6	25.2	25.3	25.2

AIAN=American Indian and Alaska Native; API=Asian and Pacific Islander

Source: U.S. Census Bureau, 2017 National Population Projections.

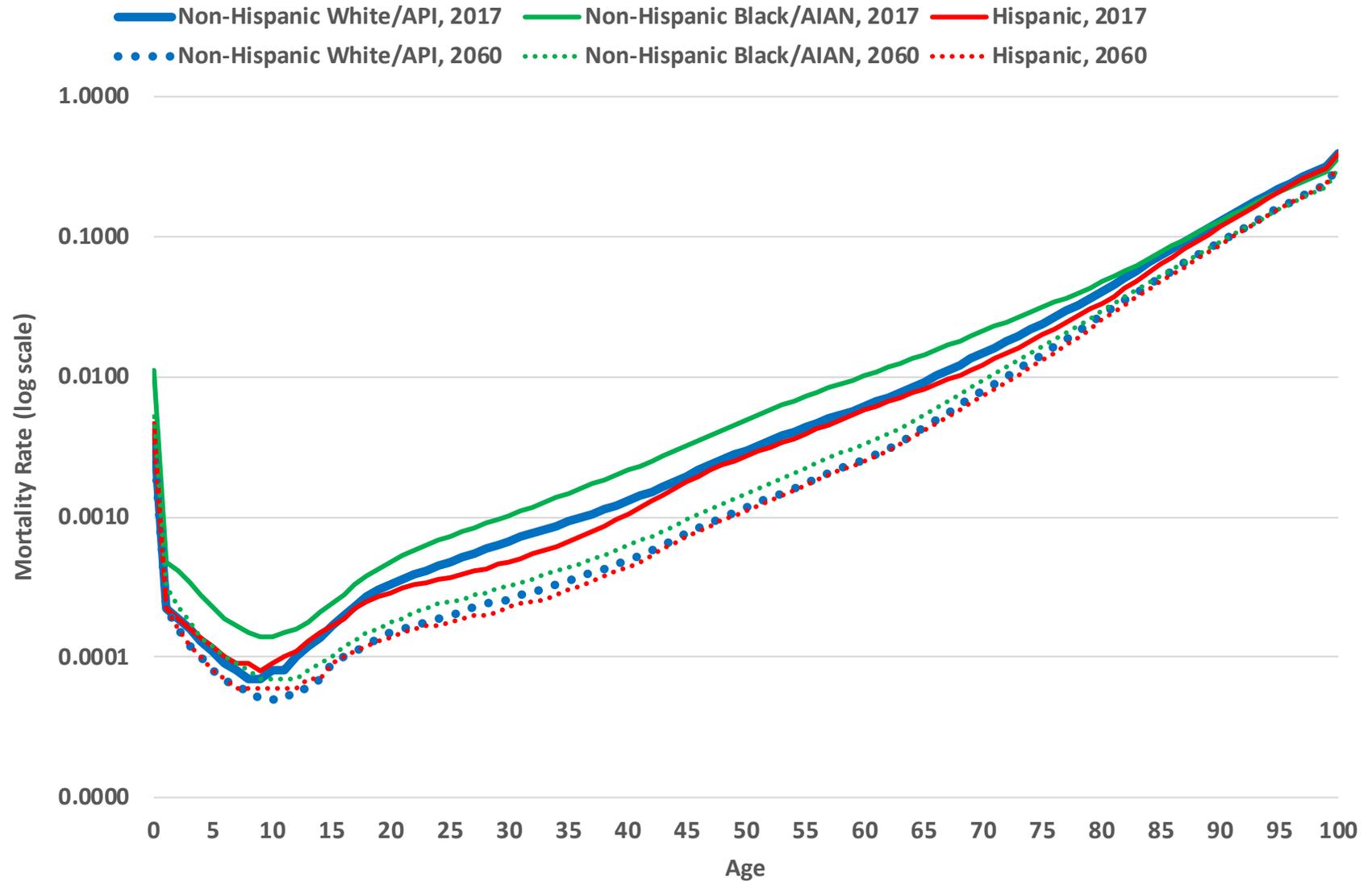
**Figure 3. Native Male Mortality Rates by Age, Race and Hispanic Origin: 2017 and 2060**



API = Asian and Pacific Islander

Source: U.S. Census Bureau, 2017 National Population Projections

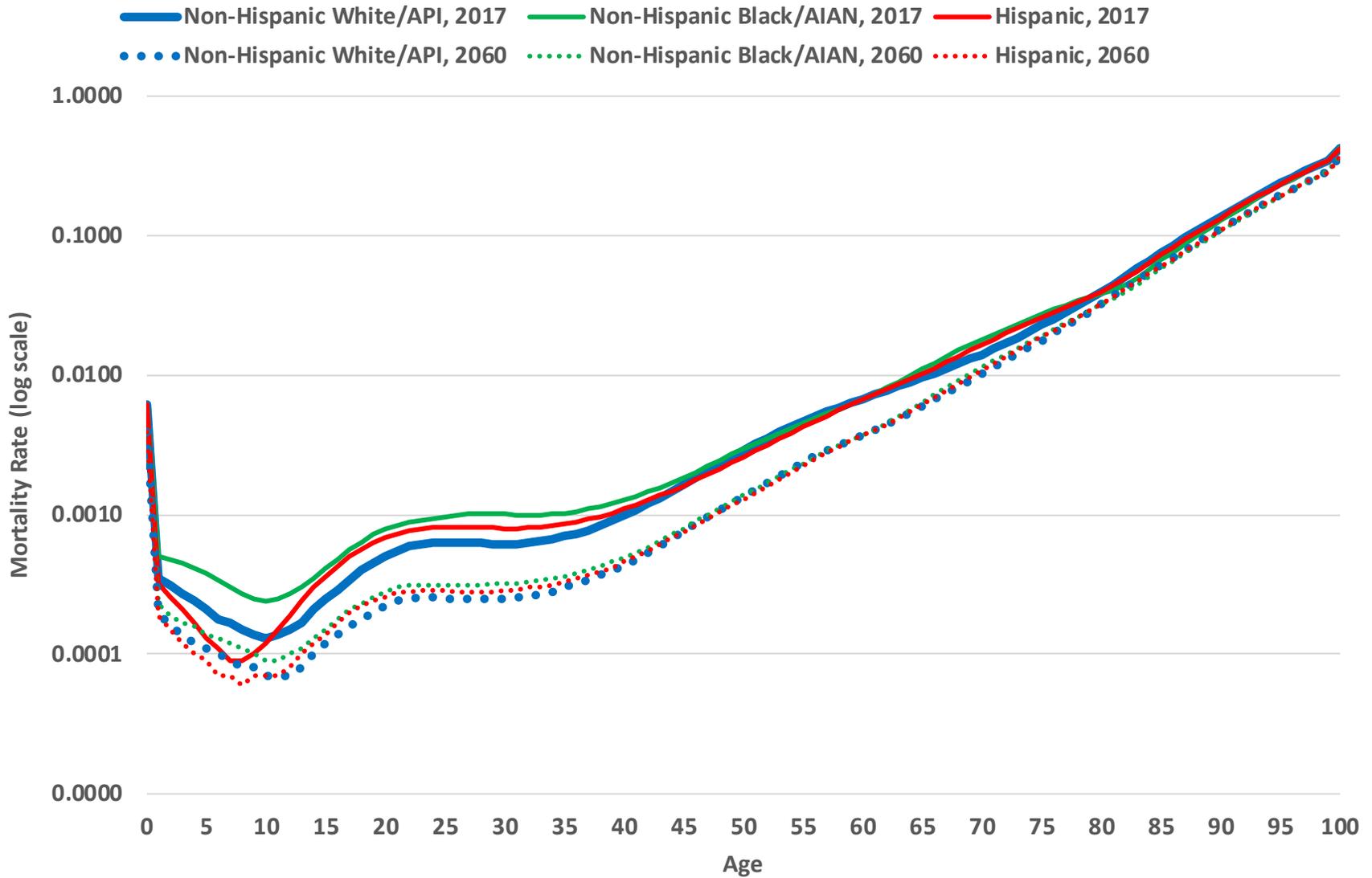
**Figure 4. Native Female Mortality Rates by Age, Race and Hispanic Origin: 2017 and**



API = Asian and Pacific Islander

Source: U.S. Census Bureau, 2017 National Population Projections

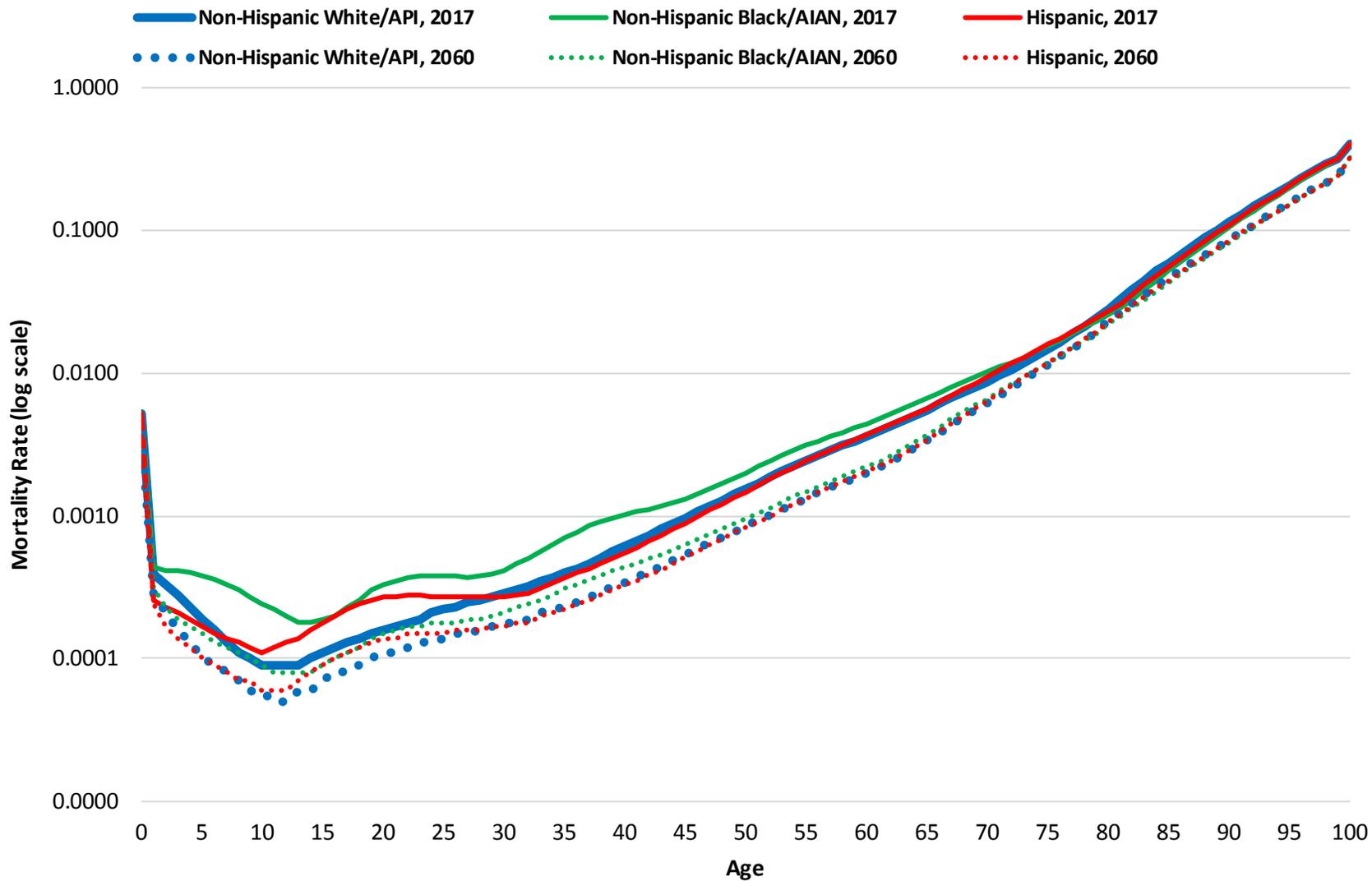
**Figure 5. Foreign-born Male Mortality Rates by Age, Race and Hispanic Origin: 2017 and 2060**



API = Asian and Pacific Islander

Source: U.S. Census Bureau, 2017 National Population Projections

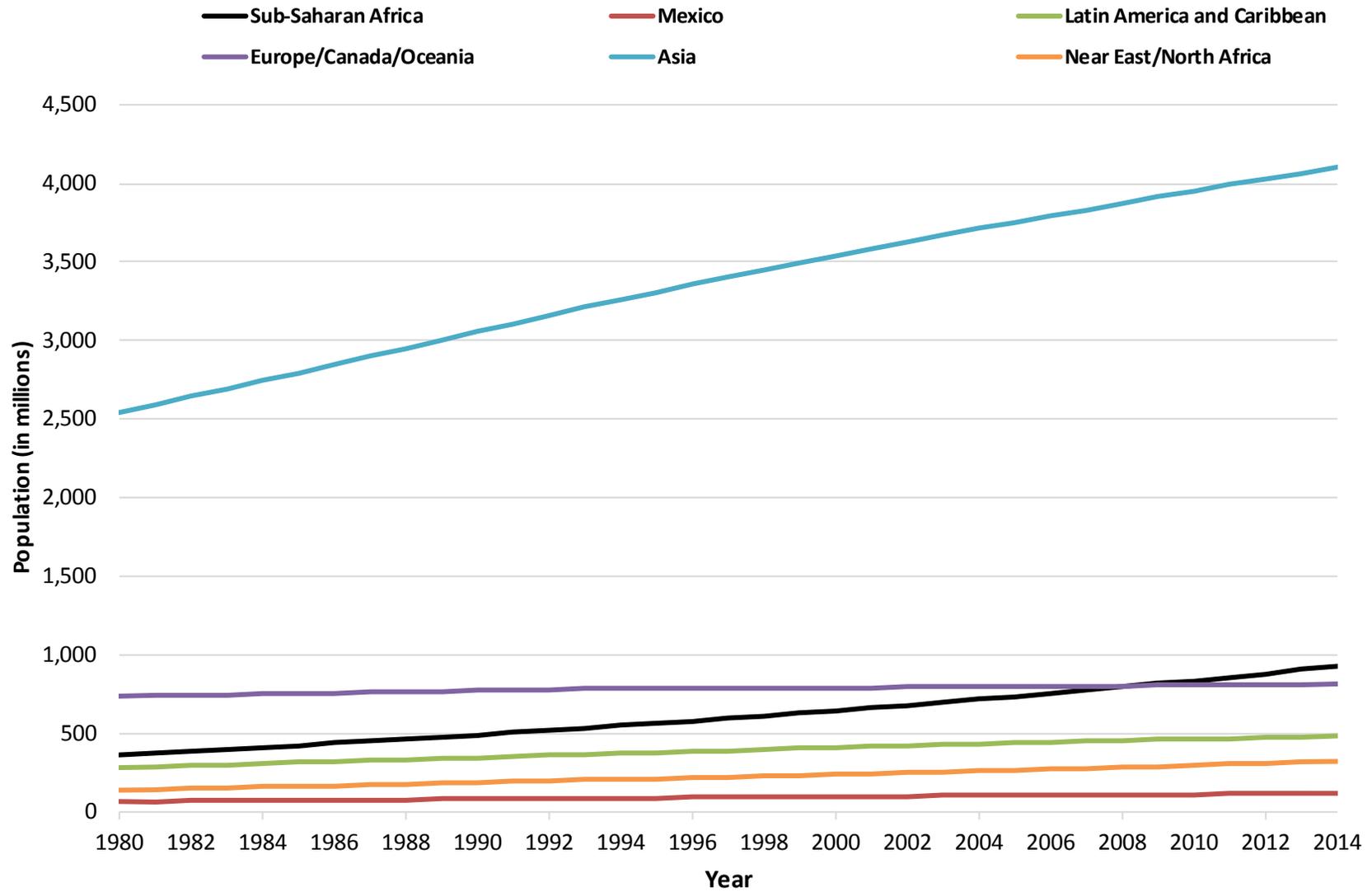
**Figure 6. Foreign-born Female Mortality Rates by Age, Race and Hispanic Origin: 2017 and 2060**



Note: API = Asian or Pacific Islander and AIAN = American Indian and Alaska Native

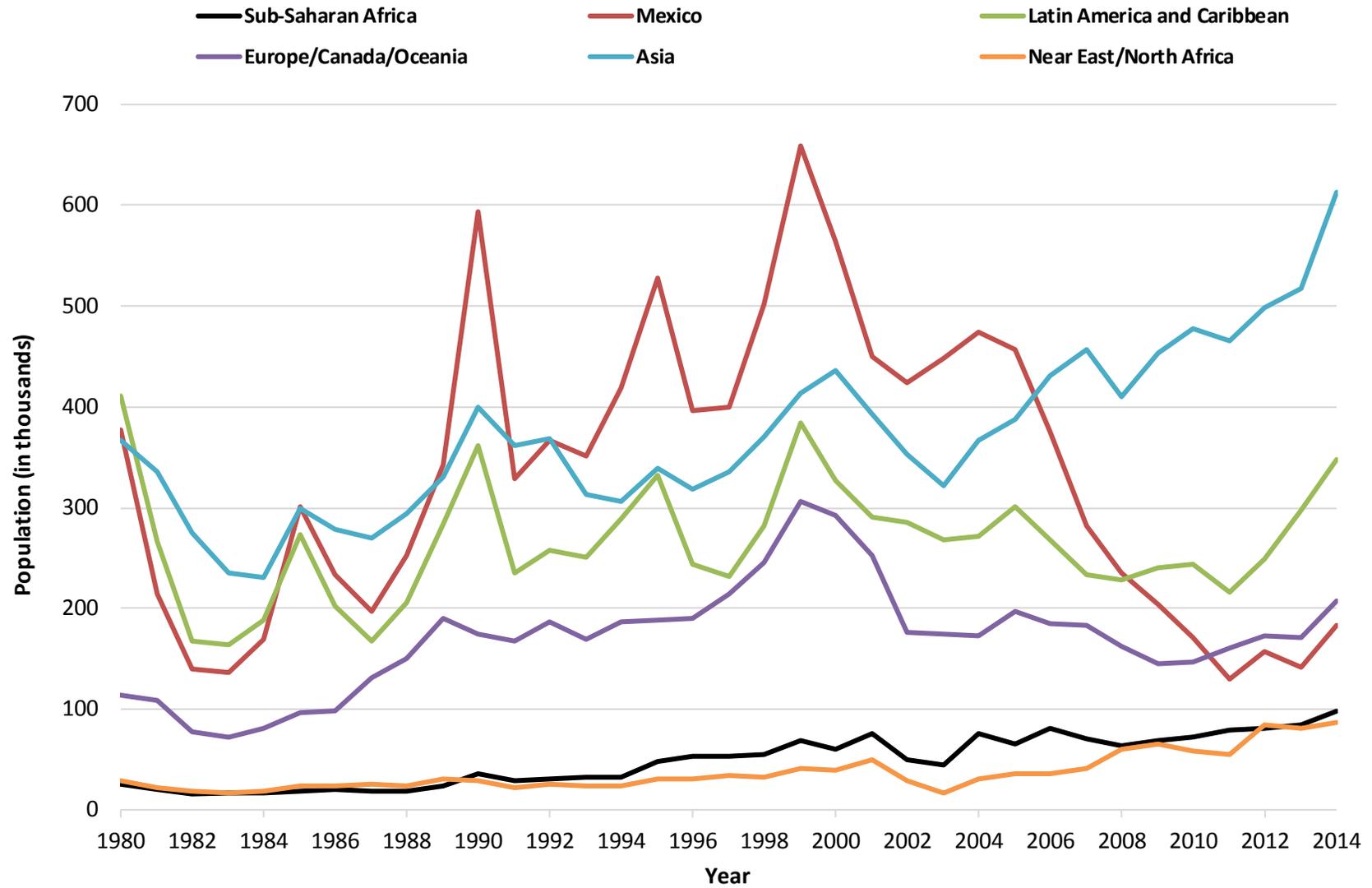
Source: U.S. Census Bureau, 2017 National Population Projections.

**Figure 7. Population Estimates for Sending Regions: 1980 to 2014**



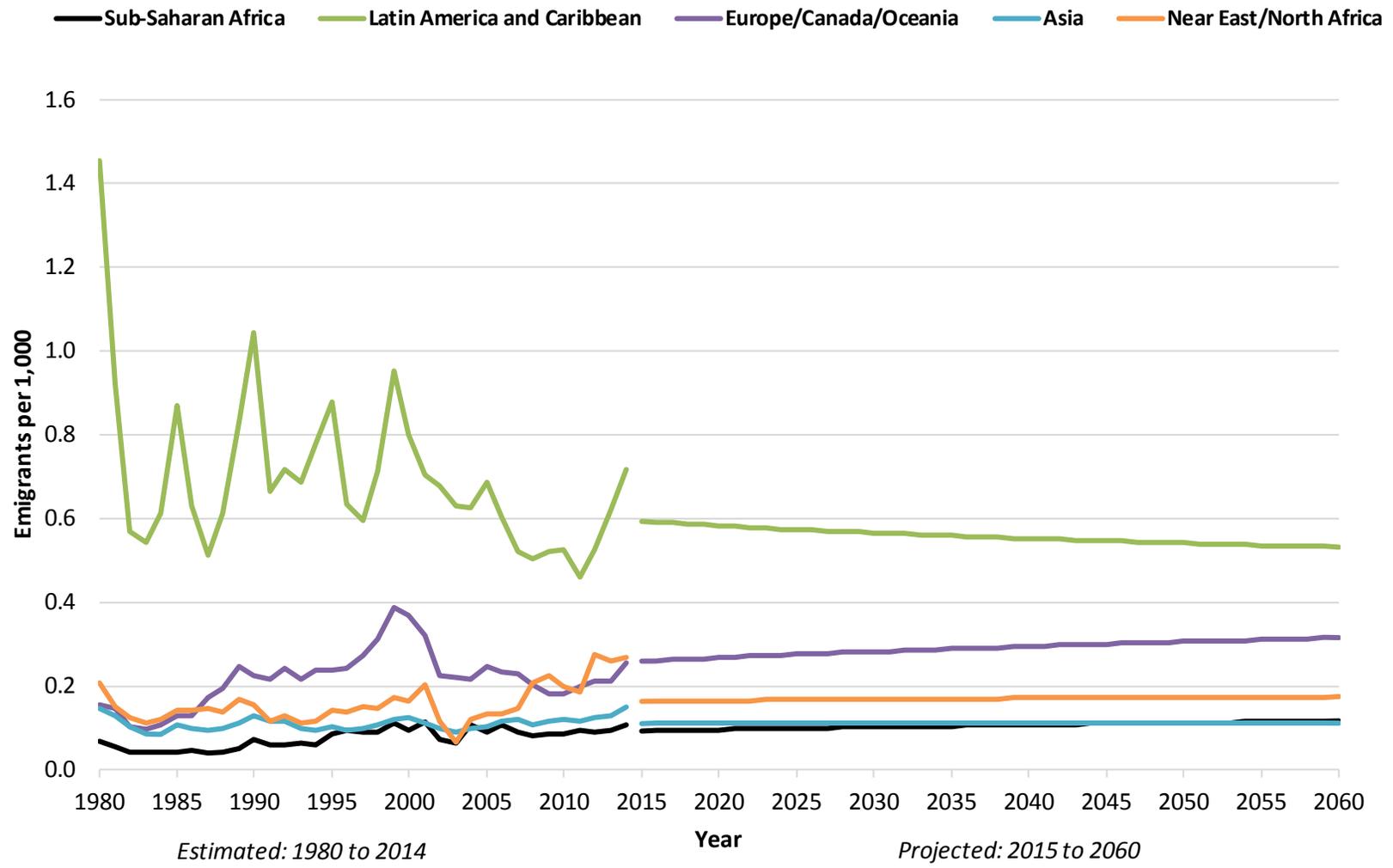
Source: U.S. Census Bureau, Population Division, International Data Base (2016).

**Figure 8. Immigration Estimates by Sending Regions: 1980 to 2014**



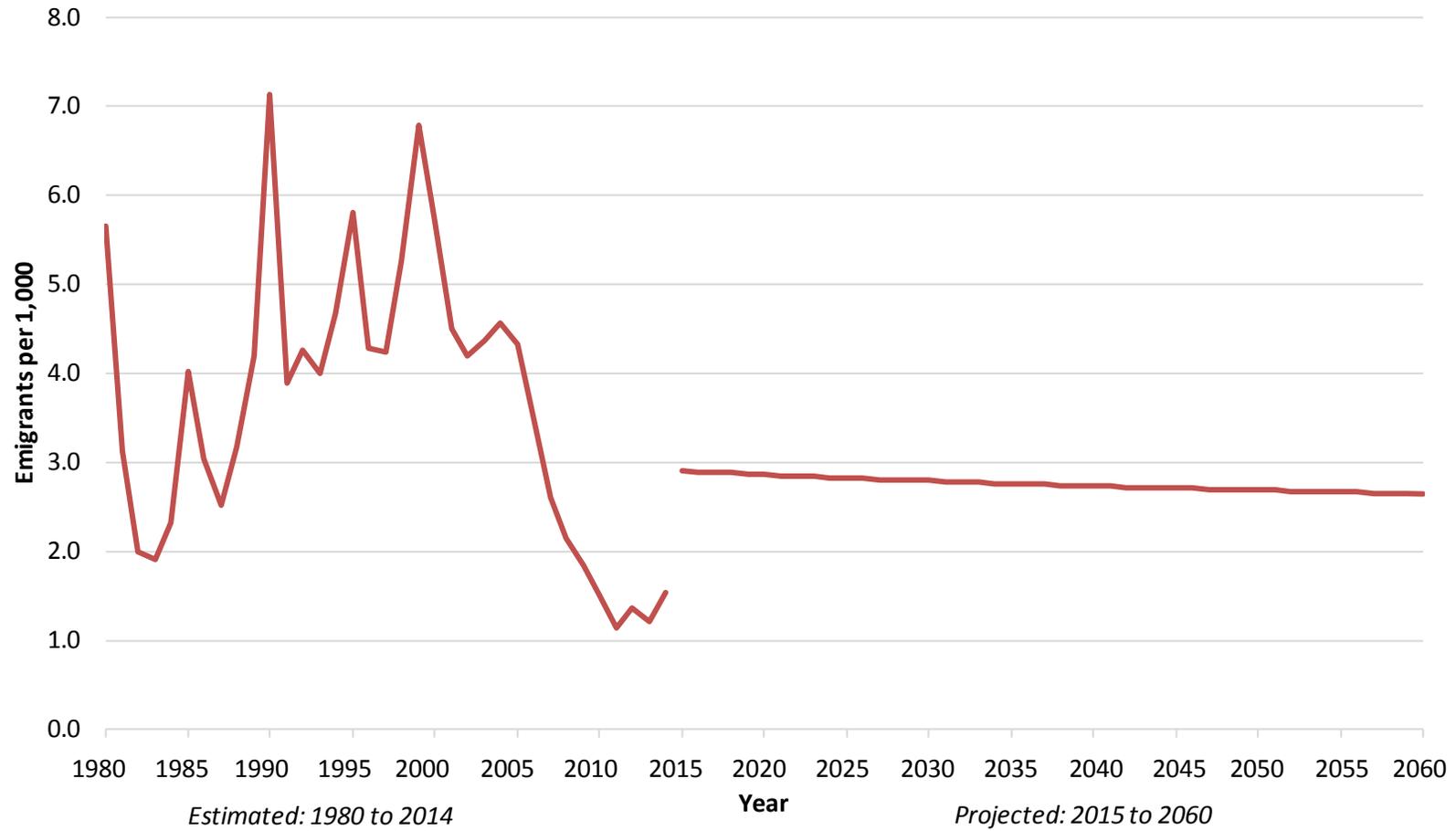
Source: U.S. Census Bureau, 1990 and 2000 Decennial Censuses and 2001 to 2015 American Community Survey 1-year estimates.

**Figure 9a. Emigration Rates from Sending Regions to the United States: 1980 to 2060**



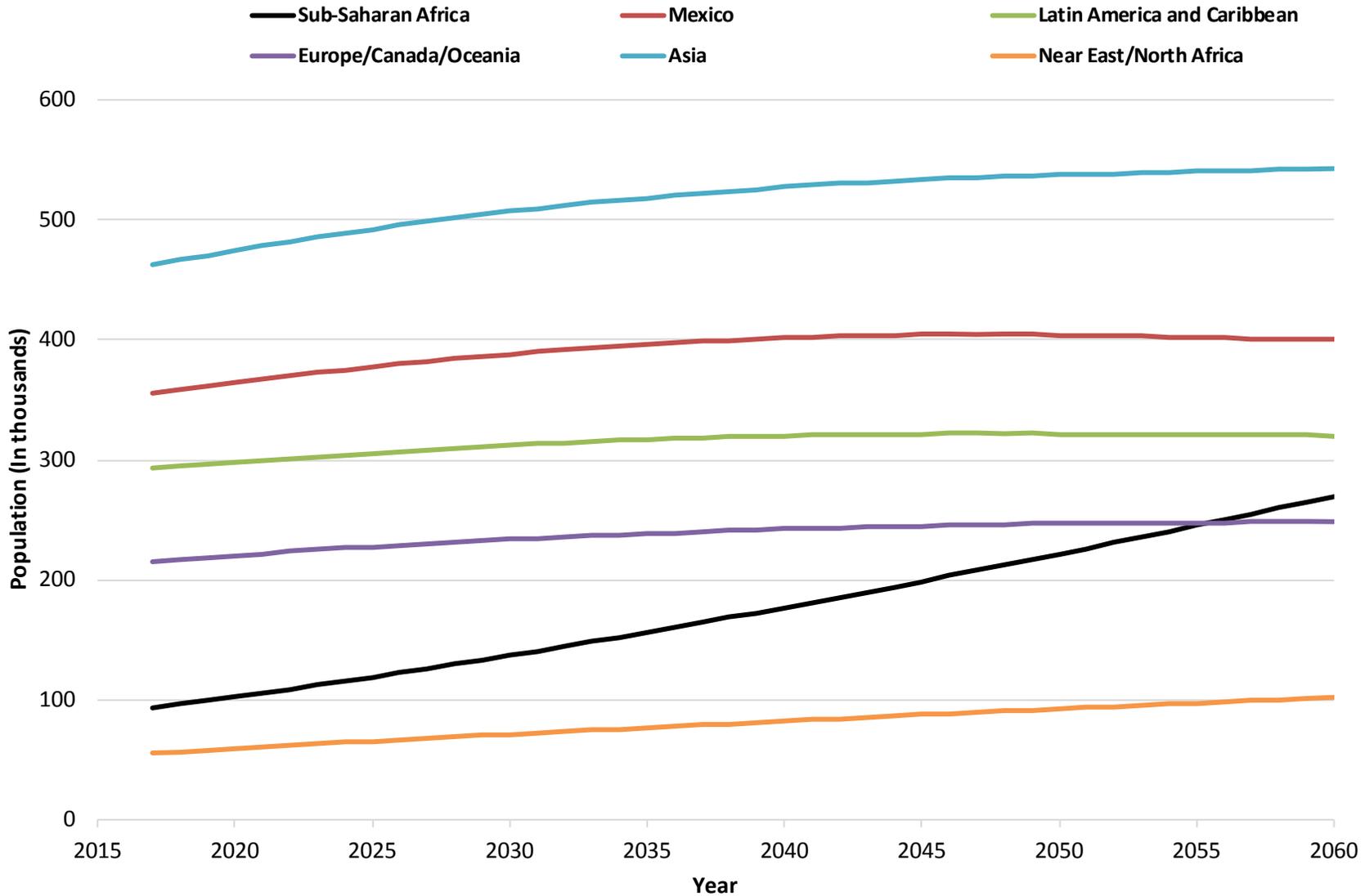
Source: U.S. Census Bureau, 2017 National Population Projections.

**Figure 9b. Emigration Rates from Mexico to the United States: 1980 to 2060**



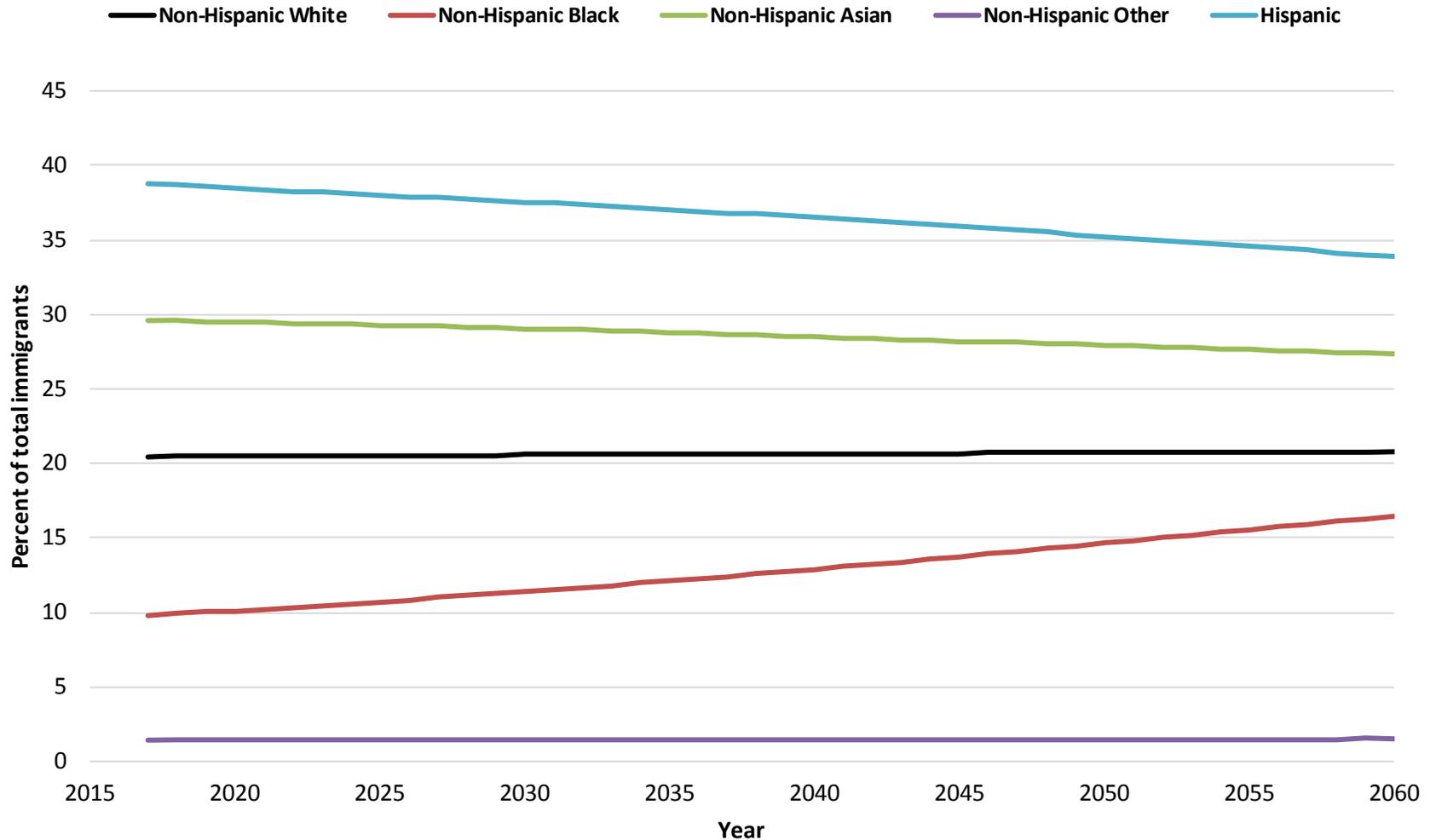
Note: Emigration rates from Mexico are shown in a separate figure from other regions, because rates from Mexico are substantially larger (Figure 9a).  
Source: U.S. Census Bureau, 2017 National Population Projections.

**Figure 10. Projections of Foreign-Born Immigration to the United States by Sending Region: 2017 to 2060**



Source: U.S. Census Bureau, 2017 National Population Projections.

**Figure 11. Distribution of Projected Foreign-Born Immigrants to the United States by Race and Hispanic Origin: 2017 to 2060**



Note: All race groups are non-Hispanic and the Hispanic group can be of any race. 'Other' includes Non-Hispanic American Indian and Alaska Native, Non-Hispanic Native Hawaiian and Other Pacific Islander, and Non-Hispanic Two or More Races.

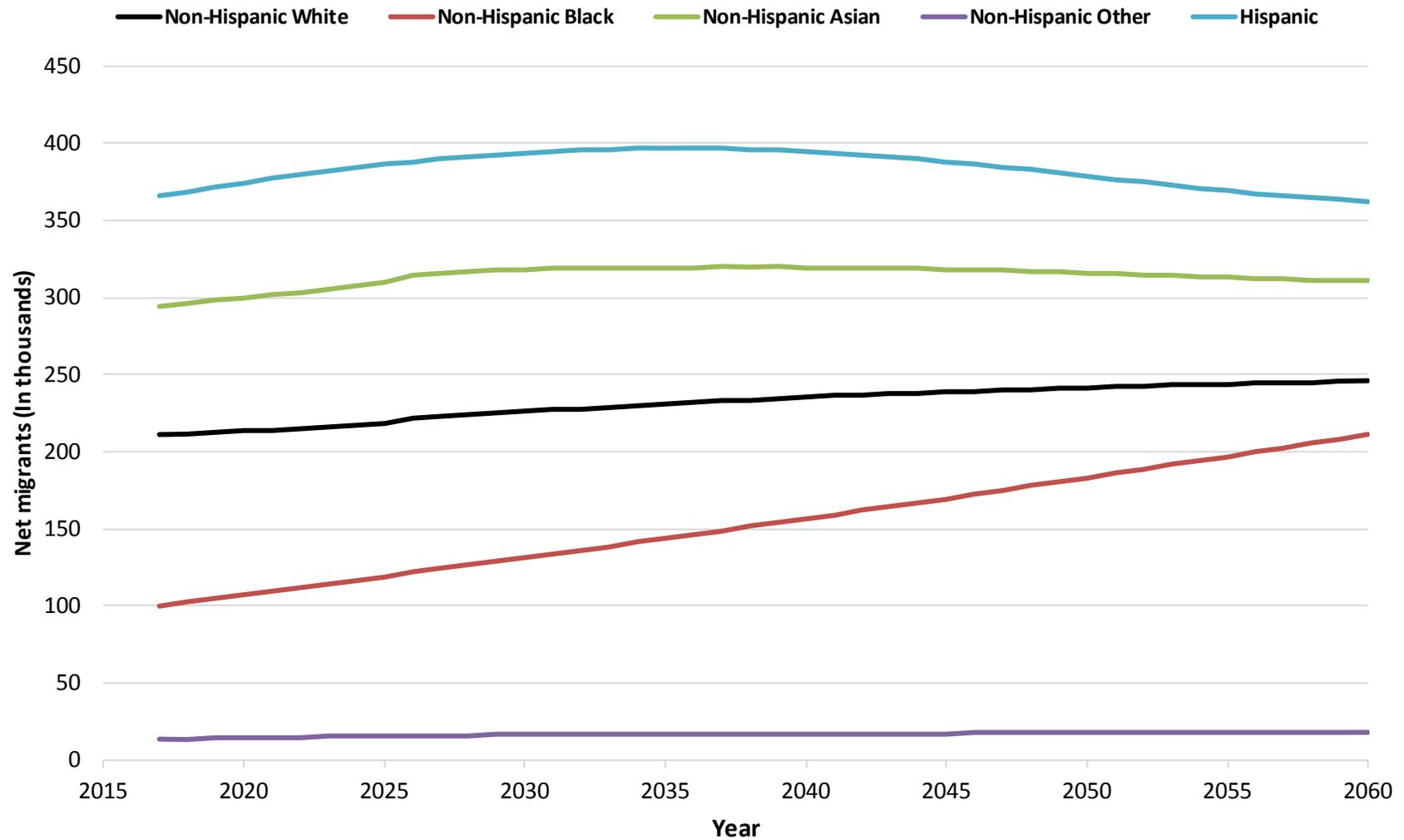
Source: U.S. Census Bureau, 2017 National Population Projections.

**Table 2. Foreign-Born Emigration Rates by Arrival Cohort, Sex, Hispanic Origin, and Age Group (per 1,000)**

Age Group	Recent Arrivals (Last 10 years)				Earlier Arrivals (10 or more years)			
	Non-Hispanic		Hispanic		Non-Hispanic		Hispanic	
	Male	Female	Male	Female	Male	Female	Male	Female
0-4	48.04	61.67	111.08	88.63	0.00	0.00	0.00	0.00
5-9	26.04	31.24	42.61	33.13	0.00	0.00	0.00	0.00
10-14	14.80	13.65	2.79	4.03	8.90	1.04	47.55	34.58
15-17	18.53	15.47	3.08	3.13	7.93	7.86	16.40	6.16
18-22	33.23	26.38	9.90	1.34	14.61	17.70	20.74	9.26
23-27	37.60	28.83	17.92	0.00	10.26	15.01	24.42	12.56
28-32	24.34	22.67	11.90	0.00	3.89	7.09	16.75	11.19
33-37	19.62	16.80	7.39	0.00	2.79	4.50	13.80	9.27
38-42	20.11	11.18	16.91	1.00	2.34	2.96	15.52	10.15
43-47	9.92	9.93	17.62	3.00	5.29	3.75	8.44	8.03
48-52	7.28	10.54	22.35	8.46	7.96	5.76	8.33	9.10
53-57	14.92	7.77	25.37	18.09	5.23	6.72	9.65	8.31
58-62	18.30	13.82	8.82	15.64	1.73	6.68	4.66	2.73
63-67	38.60	25.98	6.29	12.28	2.82	8.53	5.04	8.40
68-72	57.11	37.95	34.76	10.81	3.95	9.11	5.12	6.85
73-77	74.69	44.64	43.59	14.47	4.70	6.70	8.79	3.90
78-82	69.27	41.27	47.39	30.27	5.71	3.87	8.98	3.96
83+	35.49	37.55	56.30	25.20	16.45	7.72	20.26	7.57

Source: U.S. Census Bureau, 2017 National Population Projections.

**Figure 12. Projections of Net International Migration by Race and Hispanic Origin: 2017 to 2060**



Note: All race groups are non-Hispanic and the Hispanic group can be of any race. 'Other' includes Non-Hispanic American Indian and Alaska Native, Non-Hispanic Native Hawaiian and Other Pacific Islander, and Non-Hispanic Two or More Races.

Source: U.S. Census Bureau, 2017 National Population Projections.

**Table 3. Projected Foreign-Born Net Migration and Sex Ratios, by Race and Hispanic Origin: 2017 to 2060**

	Total (in thousands)	Percentage	Sex Ratio
<b>2017</b>	<b>985</b>	<b>100.0</b>	<b>96.5</b>
White	211	21.4	99.1
Black	100	10.1	91.9
Asian	294	29.9	83.5
Other	14	1.4	108.2
Hispanic	366	37.2	107.7
<b>2020</b>	<b>1,010</b>	<b>100.0</b>	<b>96.4</b>
White	214	21.1	98.2
Black	107	10.6	91.7
Asian	300	29.7	83.4
Other	15	1.4	107.2
Hispanic	375	37.1	108.1
<b>2030</b>	<b>1,086</b>	<b>100.0</b>	<b>94.9</b>
White	226	20.8	95.7
Black	131	12.1	89.2
Asian	318	29.3	82.7
Other	17	1.5	107.5
Hispanic	394	36.3	107.2
<b>2040</b>	<b>1,124</b>	<b>100.0</b>	<b>92.0</b>
White	235	21.0	93.2
Black	157	13.9	85.9
Asian	320	28.5	80.3
Other	17	1.5	105.0
Hispanic	395	35.1	103.9
<b>2050</b>	<b>1,138</b>	<b>100.0</b>	<b>88.9</b>
White	242	21.2	92.3
Black	183	16.1	83.4
Asian	316	27.8	78.2
Other	18	1.6	103.9
Hispanic	379	33.3	98.8
<b>2060</b>	<b>1,148</b>	<b>100.0</b>	<b>86.4</b>
White	246	21.4	91.8
Black	211	18.4	81.2
Asian	311	27.1	76.2
Other	18	1.6	102.9
Hispanic	362	31.5	94.9

Note: Sex ratios represent the number of men per 100 women. All race groups are non-Hispanic and Hispanics may be any race. The other race group includes Non-Hispanic American Indian and Alaska Native, Non-Hispanic Native Hawaiian and Other Pacific Islander, and Non-Hispanic Two or More Races.

Source: U.S. Census Bureau, 2017 National Population Projections