Methodology, Assumptions, and Inputs for the 2023 National Population Projections

November 2023

United States® Census Bureau

Table of Contents

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 revised periodically to incorporate updated data and revised assumptions about 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 2023 National Population Projections.

Methods

The projections were produced using a cohort-component method beginning with an estimated base population for July 1, 2022.[1] 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, 2023 to 2100, 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 2023 National Population Projections are described in detail in the sections that follow.

Base Population

The 2023 National Population Projections consist of the resident population by age, sex, race, Hispanic origin, and nativity through 2060 and by age, sex, and nativity for 2061 through 2100. The base population for the 2023 National Population Projections derives from the Census Bureau's Vintage 2022 Estimates of the resident population on July 1, 2022. These 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 2021 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 2022 estimates. Rounded values were used to create the native population,

[1] The base population derives from the Census Bureau's Vintage 2022 Population Estimates, which are partially based on the 2020 Census through the blended base method (U.S. Census Bureau, 2022).

which was then subtracted from the Vintage 2022 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 distinguished by year-of-entry cohort. This characteristic is added to the foreign-born population using data from the 2021 one-year ACS file. A year-of-entry distribution by age, sex, race, and Hispanic origin ranging from 0 to 10+ years since arrival in the United States 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 Census Bureau's intercensal estimates for the years 1990 to 2009 and the Vintage 2020 population estimates for 2010 to 2020. To create a consistent time series of estimates by the required characteristics, it was necessary 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 2020, 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 2020, 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 2020.[2].

The Census Bureau's population estimates do not distribute the population by nativity. To calculate population estimates by nativity, 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 2019 one-year ACS files were applied to the estimates for those years.[3] 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.

The outcome of these adjustments is final denominators which consist of population estimates by age, sex, race, Hispanic origin, and nativity from 1990 to 2020.

[2] Bridged race estimates are those where multiple-race responses are converted back to the single-race categories consistent with the 1977 OMB standards for data on race and ethnicity.
[3] 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.

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 2020 were used as the numerators in the 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.

The denominators discussed in the previous section are used to calculate both fertility and mortality measures. To calculate fertility rates, however, only required the use of population estimates for 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.[4]

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[5]
Hispanic	Asian or Pacific Islander
Non-Hispanic Asian or Pacific Islander	White
Other Non-Hispanic Foreign-Born	Other Native-born

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 during the same time period (equation 2).

Equation 2.

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

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).

For the 2023 National Population Projections, age-specific fertility rates were projected to 2100 by

[4] Non-residents are defined as persons whose reported state of residence is not one of the 50 states or the District of Columbia.

[5] Native groups include both Hispanic and non-Hispanic mothers.

assuming linear convergence of the age-specific fertility rates for all six nativity, race, and Hispanic origin groups in 2123. The 2123 convergence point is equal to the total fertility rate of the native White group in 2020, 1.52, distributed across ages using the age pattern of fertility from the foreign API group in that year. Using the age detail from the foreign API group shifts fertility toward older maternal ages over time.[6] After calculating the target value, age-specific fertility rates were interpolated from 2021 to 2123 by age, race, Hispanic origin, and nativity. The projected age-specific fertility rates were then multiplied by the population of women at each age, race, Hispanic origin, and nativity group to calculate the projected number of births from 2023 to 2100 (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 projected age-specific fertility rates for all women in 2020, 2040, 2060, 2080 and 2100. Over time, the pattern for all women is decreasing rates from ages 14 to 28 and increasing rates from ages 30 to 54. The age of peak fertility remains at age 31 across the projection period, starting at about 100 births per thousand women in 2020 and increasing to about 110 births per thousand women in 2100.

Figure 2 shows the age-specific fertility rates for each of the six nativity, race, and Hispanic origin groups in 2020. In that year, foreign-born Hispanics had higher fertility rates in the young adult ages compared with the other groups, while non-Hispanic foreign-born other race women had the highest rates in the older ages. Asian or Pacific Islander women, regardless of nativity, had the lowest age-specific fertility rates for ages under 20 in 2020.

Figure 3 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 the younger ages, rates for foreign-born Hispanics remain slightly higher, and rates for Asian or Pacific Islander women slightly lower than the other groups. However, for ages 35 and older, rates are relatively similar across all 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. Sex was assigned to projected births within each nativity, race, and Hispanic origin group of mothers. 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 2010 to 2020, within each of the six groups used to project fertility rates. All projected births are considered native.

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). The current application of this method is referred to as the

[6] Native White group includes both Hispanics and non-Hispanics.

"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.

Mortality

Data

Mortality rates were calculated from NCHS-compiled death registration data for 1989 to 2019.[7] In conjunction with population estimates from 1989 to 2019 from the denominator file discussed in the 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.[8]

Due to concerns about the quality of race reporting in the death data over the time series, non-

[7] The increased mortality from the COVID-19 pandemic in 2020 was assumed to be an isolated event. Therefore, 2020 death data were not included in formulation of the mortality assumptions.
[8] Non-residents are defined as persons whose reported state of residence is not one of the 50 states or the District of Columbia.

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 to residents who were foreign born. Native deaths are those to individuals born in the United States or in U.S. 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 by sex to the year 2123 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 2020 through 2100 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 2019. 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 2123 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 2123. Consequently, we selected the United Nations (UN) Model Life Tables with 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 2019 mortality rates by sex and single year of age. We used the natural logs of the 2019 and target mortality rates to interpolate values for 2023 through 2100 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.

Complete life tables, including survivorship ratios, were then produced from the mortality rates for 2023 through 2100. 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 or AIAN, regardless of their nativity. Despite having the lowest projected life expectancies at birth, from 2022 through 2060, people who are non-Hispanic Black and AIAN are projected to experience a larger increase in life expectancy during this time than any of the other groups. Between 2022 and 2060, life expectancy at birth for the native non-Hispanic Black and AIAN is anticipated to increase by about 9 years for males and 6 years for females. The projected increase in life expectancy is smaller for their foreign-born counterparts. There is less variation in life expectancy at birth among foreign-born race and Hispanic origin groups compared to the native race and Hispanic origin groups.

Foreign-born race and Hispanic origin groups had higher life expectancies at birth in 2022 compared

to each of their native counterparts. Foreign-born White and Asian or Pacific Islander females and foreign-born Hispanic females are projected to have the highest life expectancies at birth throughout the projection period. In 2022, the female foreign-born White and Asian or Pacific Islander group had the highest life expectancy at 85.6 years.

Figures 4-7 show mortality rates by age for the three race and Hispanic origin groups in 2022 and 2100. Mortality rates are generally projected to decline for all groups between 2022 and 2100, with some ages and groups experiencing more improvement than others. Overall, mortality rates start out lower for the foreign-born groups in 2022 for both males and females compared to their native peers.

Net International Migration

The projections of net international migration for the 2023 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: 1980-2100

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). The IDB projections are available through 2100.

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 2018 are presented in Figure 8. The populations of all regions grew between 1980 and 2018, though Asia and Africa grew substantially faster than the other regions. Asia had the largest population with over 4 billion in 2018.

Estimates of Foreign-Born Immigration: 1980-2018

Estimates of foreign-born immigration were developed using data from the 1990 and 2000 censuses and the 2001-2019 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.[9] 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 number 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 9 shows the immigration estimates from 1980 to 2018 by region. In general, the patterns observed in these immigration estimates have continued in the most recent years of data. All regions show some level of growth between 2014 to 2016 and decline from 2016 to 2018. The Asian and Latin America and Caribbean levels are substantially higher than the other groups at about 524 thousand and 396 thousand in 2018, respectively.

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 2018. 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).

[9] 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.

Equation 4.

$$Log_n(er) = a + bLog_n(n)$$

Where:

er = the emigration rate for year n

n = the year

a = the model intercept

b = the model coefficient

Figures 10a and 10b show 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 7.13 per 1,000 population in 1990 to 1.22 per 1,000 in 2018 with the model projecting a slight decline from about 2.50 per 1,000 in 2019 to about 2.00 per 1,000 in 2100.

The rates for Latin America and the Caribbean range from 1.46 per 1,000 population in 1980 to about 0.79 per 1,000 in 2018. The model projects rates to decline from about 0.63 per 1,000 in 2019 to about 0.57 in 2100.

Rates in the other regions were generally under 0.30 per 1,000 population, though the Europe, Canada, Oceania region jumped to about 0.40 per 1,000 in 1999. Europe's rates are projected to increase from 0.27 per 1,000 population in 2019 to 0.34 per 1,000 in 2100. The other three groups (Asia, Sub-Saharan Africa, and Near East and North Africa) are projected to have very stable rates between 0.10 and 0.18 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. Figures 11 and 12 present the projections of total foreign-born immigration and immigration from within each of the six regions.

Figure 11 shows the projected total foreign-born immigration from 2023 to 2100. It starts at about 1.57 million in 2023 and gradually increases across the projection period to about 2.06 million in 2100.

Figure 12 shows the projected total foreign-born immigration from 2023 to 2060 by sending region. In 2060, just under 600,000 immigrants are projected to come from Asian countries and about 356 thousand are projected to come from Latin America and the Caribbean. More than 300,000 are projected to come from Mexico 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 120 thousand in 2023 to over 300 thousand 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 through 2060 using the distributions of characteristics of immigrants within each of the six country of birth groupings from the 2015-2019 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 13 shows the race and Hispanic origin distribution of projected foreign-born immigrants through 2060. Hispanics are projected to remain the largest immigrant group, although their share of the immigrant population decreases from about 36.1 percent in 2023 to about 31.3 percent in 2060. The proportion of immigrants that are non-Hispanic Asian is also projected to decrease slightly from about 30.9 percent in 2023 to about 28.5 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 2023 to 2060. The proportion of immigrants who are non-Hispanic Black is projected to increase substantially from 10.2 percent in 2023 to more than 17.7 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.

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

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 andt_2.

Foreign-born population and immigration data came from the 2015-2019 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 t1-t2 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: 2015-2017, 2016-2018, and 2017-2019. Two of the rates have three-year periods: 2015-2018 and 2016-2019 and one rate has a four-year period: 2015-2019. We average the six rates to produce the final rate. To include a longer time series of input data in our emigration assumption and minimize the risk of assuming the trends from a particular point in time will be carried forward in the long term, we averaged the emigration rates with the emigration rates from the 2017 National Projections, which were calculated using the method described above and ACS data covering 2011-2015.

Table 2 presents the foreign-born emigration rates by age, sex, Hispanic origin, and arrival cohorts. In general, those who arrived more than 10 years ago have much lower rates of emigration than those who arrived more recently. The highest rates tend to be among those recently arrived and who are in the older age groups. Also, male groups tend to have higher emigration rates than females across the age and Hispanic origin groups.

Foreign-Born Emigration Projections

The average of the six rates was applied 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. We used the estimates of the native net emigration from the Vintage 2022 National Estimates by age, sex, race, and Hispanic origin for 2022 as the native net migration estimates and held them constant for all years of the projections.

Puerto Rico net migration by age and sex was obtained from IDB projections for 2020 through 2100. Net migration from Puerto Rico is modeled in the IDB.[10]

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 14 shows the total net international migration from 2023 to 2100. The level gradually rises from a low of 853 thousand in 2023 to a high of 976 thousand in 2079, then gradually drops to 944 thousand in 2100.

Figure 15 shows net international migration by race and Hispanic origin. Hispanics have the highest levels of net international migration across the projection period, running between 281 and 308 thousand. The non-Hispanic Asian group holds steady across the period at around 290 thousand. Non-Hispanic White values are relatively constant across the period at about 160 thousand. The Non-Hispanic Other group also has a very flat pattern at around 22 thousand across the projection period. In contrast to the other groups, net migration for the Non-Hispanic Black population increases substantially across the period from about 84 thousand in 2023 to about 200 thousand in 2060.

Table 3 shows the distribution and sex ratios of net international migration by race and Hispanic

[10] For more information on the net migration calculations in the IDB, please visit https://www.census.gov/programs-surveys/international-programs/about/idb.html

origin from 2023 to 2060. The percent of net international migrants that are projected to be non-Hispanic White remained mostly constant through 2060 at less than 20 percent. The percent non-Hispanic Black is projected to increase from 9.9 percent in 2023 to 21.0 percent in 2060, while the percent non-Hispanic Asian is projected to decrease from 33.8 percent in 2023 to 29.6 percent in 2060. Hispanics are projected to decrease from 34.4 percent of net international migration in 2023 to 29.4 percent in 2060.

Over the projection period, the sex ratio of net international migration decreases from 86.6 in 2023 to 83.7 in 2060. The only group that has a sex ratio over 100.0 is the Non-Hispanic Other group. Non-Hispanic Asians have the lowest sex ratios starting with 78.3 in 2023 and declining to 74.6 in 2060 while the other groups tend to be closer to 100.0.

Population Projections

The projected fertility rates, mortality rates, and international migration components described in this document were used to generate the main series of projections of the U.S. 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 2023 to 2060 by nativity, age, sex, race, and Hispanic origin and from 2061 to 2100 by nativity, age, and sex.

In addition to the main series of projections described above, we have produced three alternative versions of the 2023 National Projections: 'high immigration', 'low immigration' and 'zero immigration'. Foreign-born immigration is arguably the most uncertain of the population change components used to produce our projections, so we have opted to base our alternative projection scenarios on variations to this component. These scenarios illustrate the sensitivity of the projections, in terms of total population change as well as changes in the composition of the population, to variation in the foreign-born immigration component.

We developed the alternative series by manipulating the level of foreign-born immigration. No changes were made to the foreign-born emigration rates for these scenarios, nor were changes made to projections of the net native-born migration, which includes migration between the United States and Puerto Rico as well as migration of the native born. The fertility and mortality inputs for the main series were also used to develop these alternative scenarios.

The high foreign-born immigration inputs were created by increasing the main series' foreign-born immigration projections by 50 percent.

The low foreign-born immigration inputs were created to be log symmetrical to the high immigration scenario. It is important to use log symmetry because the low scenario can only vary between the main series value and 0, whereas the high scenario can vary between the main series value and infinity. For example, if we doubled the main series for the high scenario and reduced the main series values by the same amount for the low scenario, then the low scenario would be 0 across the time series. Making them log symmetrical allows the low scenario to approach 0 as the high scenario approaches infinity. To calculate the low scenario, we:

1) take the log of the main and high series;
2) subtract the main series log value from the high series log value;
3) subtract that difference from the main series log value; and
4) reverse the log transformation.

The zero immigration inputs were created by setting all foreign-born immigration values to 0. The zero-immigration series is useful in analyzing the overall impact of foreign-born immigration on the size and

composition of the U.S. population. This series is provided for analytical purposes only and does not indicate that foreign-born immigration has dropped to zero or that it is expected to fall to zero.

Each projection scenario was processed with the same code used to produce the main series; the exception being that the alternative foreign-born immigration files were referenced for each version rather than the main series file.

Projections of the resident population and components of change from the 2023 National Population Projections are available on the Census Bureau Web site at https://www.census.gov/programs-surveys/popproj.html.

References

Ahmed, B. and G. Robinson. 1994. "Estimates of Emigration of the Foreign-born Population: 1980-1990." Population Division Working Paper No. 9, U.S. Census Bureau.

Guarneri, C.E. and C. Dick. 2012. *Methods of Assigning Race and Hispanic Origin to Births from Vital Statistics Data*. Presented at the Federal Committee on Statistical Methodology Annual Meeting, January 10-12, Washington, DC.

Hollmann, F.W. and W.W. Kingkade. 2005. *Impact of Racial and Ethnic Exogamy and International Migration on Forecast Population Distributions for the United States in 2030: Results of a Macro-Simulation*. Presented at the XXV International Population Conference of the International Union for the Scientific Study of Population, Tours, France.

Office of Management and Budget. 1997. *Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity*. Federal Register 62FR58781-58790, October 30, 1997. <https://obamawhitehouse.archives.gov/omb/fedreg_1997standards>.

Smith, A.S. and N.A. Jones. 2003. *Dealing with the Changing U.S. Racial Definitions: Producing Population Estimates Using Data with Limited Race Detail*. Presented at the Annual Meetings of the Population Association of America, Minneapolis, MN.

U.S. Census Bureau. 2023. *International Data Base.* < https://www.census.gov/data-tools/demo/idb/#/dashboard?COUNTRY_YEAR=2023&COUNTRY_YR_ANIM=2023>.

_____. 2020. *International Data Base: Population Estimates and Projections Methodology*. < https://www2.census.gov/programs-surveys/international-programs/technical-documentation/methodology/idb-methodology.pdf>.

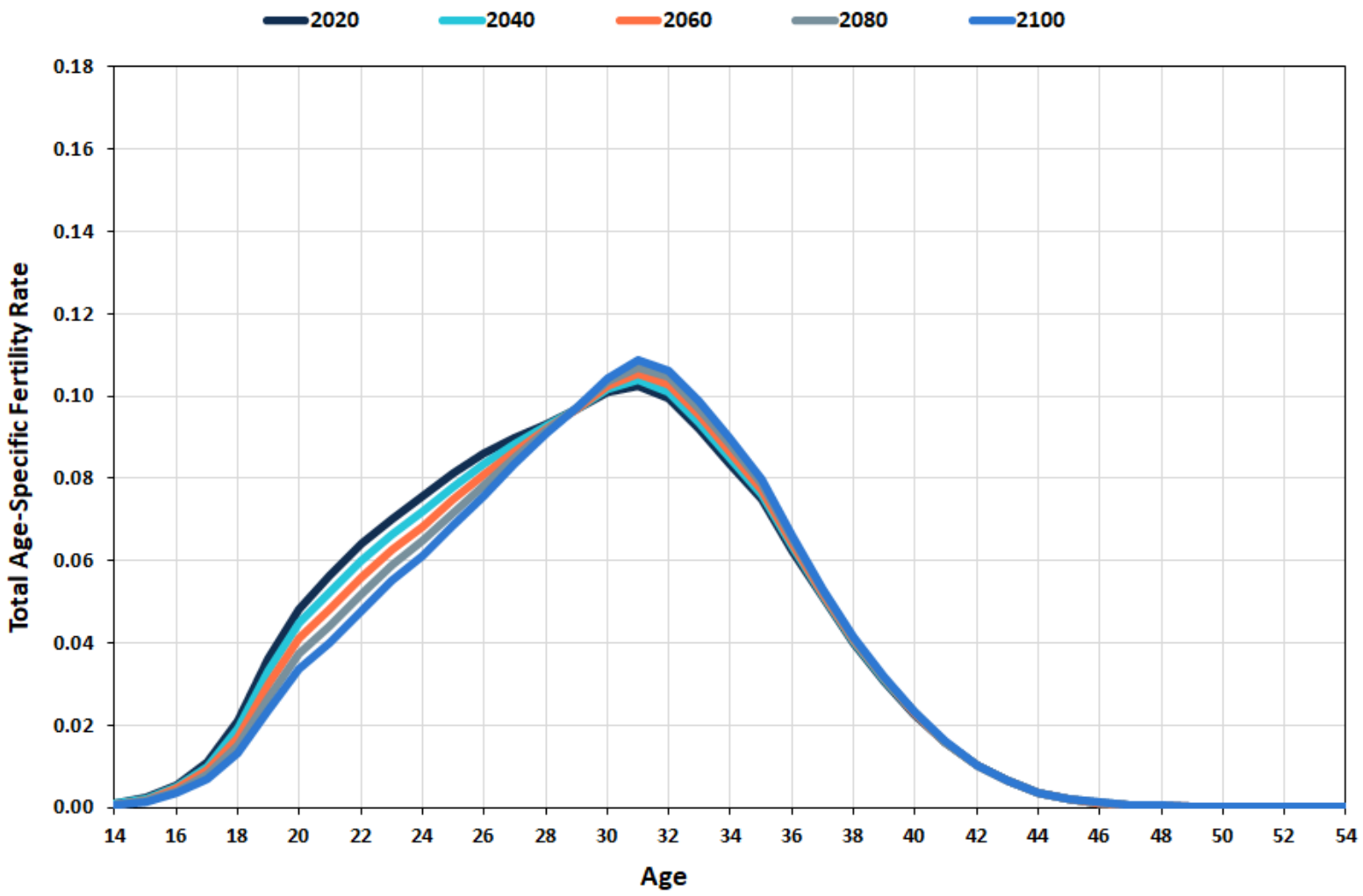
_____. 2022. *Vintage 2022 Nation, States, Counties, and Puerto Rico Population Methodology.* < https://www.census.gov/programs-surveys/popest/technical-documentation/methodology.html>.

_____. 2011. *Intercensal Estimates*. <http://www.census.gov/popest/data/intercensal>.

United Nations. 2023. *Model Life Tables: Complete life tables (1 year increment).* < https://www.un.org/development/desa/pd/data/model-life-tables >.

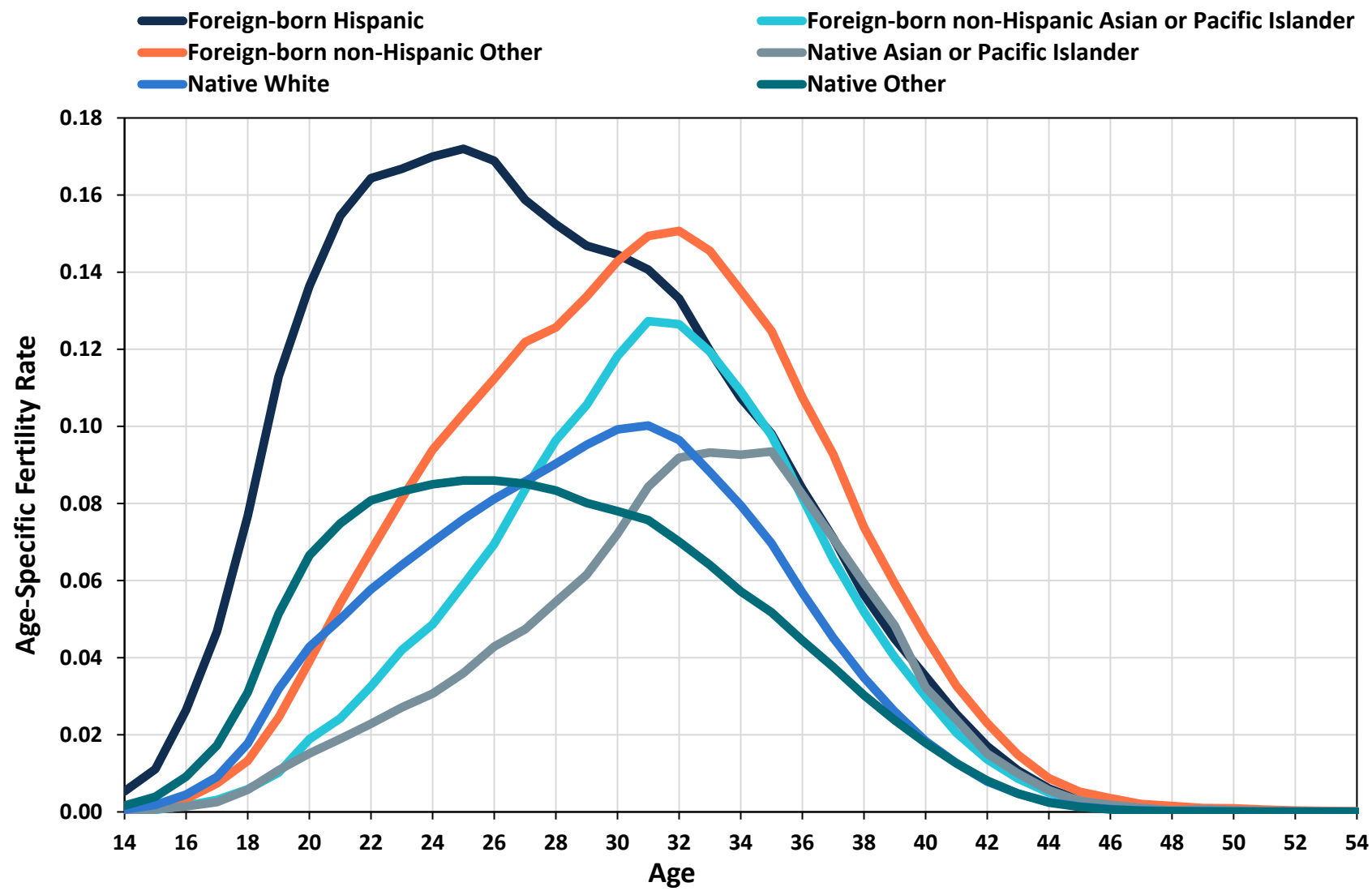
Tables and Figures

Figure 1. Total Age-Specific Fertility Rates: 2020 to 2100



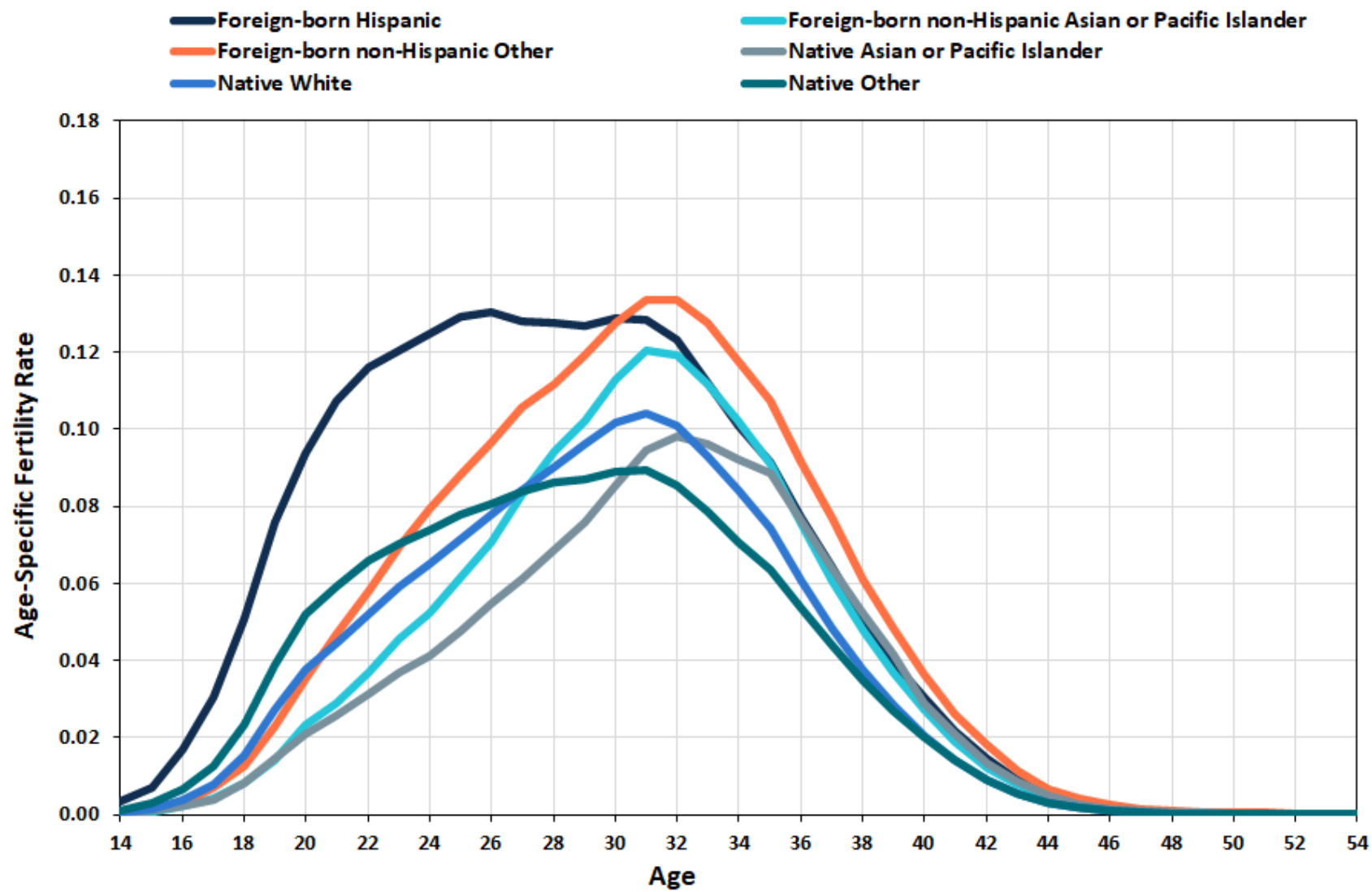
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 2. Age-Specific Fertility Rates by Nativity, Race, and Hispanic Origin: 2020



Note: The 'other' race group represents Black and American Indian or Alaska Native races.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 3. Projected Age-Specific Fertility Rates by Nativity, Race, and Hispanic Origin: 2060



Note: The 'other' race group represents Black and American Indian or Alaska Native races.
Source: U.S. Census Bureau, 2023 National Population Projections.

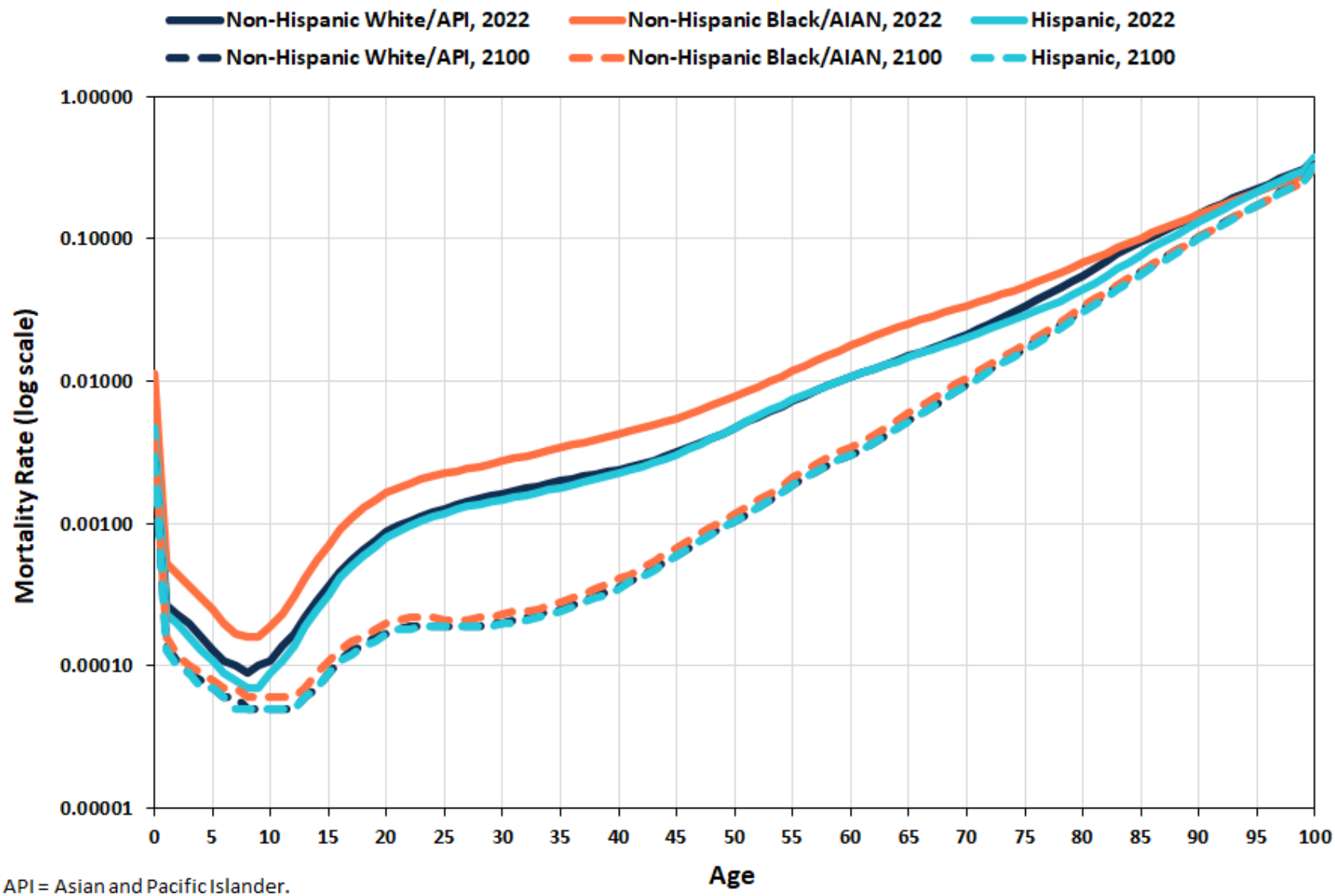
Table 1. Life Expectancy at Birth and Age 65 by Nativity, Sex, Race, and Hispanic Origin: 2022 and Projected to 2100

	Projection Year								
	2022	2030	2040	2050	2060	2070	2080	2090	2100
Life Expectancy at Birth									
Total Male	77.2	78.5	79.9	81.3	82.5	83.5	84.5	85.5	86.3
Native-born Male	76.5	77.9	79.5	80.9	82.2	83.3	84.4	85.3	86.2
White/API	77.2	78.5	79.9	81.2	82.4	NA	NA	NA	NA
Black/AIAN	71.5	73.6	76.1	78.2	80.1	NA	NA	NA	NA
Hispanic	78.3	79.5	80.8	82.0	83.1	NA	NA	NA	NA
Foreign-born Male	81.1	81.9	82.7	83.6	84.3	85.0	85.6	86.3	86.8
White/API	81.5	82.2	83.0	83.7	84.4	NA	NA	NA	NA
Black/AIAN	80.2	81.1	82.1	83.0	83.9	NA	NA	NA	NA
Hispanic	80.9	81.7	82.6	83.5	84.3	NA	NA	NA	NA
Total Female	82.1	83.0	84.1	85.2	86.1	87.0	87.9	88.7	89.4
Native-born Female	81.5	82.5	83.7	84.8	85.8	86.8	87.7	88.5	89.3
White/API	81.9	82.9	84.0	85.0	86.0	NA	NA	NA	NA
Black/AIAN	78.2	79.7	81.5	83.1	84.5	NA	NA	NA	NA
Hispanic	83.6	84.4	85.3	86.2	86.9	NA	NA	NA	NA
Foreign-born Female	85.5	86.0	86.6	87.2	87.8	88.3	88.8	89.4	89.9
White/API	85.6	86.1	86.7	87.3	87.8	NA	NA	NA	NA
Black/AIAN	84.4	85.1	85.9	86.6	87.3	NA	NA	NA	NA
Hispanic	85.5	86.0	86.6	87.2	87.8	NA	NA	NA	NA
Life Expectancy at Age 65									
Total Male	18.8	19.3	19.9	20.5	21.1	21.6	22.2	22.7	23.2
Native-born Male	18.5	19.0	19.7	20.3	20.9	21.5	22.1	22.7	23.2
White/API	18.7	19.2	19.8	20.4	21.0	NA	NA	NA	NA
Black/AIAN	16.4	17.2	18.1	19.0	19.9	NA	NA	NA	NA
Hispanic	19.7	20.2	20.7	21.2	21.7	NA	NA	NA	NA
Foreign-born Male	20.9	21.2	21.5	21.9	22.3	22.6	23.0	23.3	23.6
White/API	21.0	21.3	21.6	22.0	22.3	NA	NA	NA	NA
Black/AIAN	20.3	20.7	21.1	21.5	22.0	NA	NA	NA	NA
Hispanic	20.8	21.2	21.5	21.9	22.3	NA	NA	NA	NA
Total Female	21.4	21.9	22.5	23.1	23.7	24.2	24.8	25.4	25.9
Native-born Female	21.1	21.6	22.3	22.9	23.5	24.1	24.7	25.3	25.8
White/API	21.1	21.6	22.3	22.9	23.5	NA	NA	NA	NA
Black/AIAN	19.8	20.5	21.4	22.2	22.9	NA	NA	NA	NA
Hispanic	22.5	22.9	23.4	23.9	24.3	NA	NA	NA	NA
Foreign-born Female	23.4	23.7	24.0	24.4	24.8	25.1	25.5	25.9	26.2
White/API	23.4	23.7	24.0	24.4	24.8	NA	NA	NA	NA
Black/AIAN	23.1	23.4	23.8	24.2	24.6	NA	NA	NA	NA
Hispanic	23.4	23.7	24.1	24.5	24.8	NA	NA	NA	NA

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

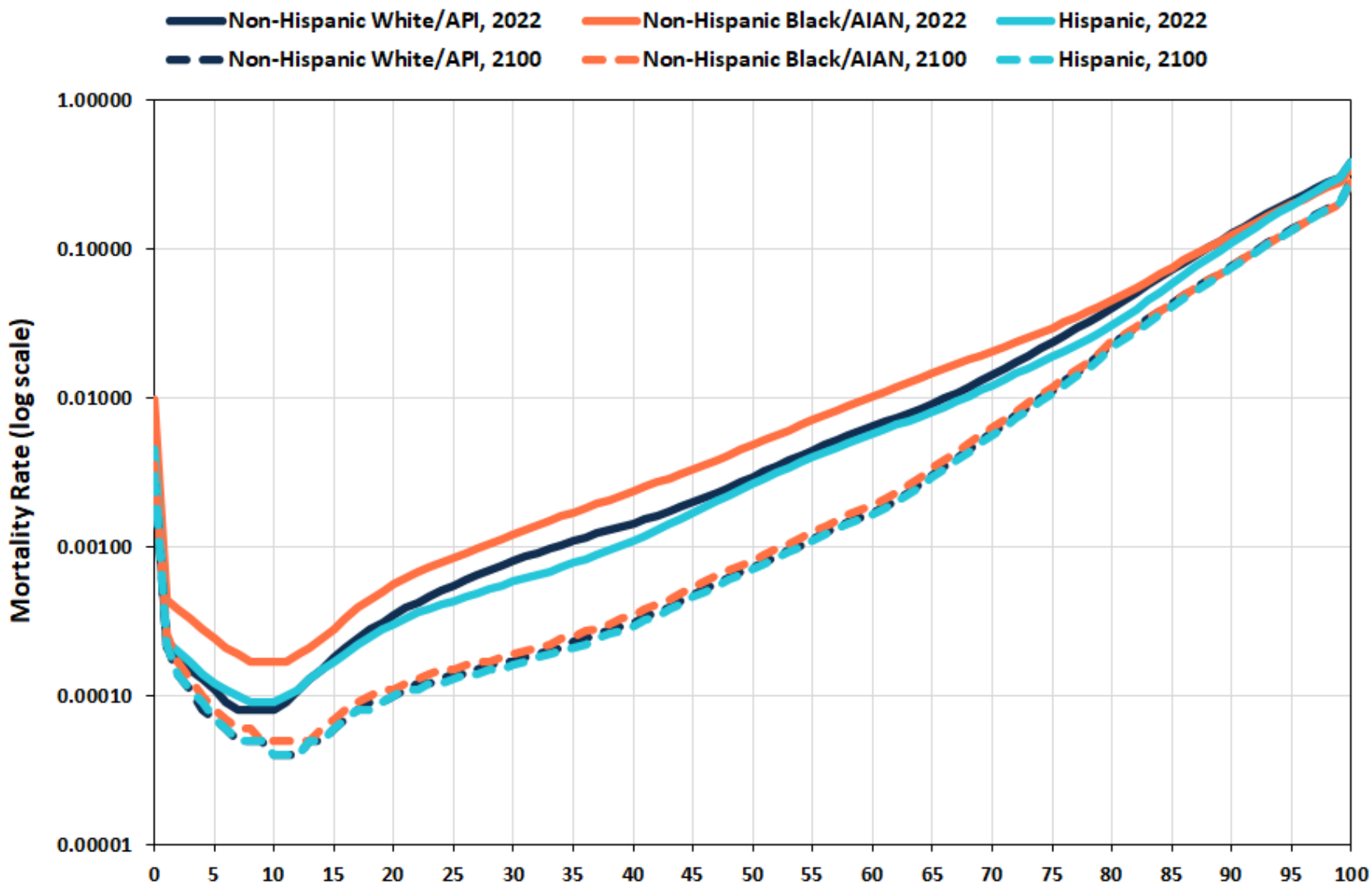
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 4. Mortality Rates by Age, Race, and Hispanic Origin for Native Males: 2022 and Projected in 2100



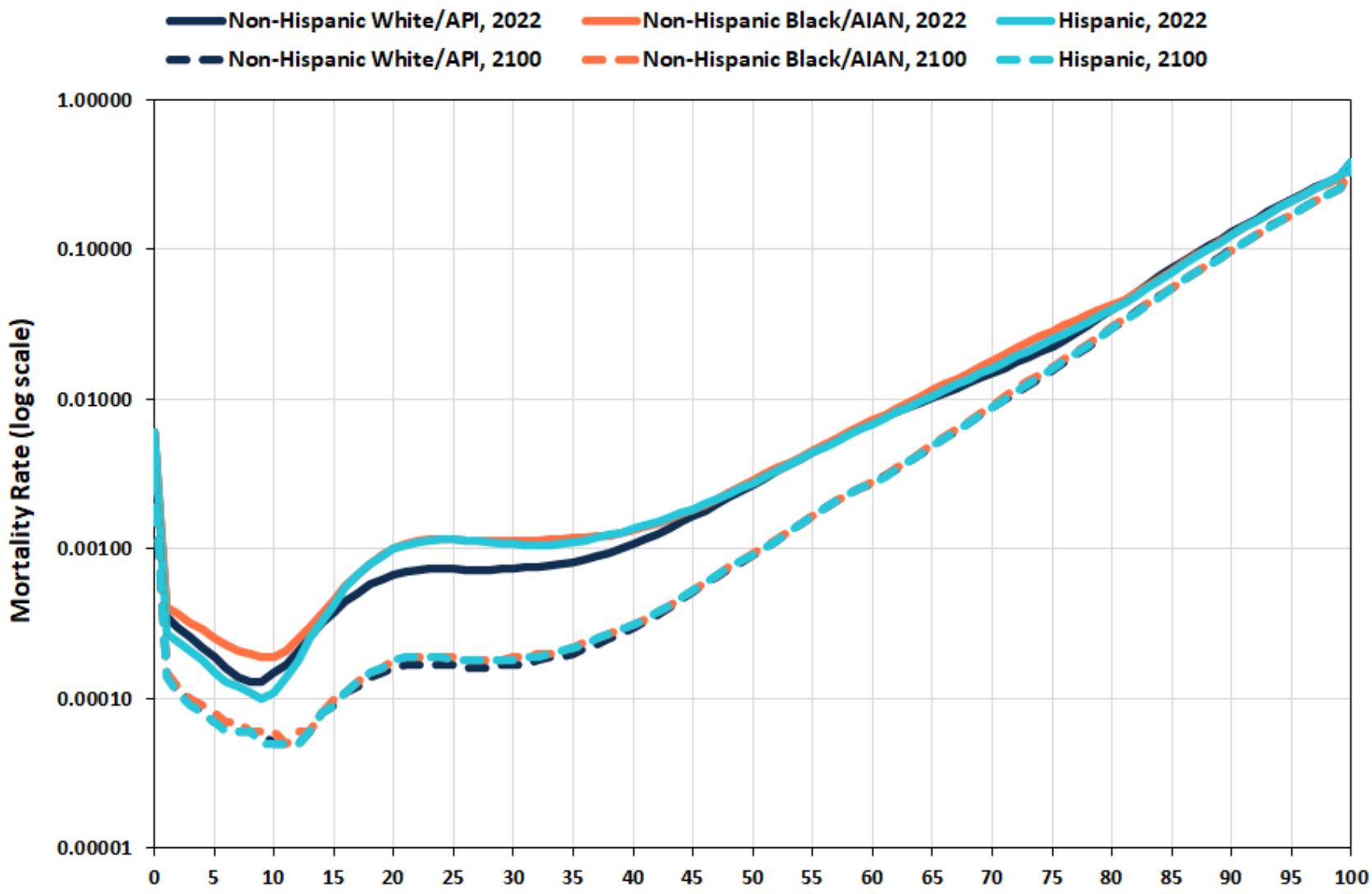
API = Asian and Pacific Islander.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 5. Mortality Rates by Age, Race, and Hispanic Origin for Native Females: 2022 and Projected in 2100



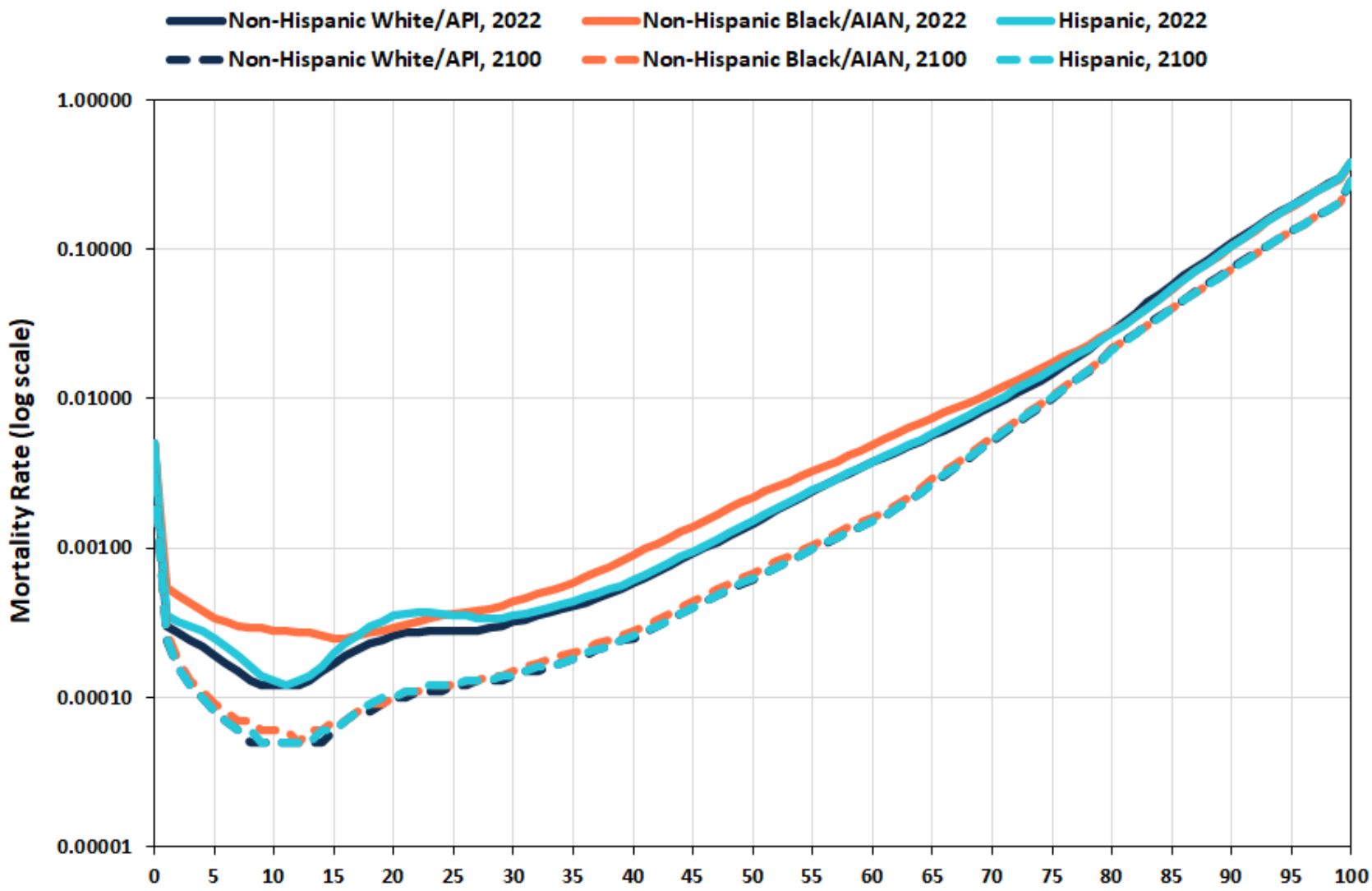
API = Asian and Pacific Islander.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 6. Mortality Rates by Age, Race, and Hispanic Origin for Foreign-born Males: 2022 and Projected in 2100



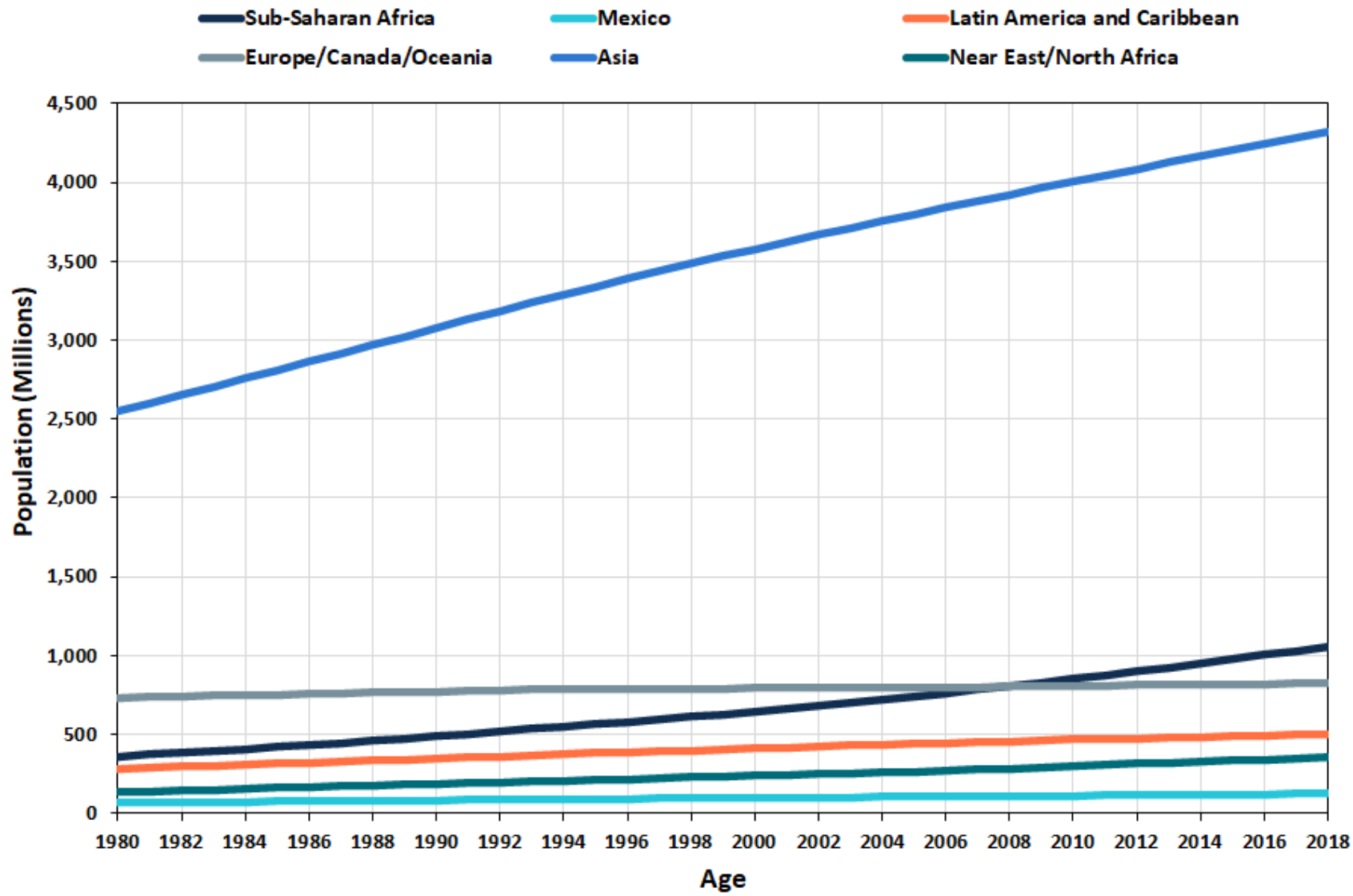
API = Asian and Pacific Islander.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 7. Mortality Rates by Age, Race, and Hispanic Origin for Foreign-born Females: 2022 and Projected in 2100



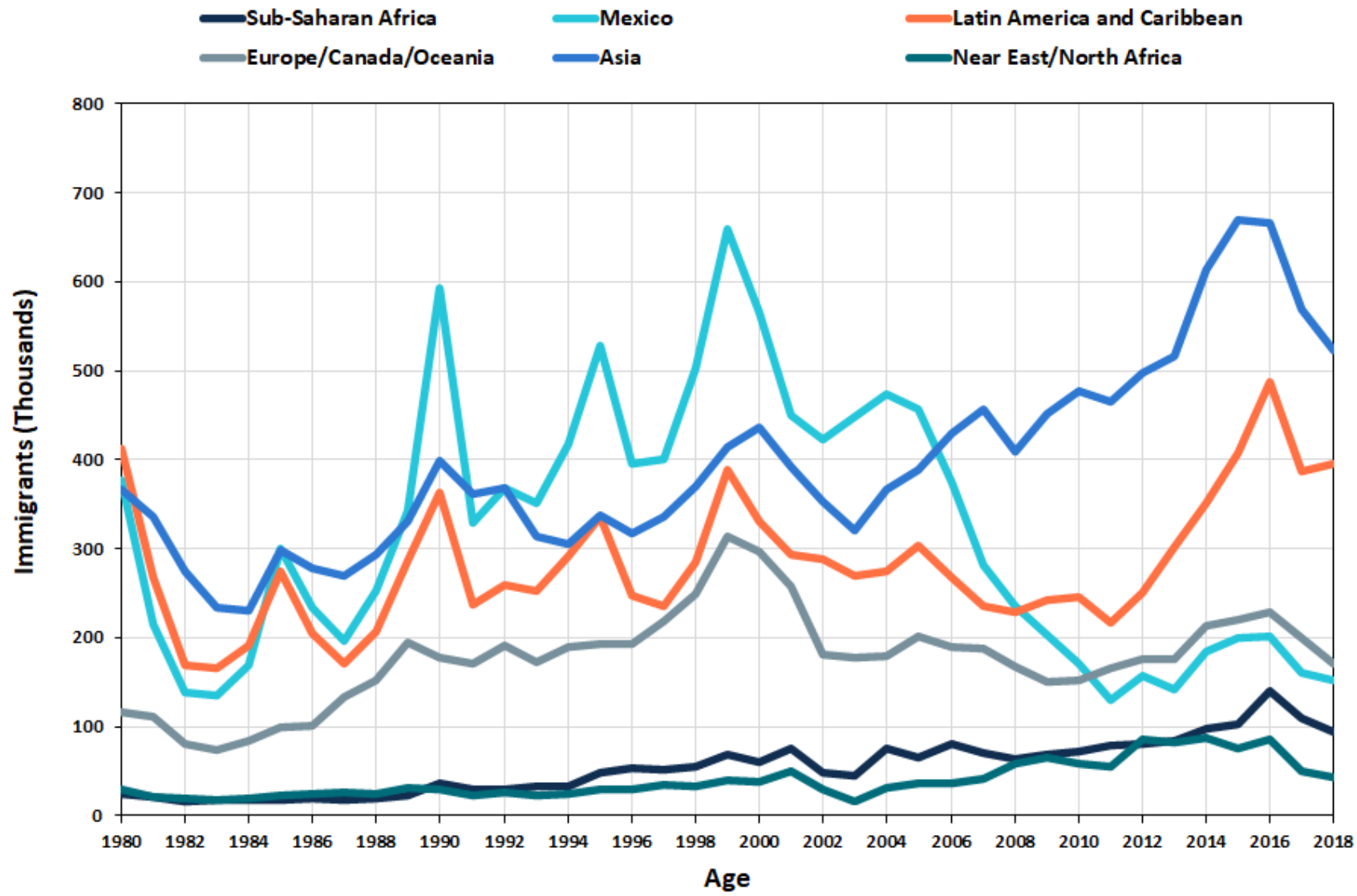
API = Asian and Pacific Islander.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 8. Population Estimates for Sending Regions: 1980 to 2018



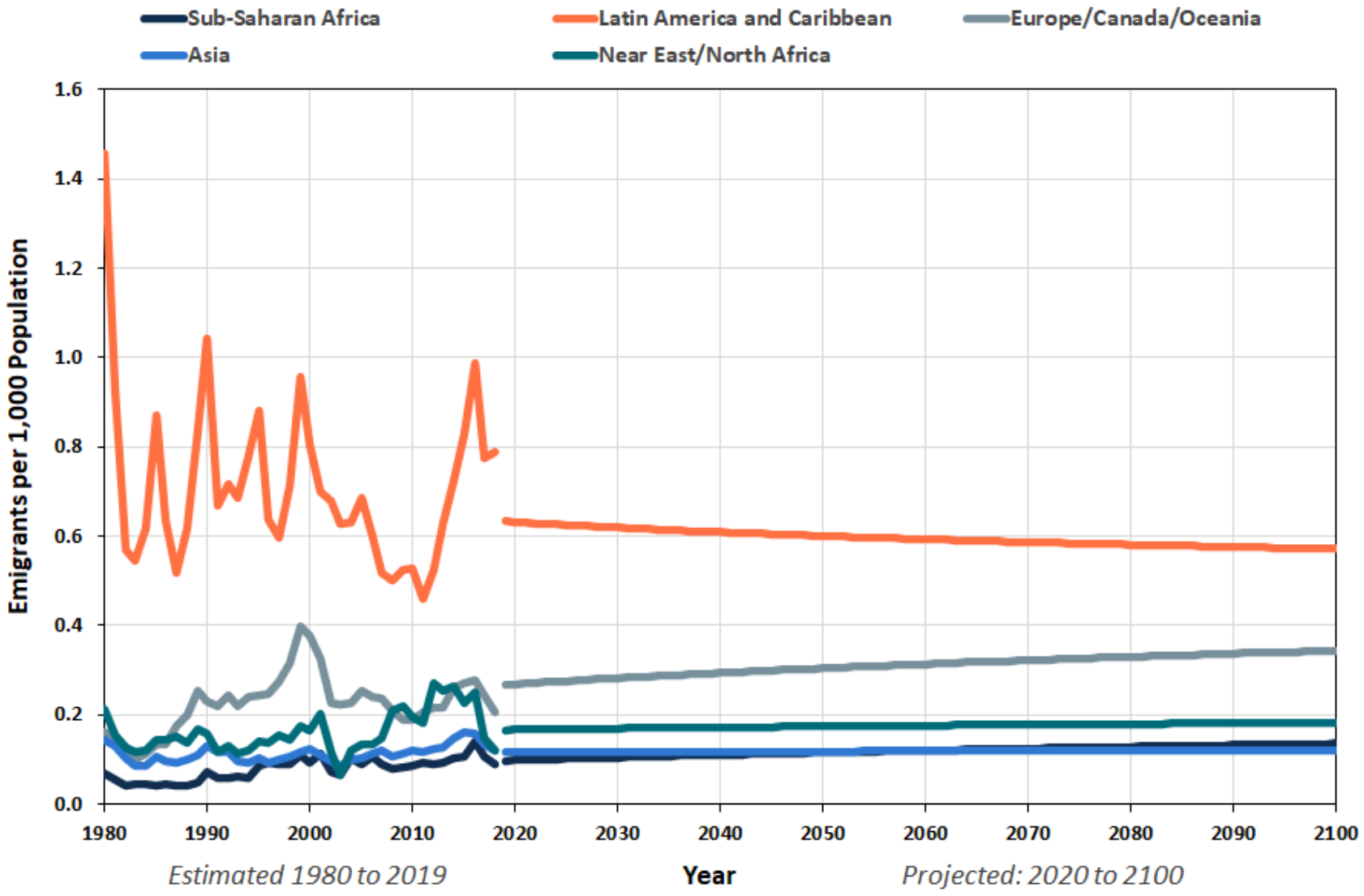
Source: U.S. Census Bureau, Population Division, International Data Base (2023).

Figure 9. Immigration Estimates by Sending Region: 1980 to 2018



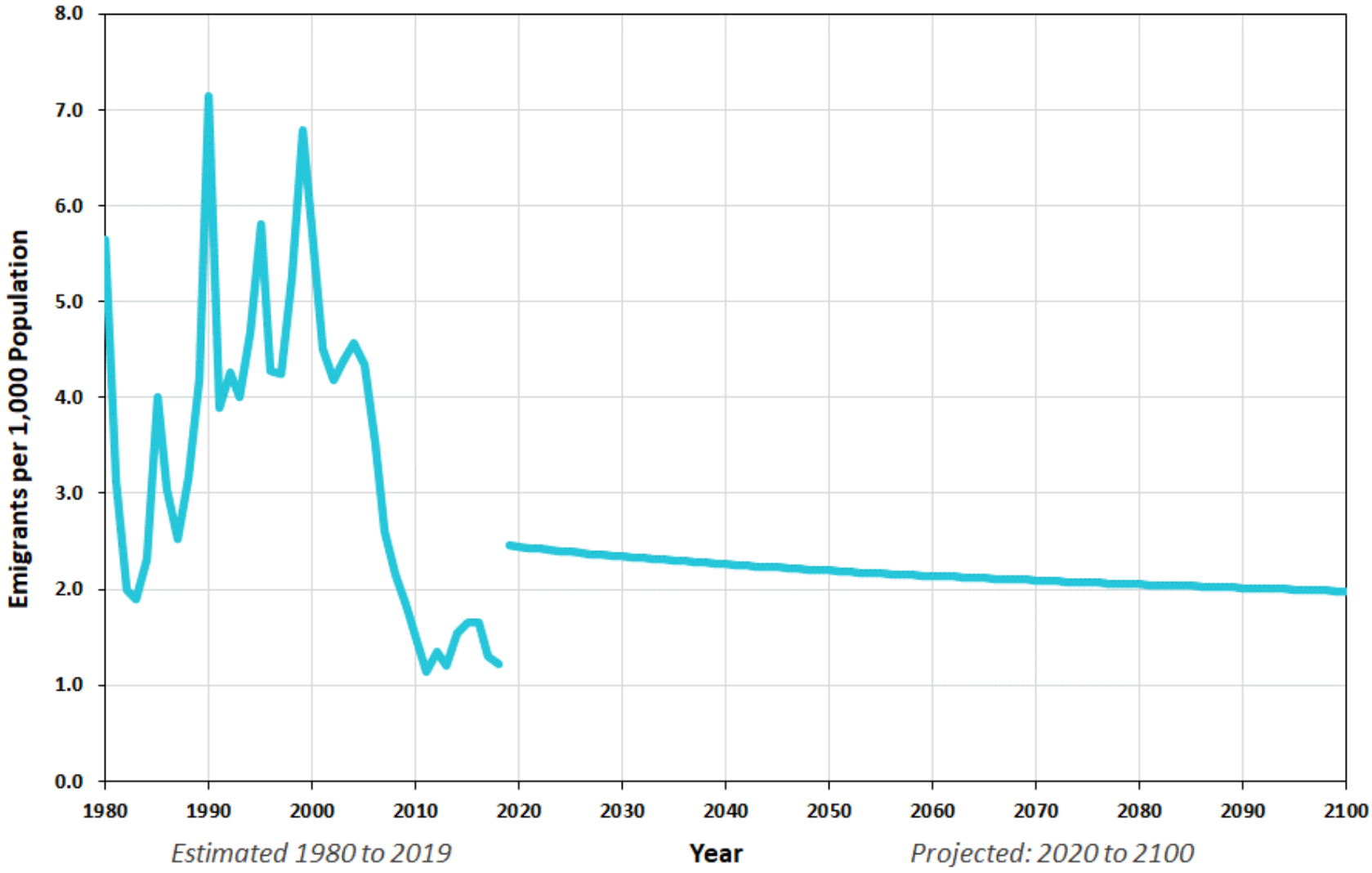
Source: U.S. Census Bureau, Population Division, International Data Base (2023).

Figure 10a. Emigration Rates from Sending Regions to the United States: 1980 to 2100



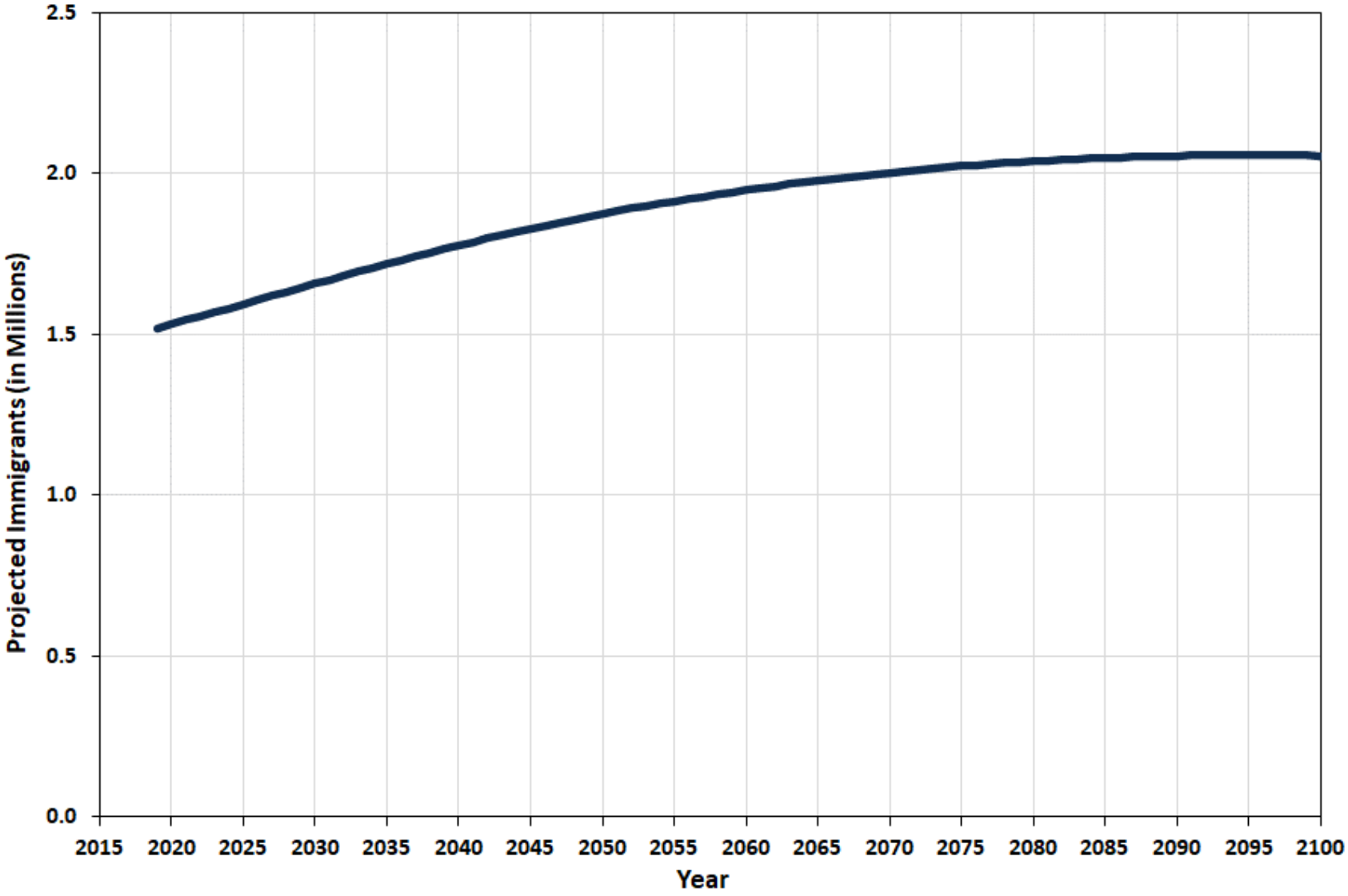
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 10b. Emigration Rates from Mexico to the United States: 1980 to 2100



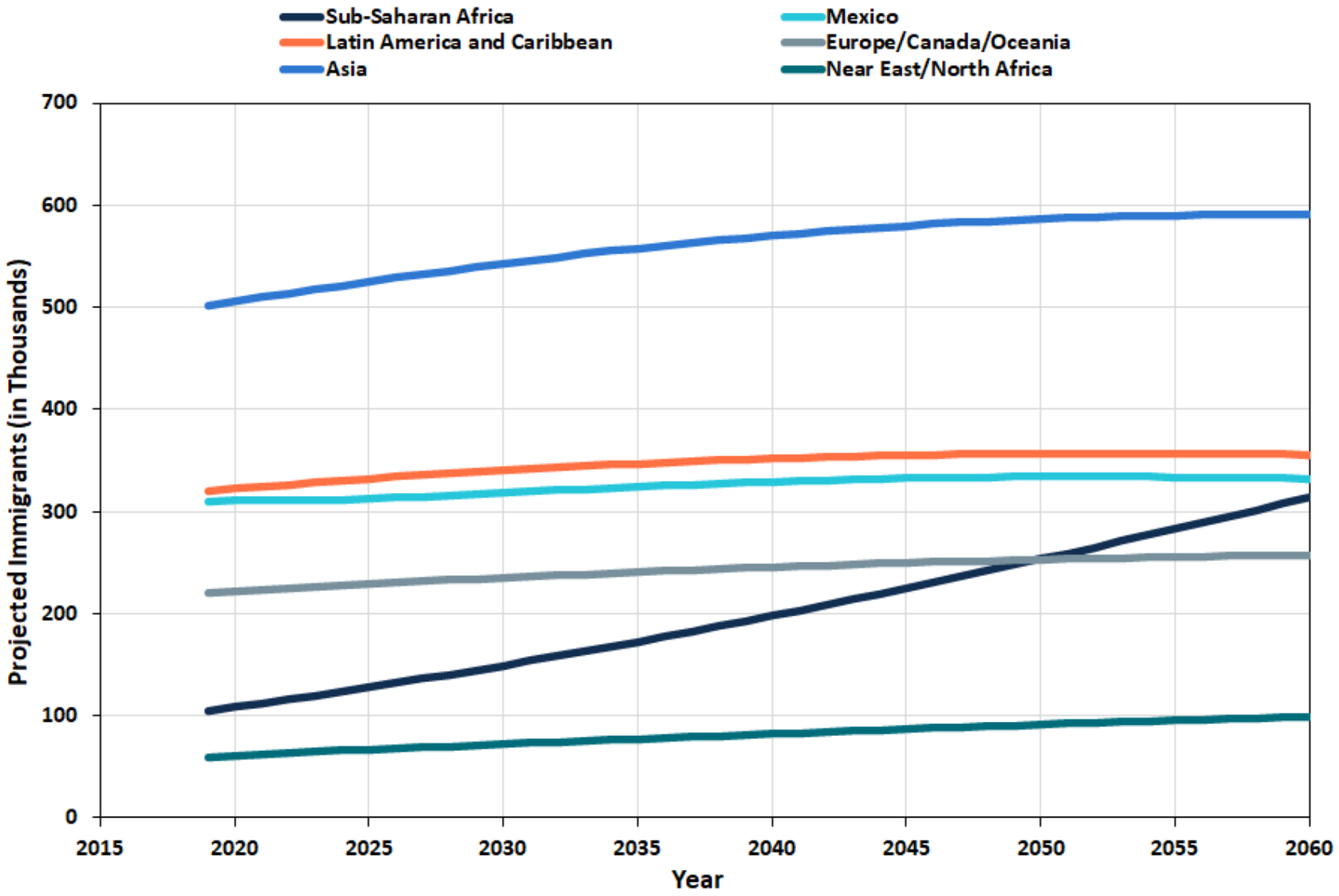
Note: Emigration rates from Mexico are shown in a separate figure from other regions because rates from Mexico are substantially larger than those in Figure 10a.
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 11. Projections of Foreign-Born Immigration to the United States: 2019 to 2100



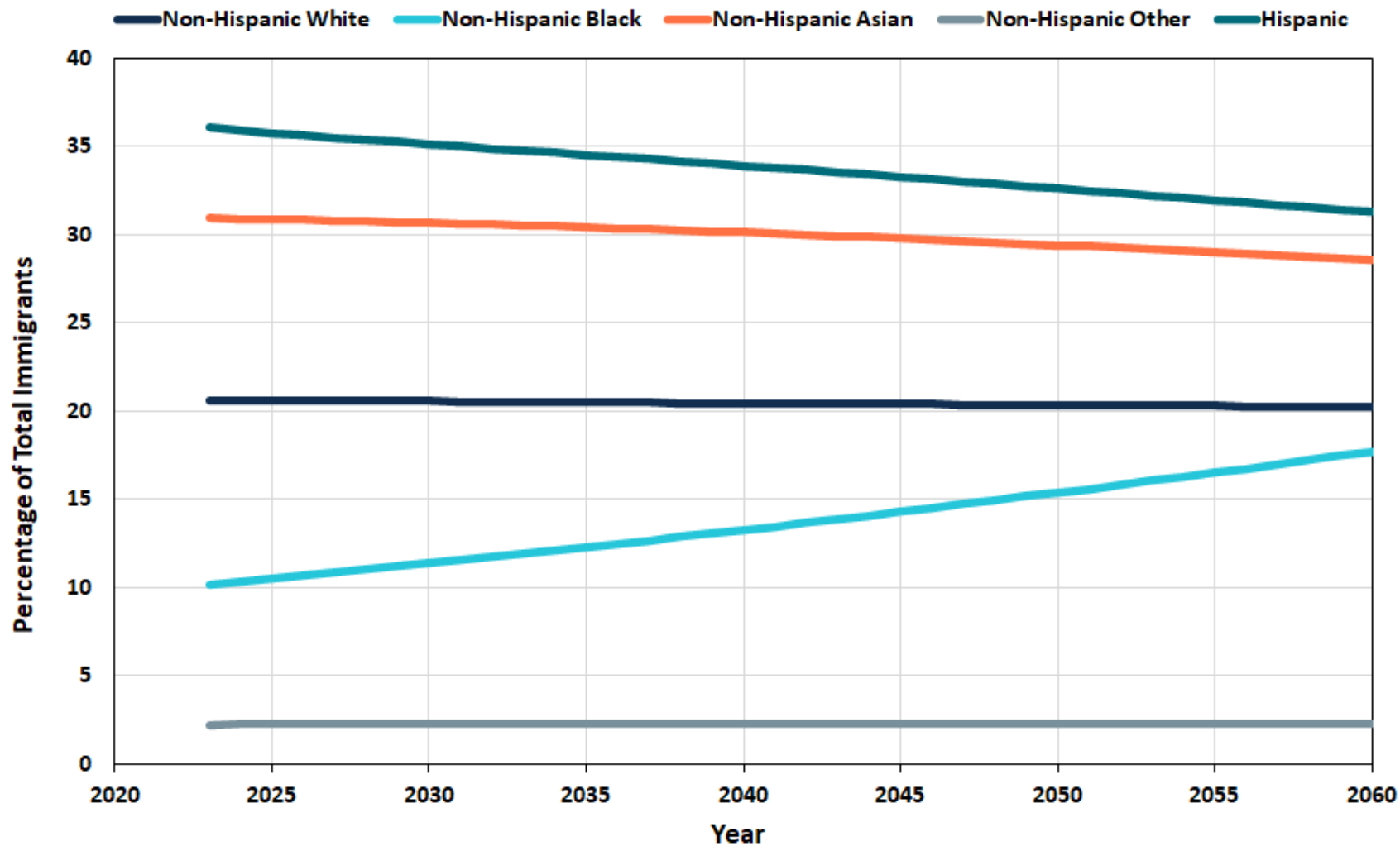
Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 12. Projections of Foreign-Born Immigration to the United States by Sending Region: 2019 to 2060



Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 13. Distribution of Projected Foreign-Born Immigrants to the United States by Race and Hispanic Origin: 2023 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 Hawiian and Pacific Islander, and non-Hispanic Two or More Races.
Source: U.S. Census Bureau, 2023 National Population Projections.

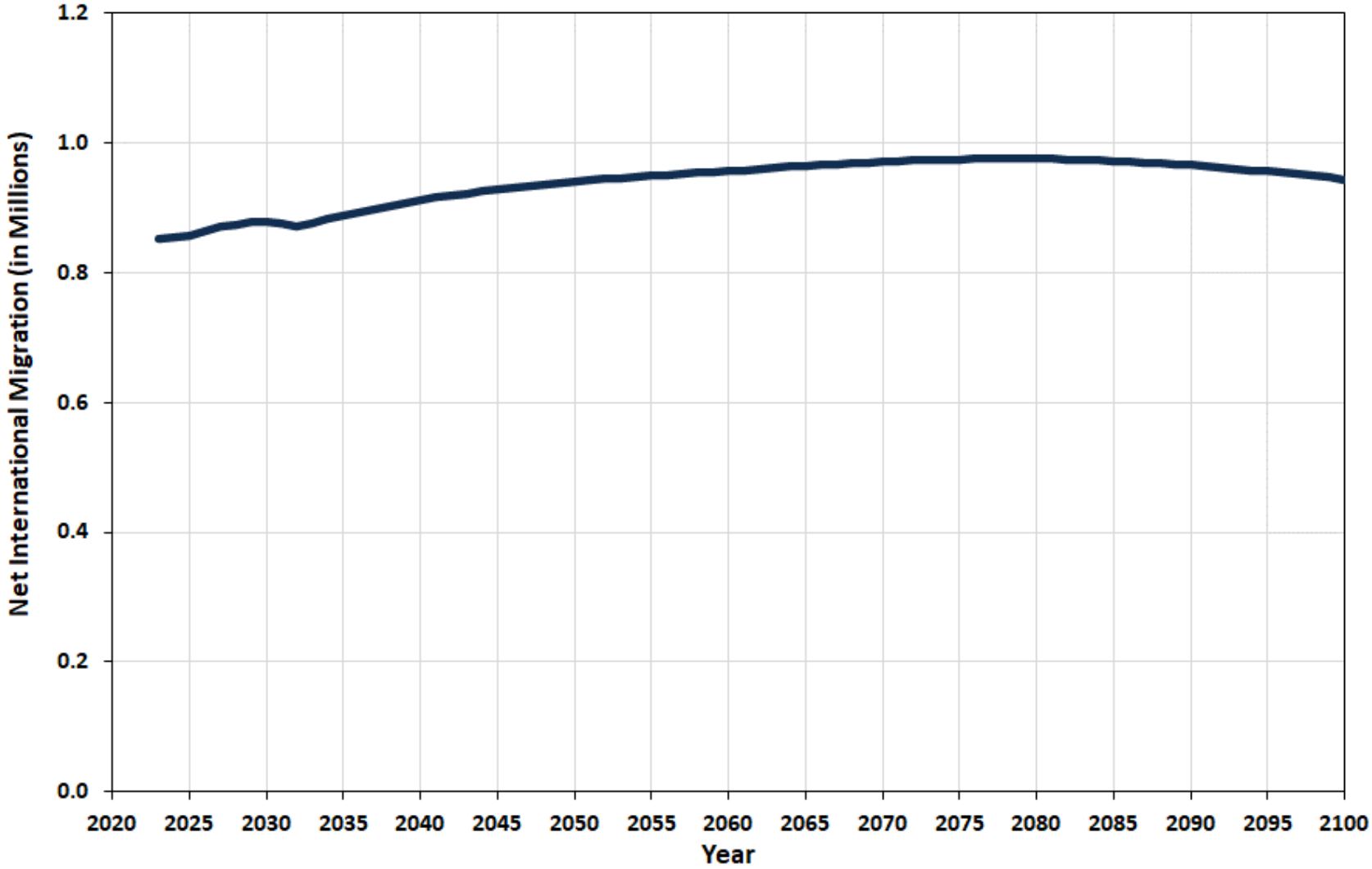
Table 2. Foreign-Born Emigration Rates (Emigrants per 1,000 Population) by Arrival Cohort, Sex, Hispanic Origin, and Age Group

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	61.61	74.90	123.92	95.83	NA	NA	NA	NA
5-9	42.65	52.16	48.07	34.00	NA	NA	NA	NA
10-14	25.72	26.07	2.69	2.02	6.39	9.44	26.78	24.84
15-17	23.35	20.20	5.87	6.56	6.42	9.15	14.43	11.24
18-22	40.65	36.60	14.30	11.12	11.86	13.41	23.65	14.51
23-27	48.29	40.65	20.23	6.29	9.52	11.07	31.22	16.09
28-32	34.95	31.25	15.57	0.50	5.94	8.29	23.24	15.41
33-37	30.92	24.83	13.40	0.65	7.78	7.80	17.97	15.17
38-42	28.91	18.22	20.79	6.08	9.50	6.35	21.18	16.15
43-47	18.22	16.05	17.44	8.55	8.03	6.11	17.46	12.81
48-52	19.53	18.23	21.21	13.48	8.93	8.24	15.16	11.94
53-57	28.59	22.15	25.31	16.87	7.91	7.31	13.28	10.56
58-62	34.76	35.85	16.80	27.25	3.97	5.97	9.81	5.92
63-67	52.36	50.61	21.40	33.35	6.39	7.69	12.13	9.72
68-72	66.75	62.67	40.73	35.83	8.26	7.05	10.08	7.46
73-77	78.40	68.55	52.56	40.37	6.83	4.74	8.02	5.79
78-82	82.56	60.83	60.98	41.72	7.97	4.69	12.42	6.27
83+	59.38	54.60	57.08	52.34	15.59	10.42	17.39	9.66

NA = Not Applicable.

Source: U.S. Census Bureau, 2023 National Population Projections.

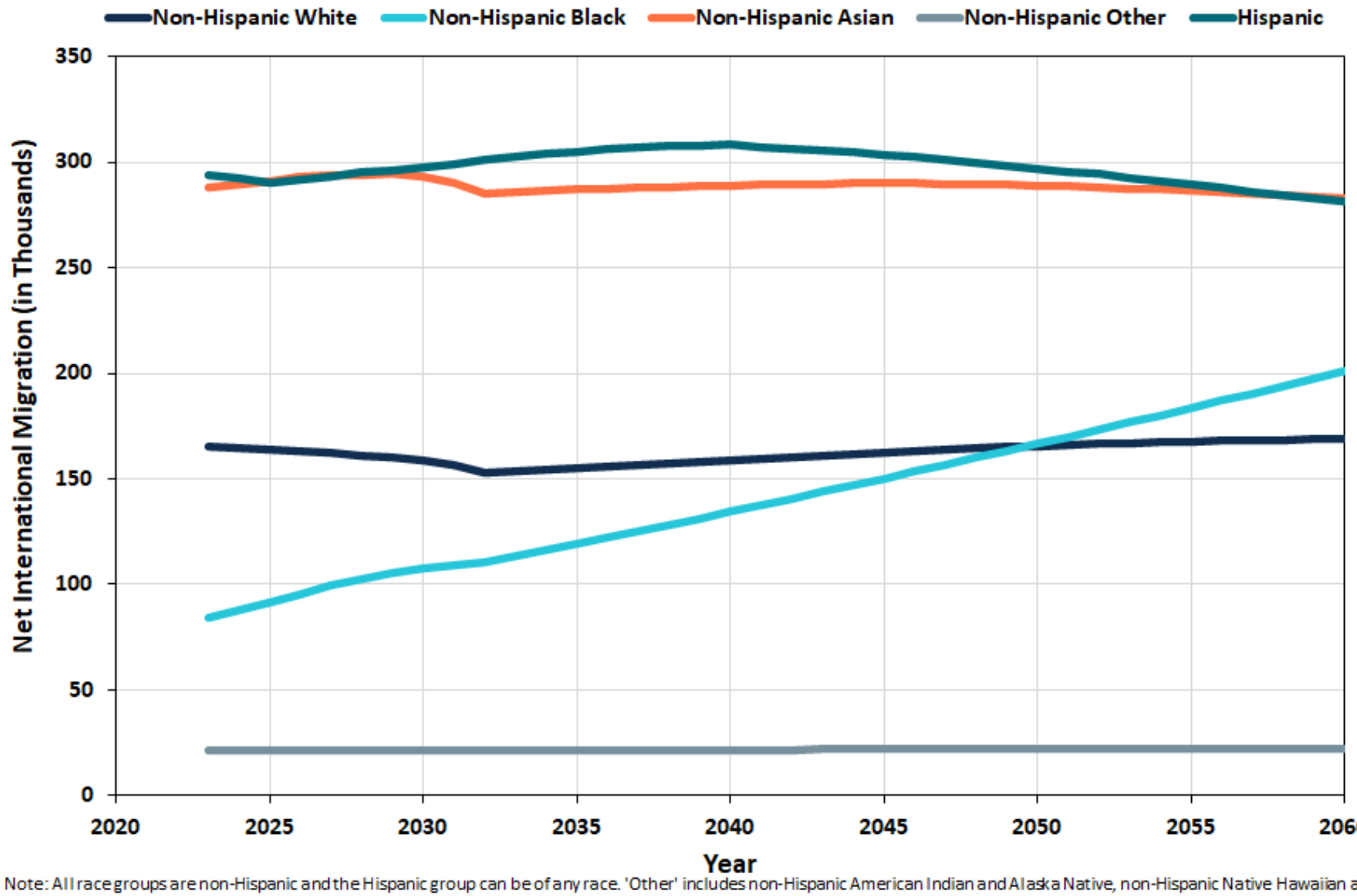
Figure 14. Projections of Net International Migration: 2023 to 2100



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 Pacific Islander, and non-Hispanic Two or More Races.

Source: U.S. Census Bureau, 2023 National Population Projections.

Figure 15. Projections of Net International Migration by Race and Hispanic Origin: 2023 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 Pacific Islander, and non-Hispanic Two or More Races.
Source: U.S. Census Bureau, 2023 National Population Projections.

Table 3. Projected Net International Migration and Sex Ratios by Race and Hispanic Origin: 2023-2060			
	Total (in Thousands)	Percentage	Sex Ratio
2023	**853**	**100.0**	**86.6**
Non-Hispanic White	165	19.4	96.5
Non-Hispanic Black	84	9.9	84.5
Non-Hispanic Asian	288	33.8	78.3
Non-Hispanic Other	22	2.5	104.6
Hispanic	294	34.4	89.2
2030	**879**	**100.0**	**86.9**
Non-Hispanic White	158	18.0	93.8
Non-Hispanic Black	108	12.3	84.5
Non-Hispanic Asian	293	33.4	78.6
Non-Hispanic Other	22	2.5	101.0
Hispanic	297	33.8	92.0
2040	**912**	**100.0**	**85.8**
Non-Hispanic White	159	17.4	91.3
Non-Hispanic Black	134	14.7	81.6
Non-Hispanic Asian	289	31.7	76.8
Non-Hispanic Other	22	2.4	97.0
Hispanic	308	33.8	93.3
2050	**940**	**100.0**	**84.7**
Non-Hispanic White	166	17.6	90.3
Non-Hispanic Black	167	17.7	79.7
Non-Hispanic Asian	289	30.7	75.6
Non-Hispanic Other	22	2.3	95.4
Hispanic	297	31.6	93.5
2060	**956**	**100.0**	**83.7**
Non-Hispanic White	169	17.7	89.6
Non-Hispanic Black	201	21.0	78.0
Non-Hispanic Asian	283	29.6	74.6
Non-Hispanic Other	22	2.3	93.9
Hispanic	281	29.4	93.9

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

Source: U.S. Census Bureau, 2023 National Population Projections.