Age transition and projection

Ernesto F. L. Amaral

April 26, 2016

References:
Weeks JR. 2015. Population: An Introduction to Concepts and Issues. 12th edition. Boston: Cengage Learning. Chapter 8 (pp. 298–342).
RAND Health. 2015. “Current and future demographic of the Veteran population.” In: Current and Projected Characteristics and Unique Health Care Needs of the Patient Population Served by the Department of Veterans Affairs. Santa Monica: RAND Corporation. http://www.rand.org/t/rr1165z1. Chapter 3 (pp. 31–56), Appendix A (pp. 171–211).

Outline

- The age transition
  - Weeks 2015, Chapter 8, pp. 298–342
- Projection of Veteran population
  - RAND Health 2015, Chapter 3, pp. 31–56

The age transition

(Weeks 2015, Chapter 8, pp. 298–342)

- What is the age transition?
- The concepts of age and sex
- Demographic drivers of the age transition
- Age transitions at work
- Population aging as part of the age transition
- Reading the future from the age structure

What is the age transition?

- Age transition represents a shift from a very young population in which there are slightly more males than females to an older population in which there are more females than males
- The interaction of fertility, mortality, and migration produces the age and sex structure
  - This structure can be viewed as a key to the life of a social group
  - It is a record of past history and a sign of the future

Age transition is the master transition

- The overall demographic transition is less about population growth per se
  - It is about the growth of population in different age groups over time and in different places
- Age and sex each have biological and social components
  - We are born as a male or female, and we continuously grow older until we die
  - Those are the biological parts

Age stratification theory

- This is part of the social component of age
- Societies distribute resources unequally by age
- These resources include economic goods, as well as social approval, acceptance, and respect
- Age stratification, prestige, and power are influenced by the needs of society and by characteristics of people at each age
  - Infancy, childhood, adolescence, young adulthood, middle age, young-old, old-old

Aspects of human society that vary by age and sex

Category	Characteristic or activity
Demographic	Being sick and having restricted activities of daily living
	Dying
	Being sexually active
	Having a baby
	Moving or migrating

Aspects of human society that vary by age and sex

Category	Characteristic or activity
Social	Getting married/divorced
	Being involved in religious organizations and activity
	Being involved in political organizations and activity
	School enrollment
	Level of educational attainment
	Being involved in criminal or other socially disapproved behavior

Aspects of human society that vary by age and sex

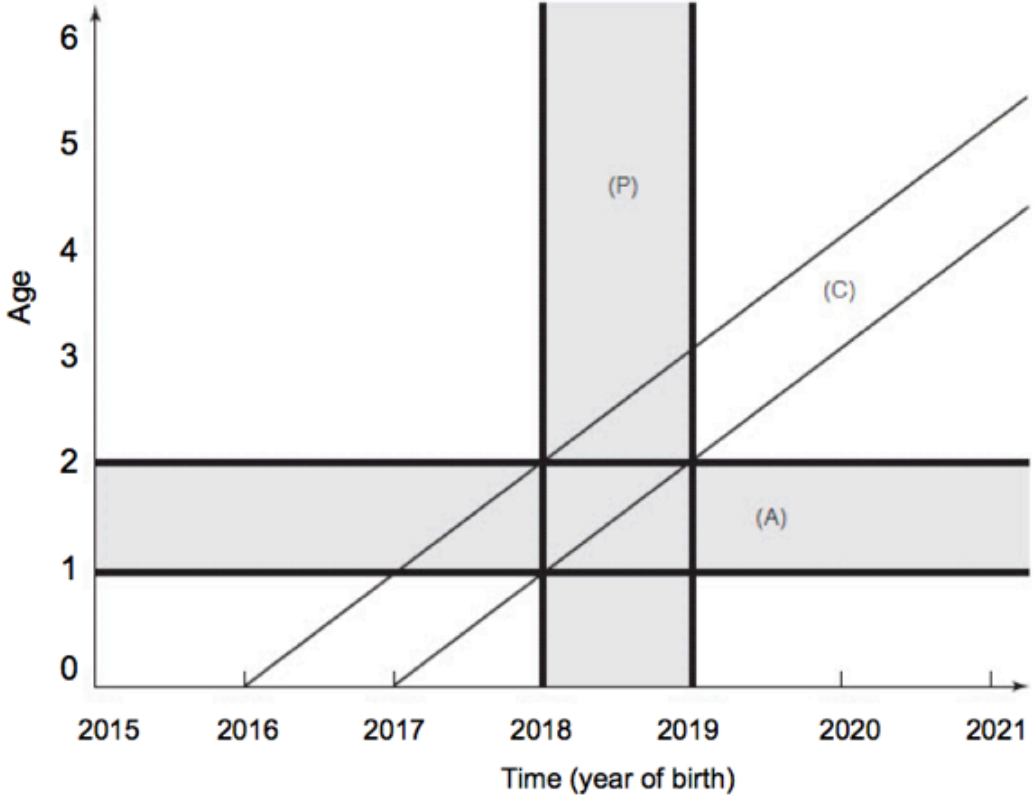
Category	Characteristic or activity
Economic	Being in the labor force
	Occupation within the labor force
	Current income
	Level of accumulated wealth

Age cohorts and cohort flow

- Age cohort is a group of people born during the same time period
- Cohort flow
  - People of same age are influenced by the same historical circumstances
- As we measure change over time, we must distinguish the separate effects of age, period, and cohort...

Lexis diagram

relationship between age (A), period (P), and cohort (C)



Gender roles

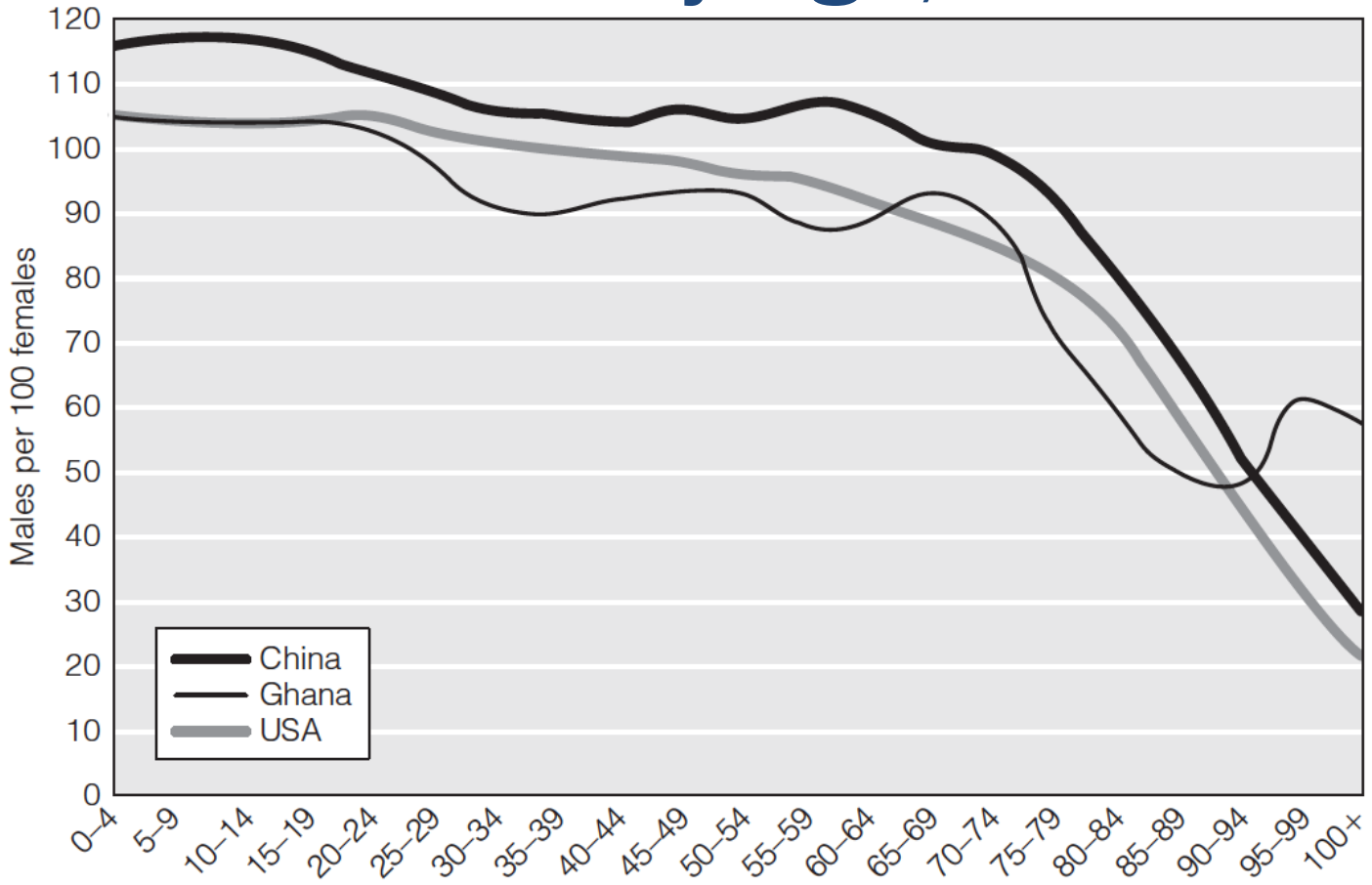
- This is part of the social component of sex
- Women have historically been treated differently than men
  - Biological differences have been used against them
- Hormones do underlie certain kinds of behavioral differences between males and females
- However, social environment has the strongest influence on gendered behavior

Sex ratio

$$Sex\ ratio = \frac{Number\ of\ males}{Number\ of\ females} * 100$$

- Rarely populations have the same numbers of males and females at each age
- Sex ratios at birth are typically between 103 and 110
  - Due to social and biological reasons
- Sex ratio is indicative of discrimination against girls
  - Fertility: before birth (e.g. selective abortion)
  - Health/mortality: after birth (e.g. vaccination, malnutrition)
- Migration: higher rates among males at working ages

Sex ratios by age, 2015



Feminization of old age

- Women live longer than men in almost every human society (biological characteristic)
  - True in most other animal species, as well
- Ages 75+ in the United States
  - 1950: 83 males per 100 females
  - 1990: 54 males per 100 females
  - 2010: 62 males per 100 females
  - Nearly 2/3 of the 75+ people alive in the U.S. are women
- Pakistan: there are more men than women at 65–74
  - 142 males per 100 females (1950) and 103 (2015)

Dynamics of the age transition

- Young population
  - Population with a relatively high percentage (30%+) of people under age 15
- Old population
  - Population with a relatively high percentage (10%+) aged 65 or older
- Population grows younger
  - Proportion of young people is increasing relative to the total
- Aging population
  - Proportion of older people is increasing relative to the total

Dependency ratio

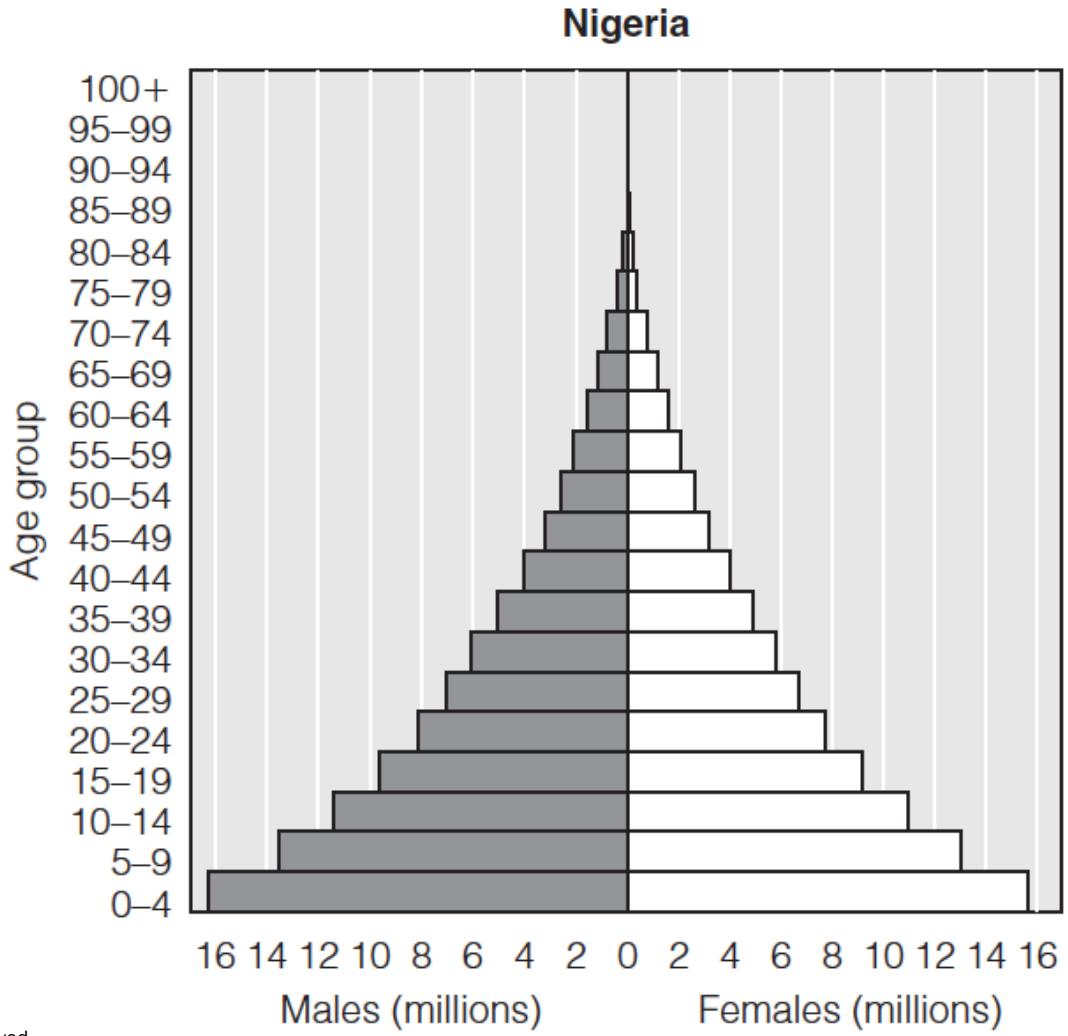
- Dependency ratio measures age transition dynamics
  - Ratio of the dependent-age population to the working-age population
  - It assumes that children and elderly are not economically productive and depend upon the working-age population

$$Total\ dependency\ ratio = \frac{(Population\ 0–14) + (Population\ 65+)}{Population\ 15–64}$$

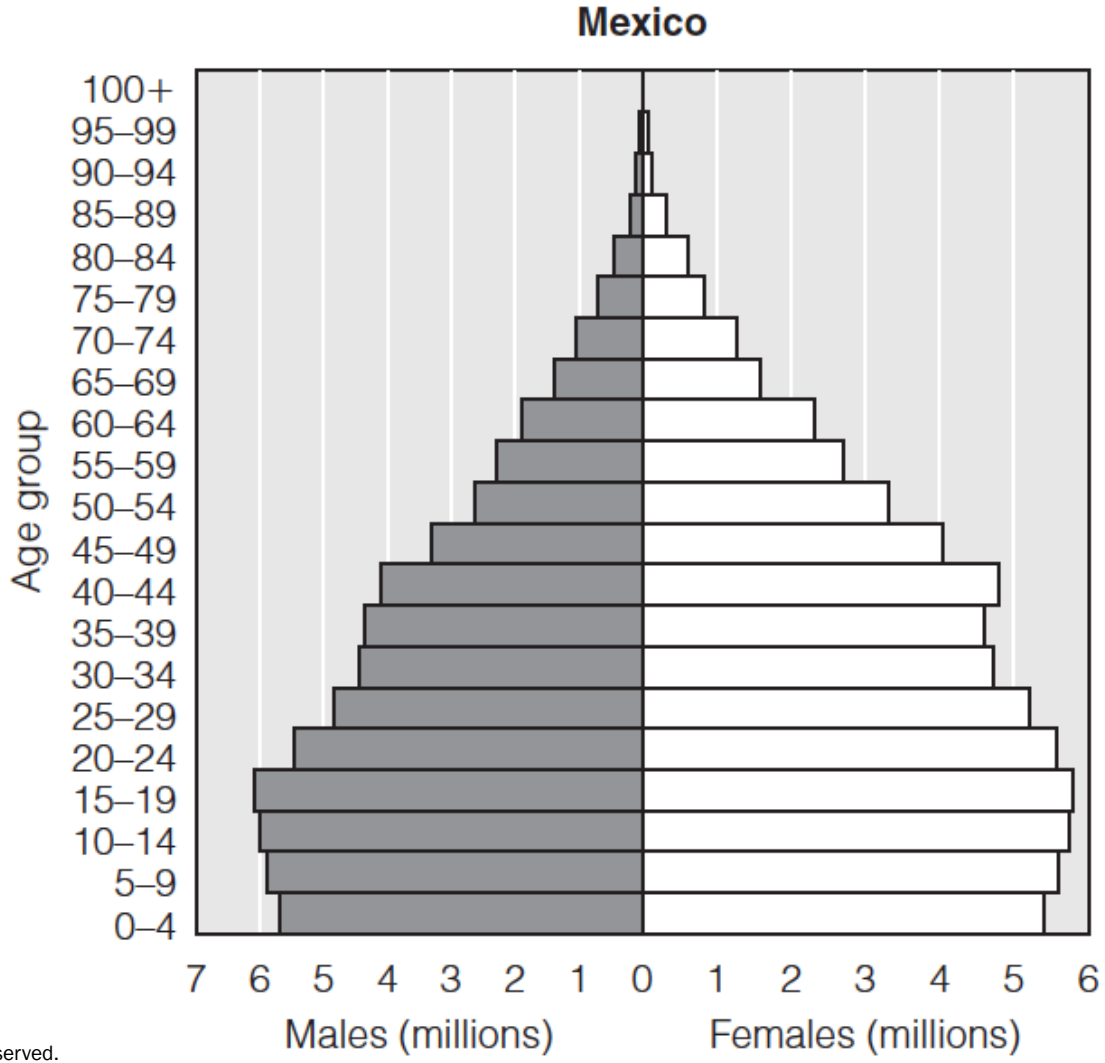
$$Child\ dependency\ ratio = \frac{Population\ 0–14}{Population\ 15–64}$$

$$Old\ age\ dependency\ ratio = \frac{Population\ 65+}{Population\ 15–64}$$

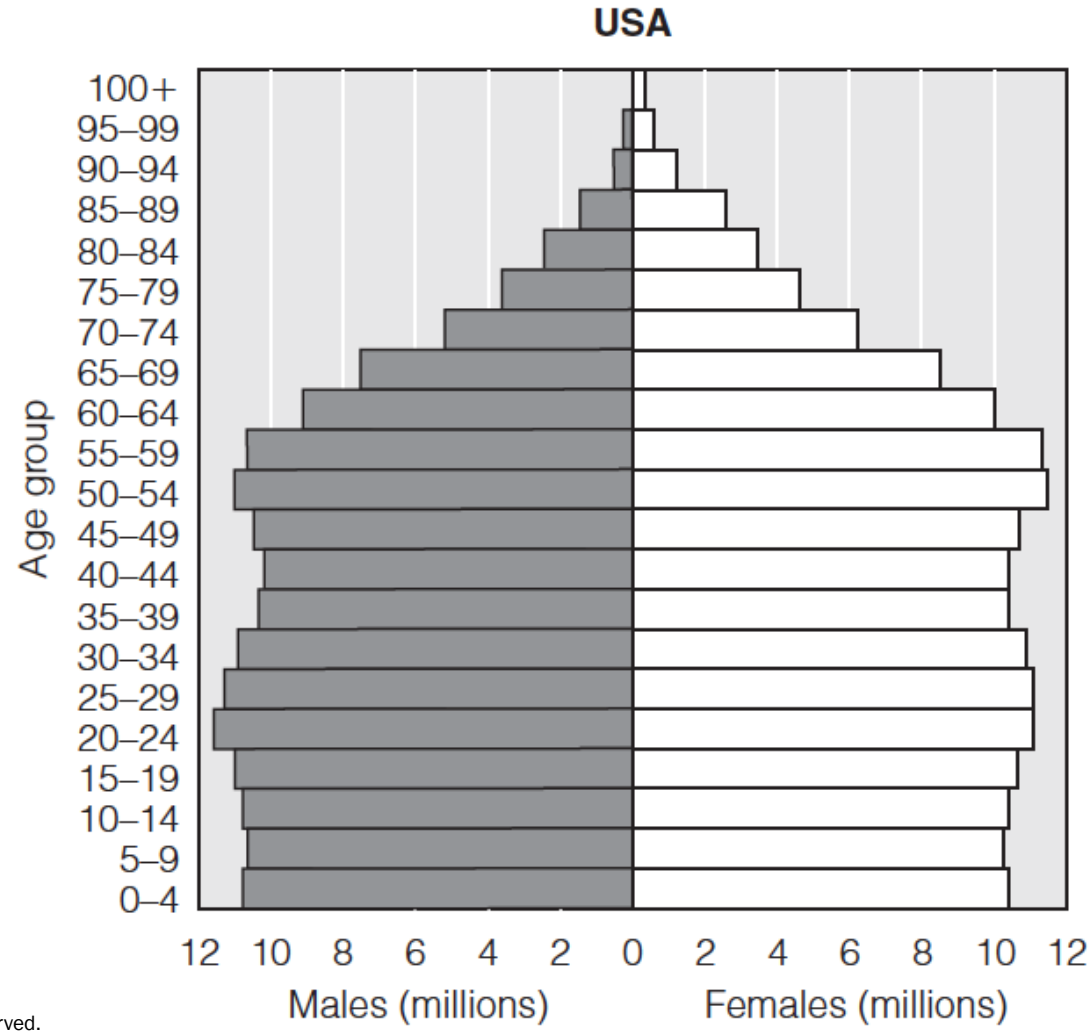
2015



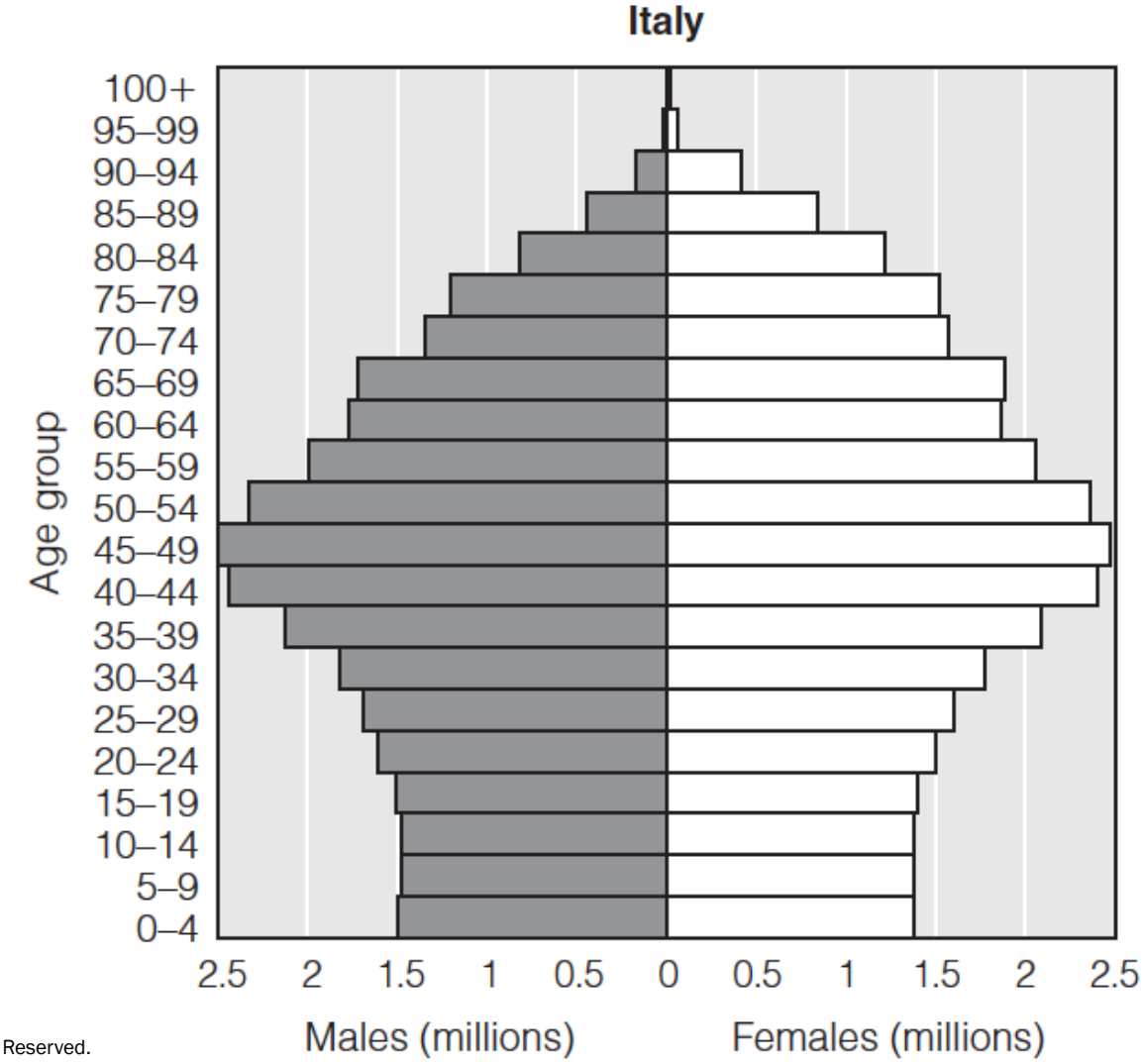
2015



2015

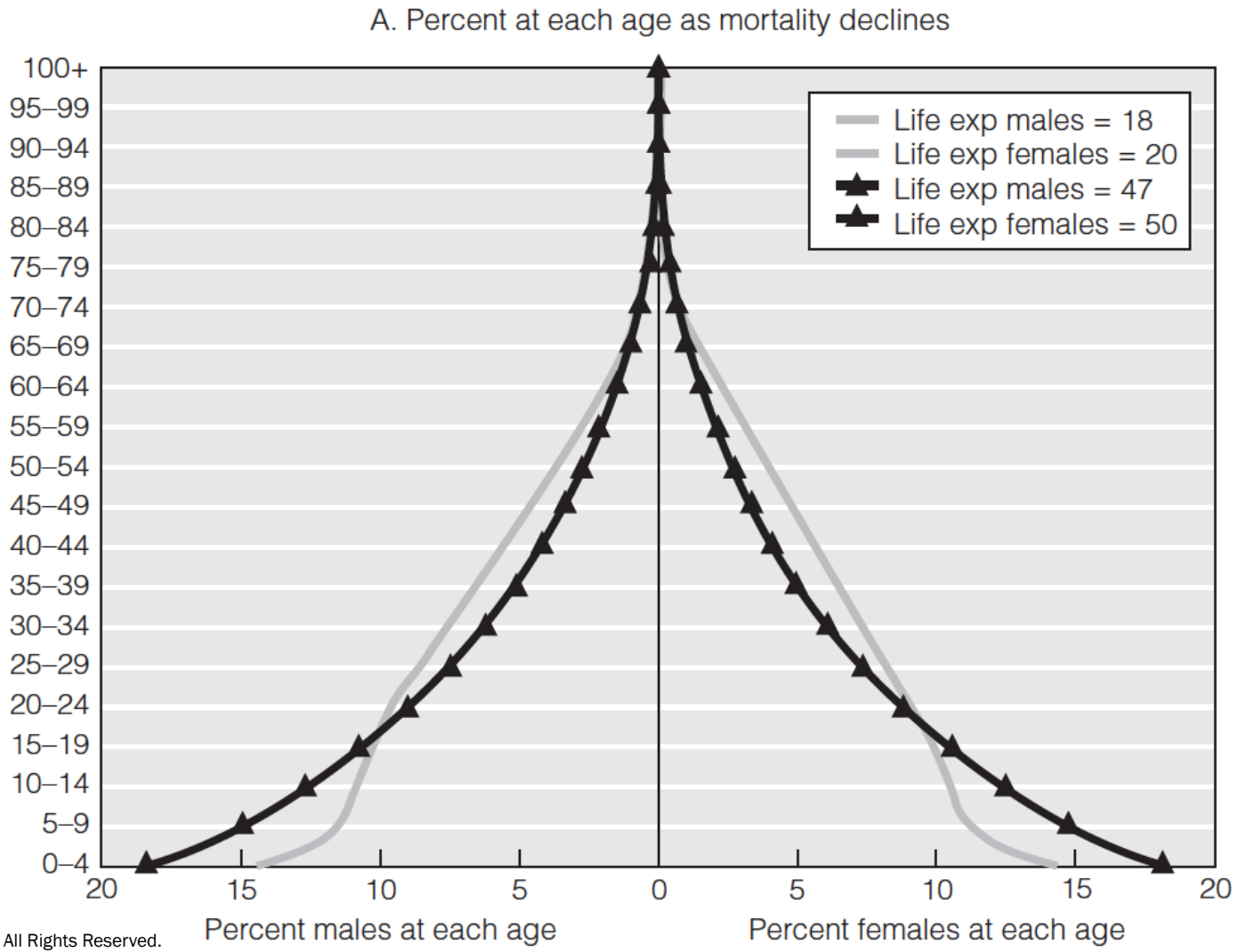


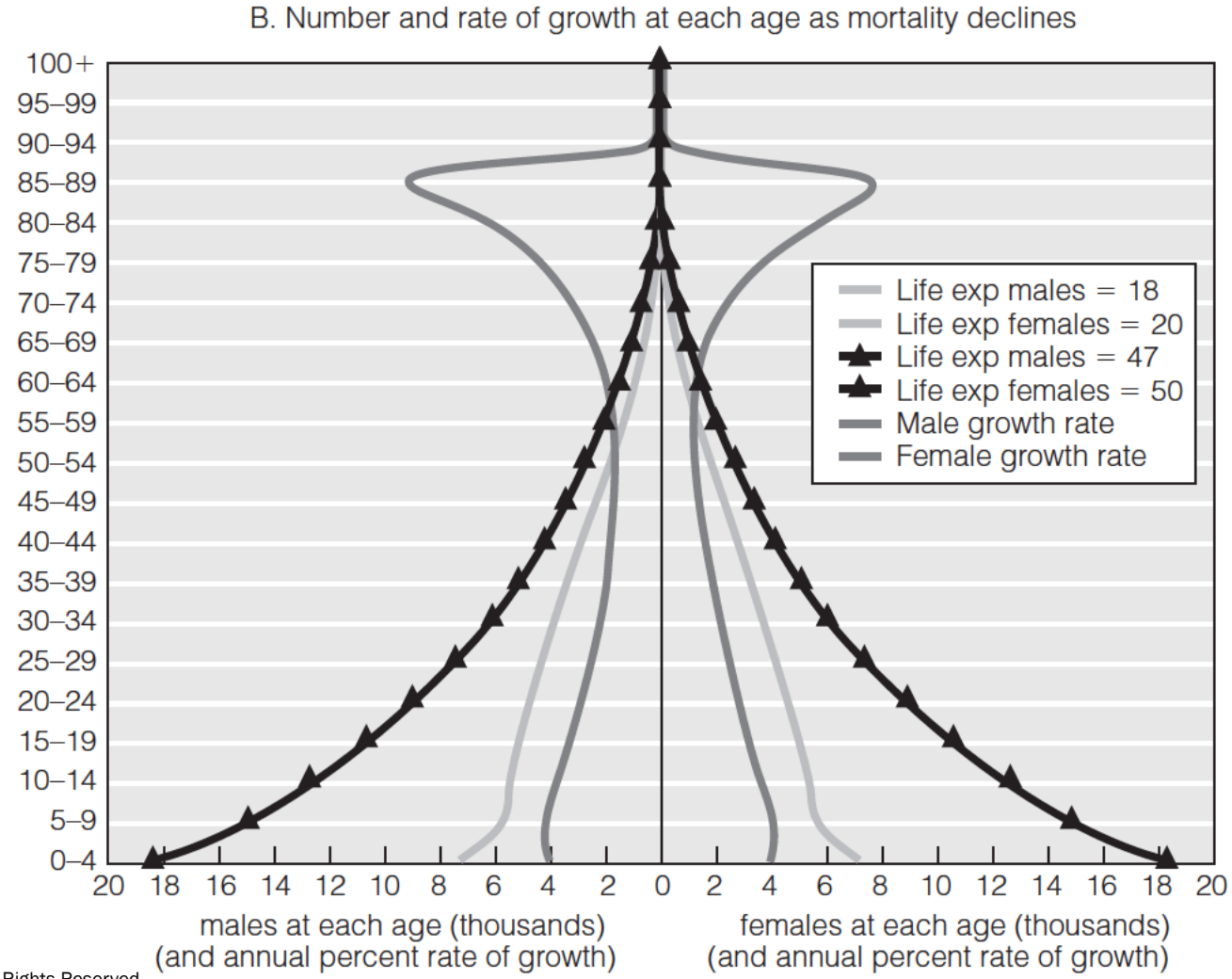
2015

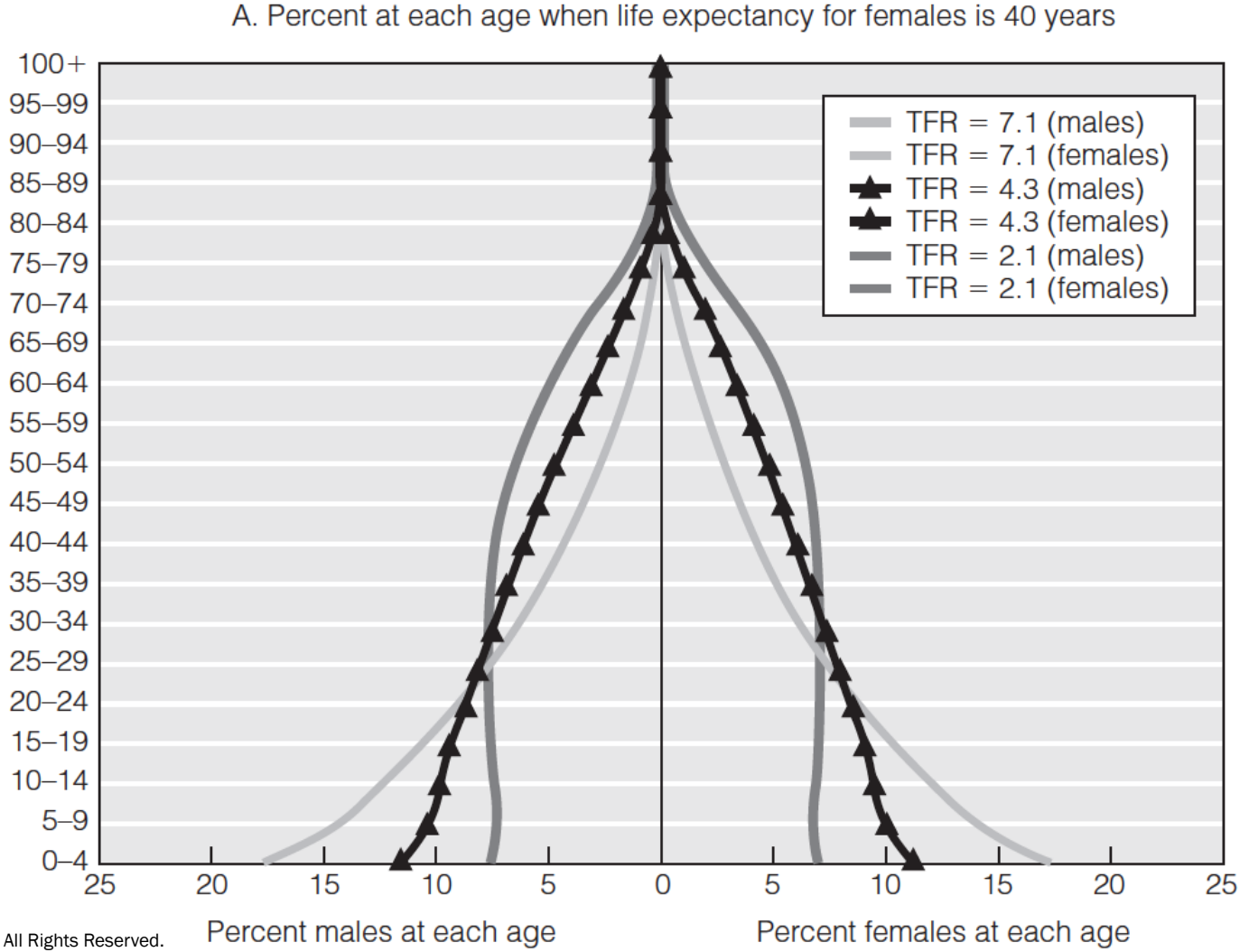


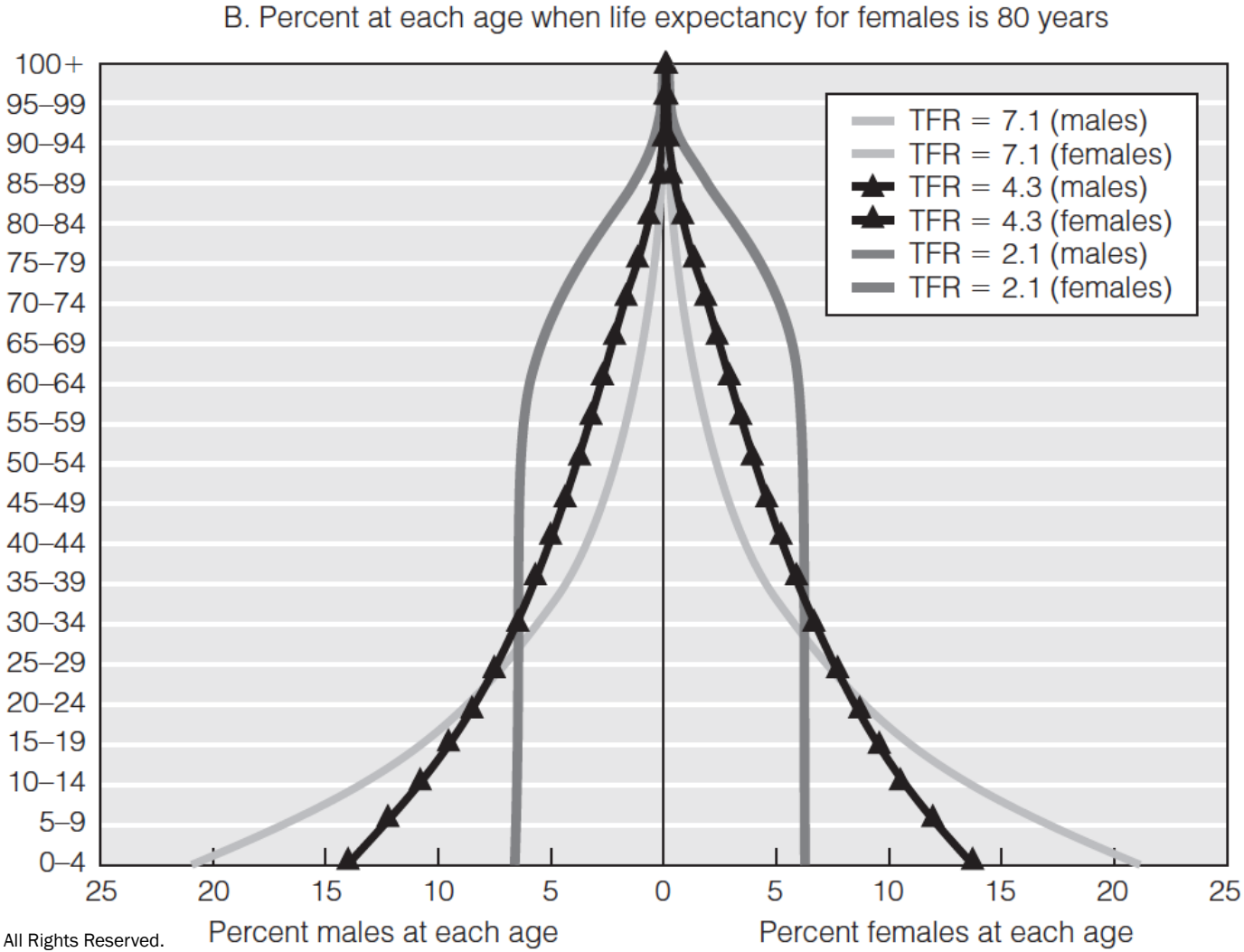
Demographic drivers of age transition

- Declining mortality makes a population younger
  - It tends to disproportionately benefit children
- Declining fertility ages a population
- Migration
  - Takes young adults (and their children) out of the donor region (origin)
  - Adds them to the host region (destination)
- **Stable population models** can demonstrate the impact on an age structure as demographic components change...

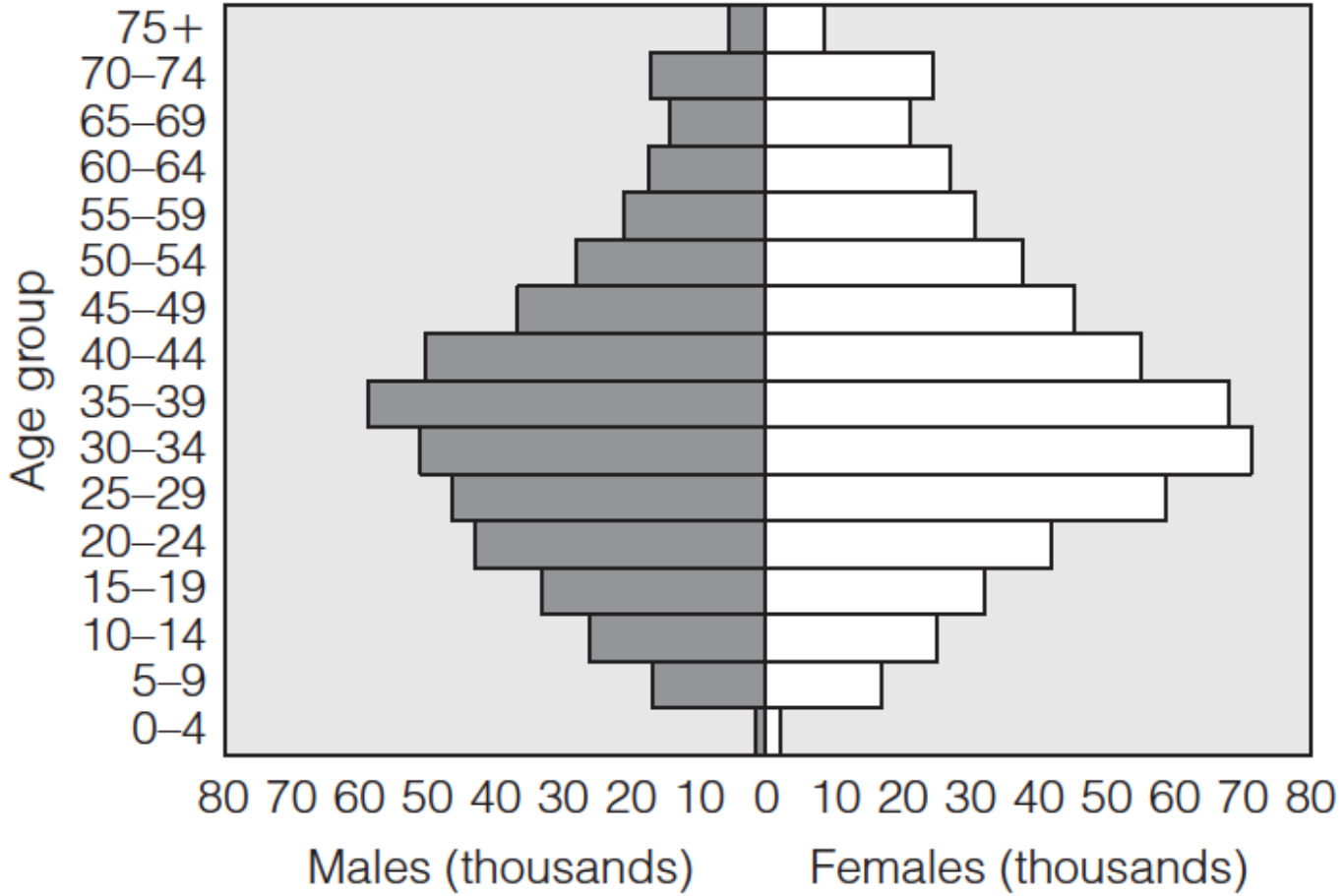






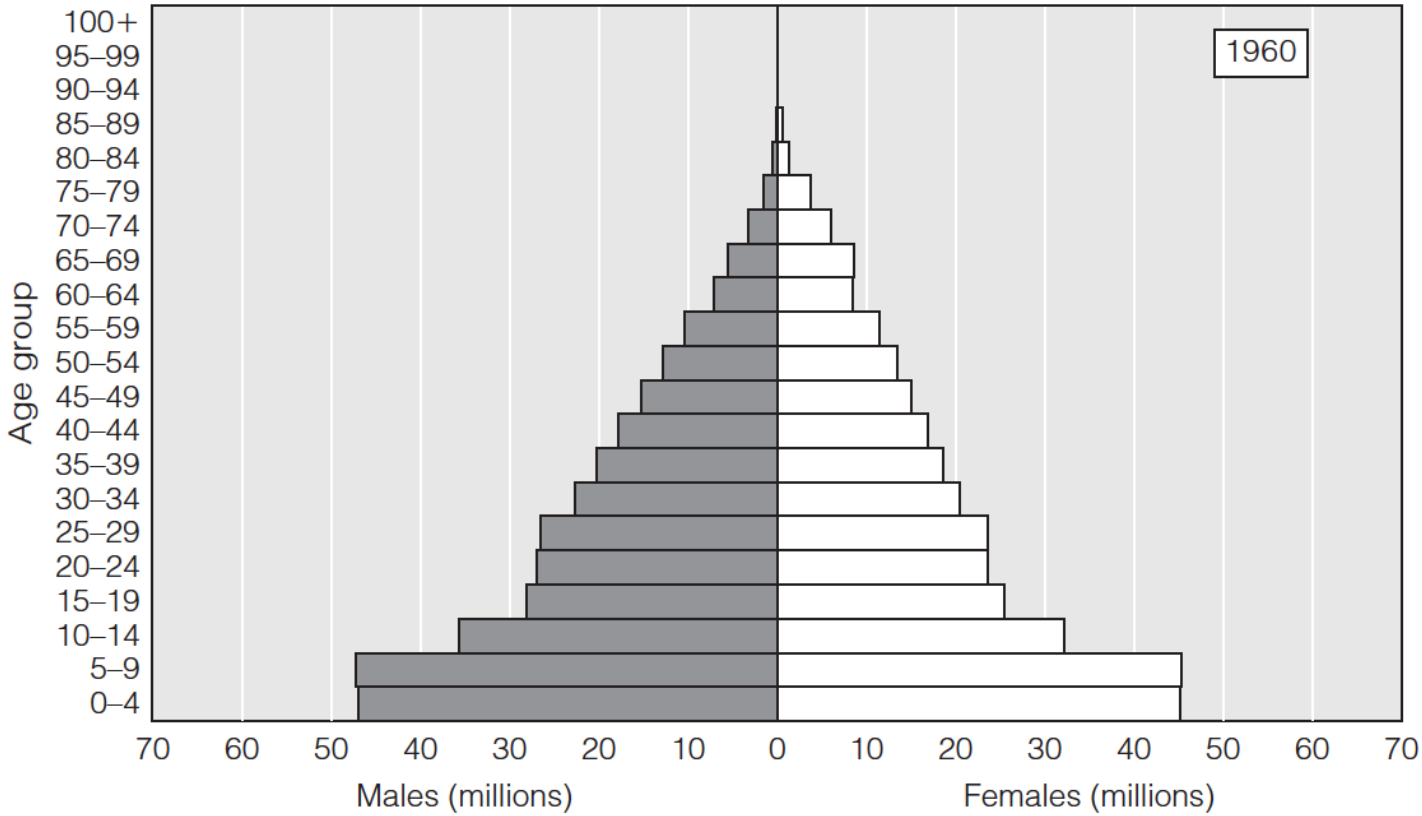


Legal immigrants in the U.S., 2012



China's demographic dividend

(youth bulge as a good thing)



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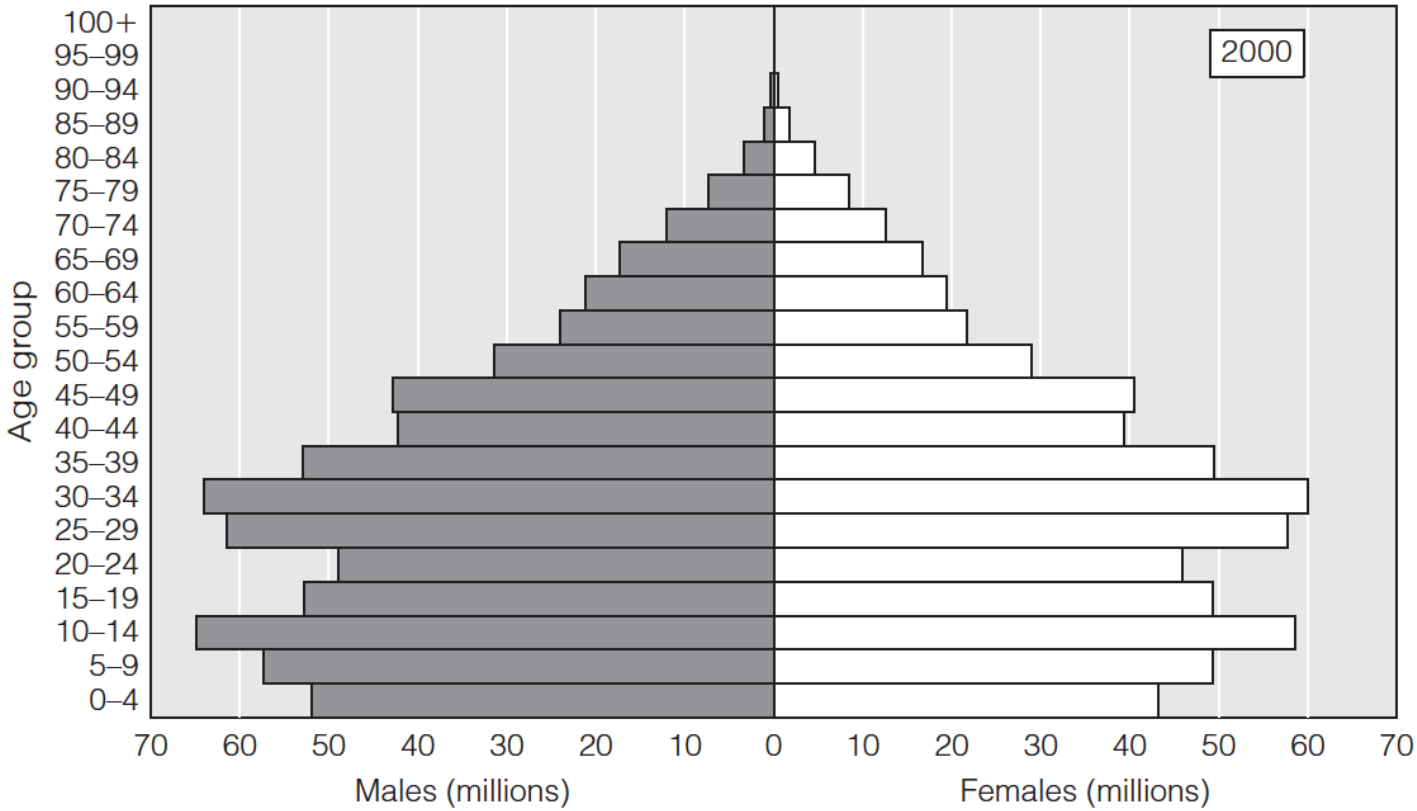

China's demographic dividend

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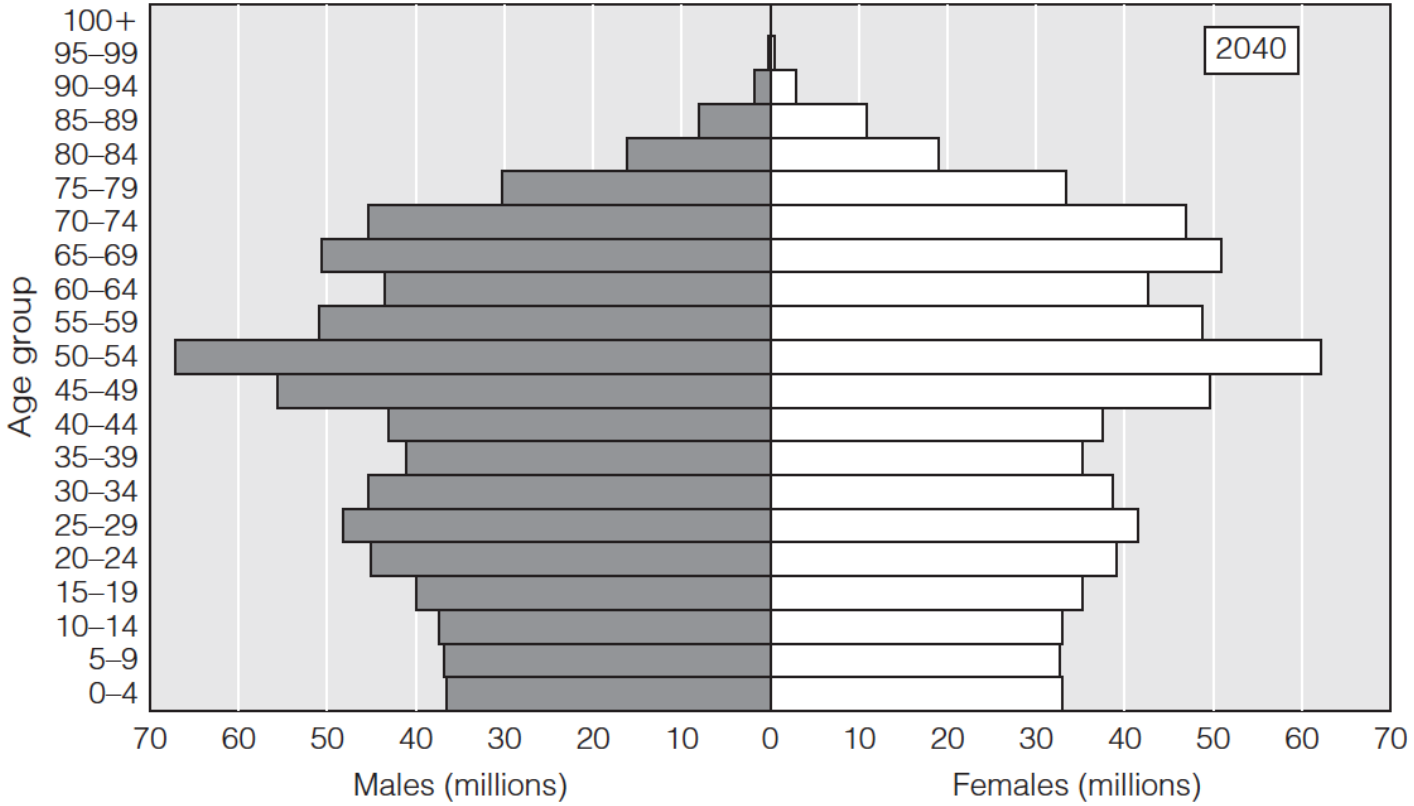
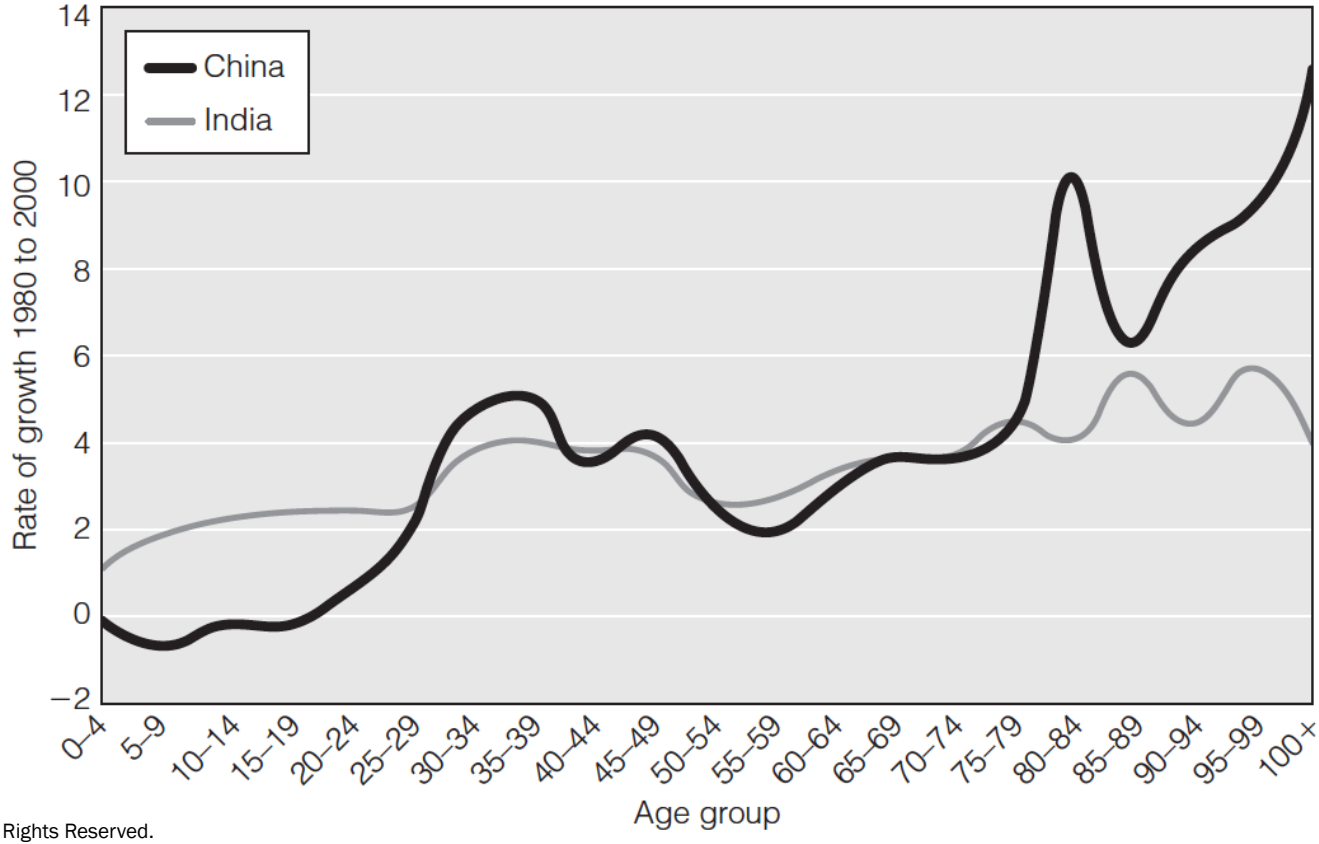
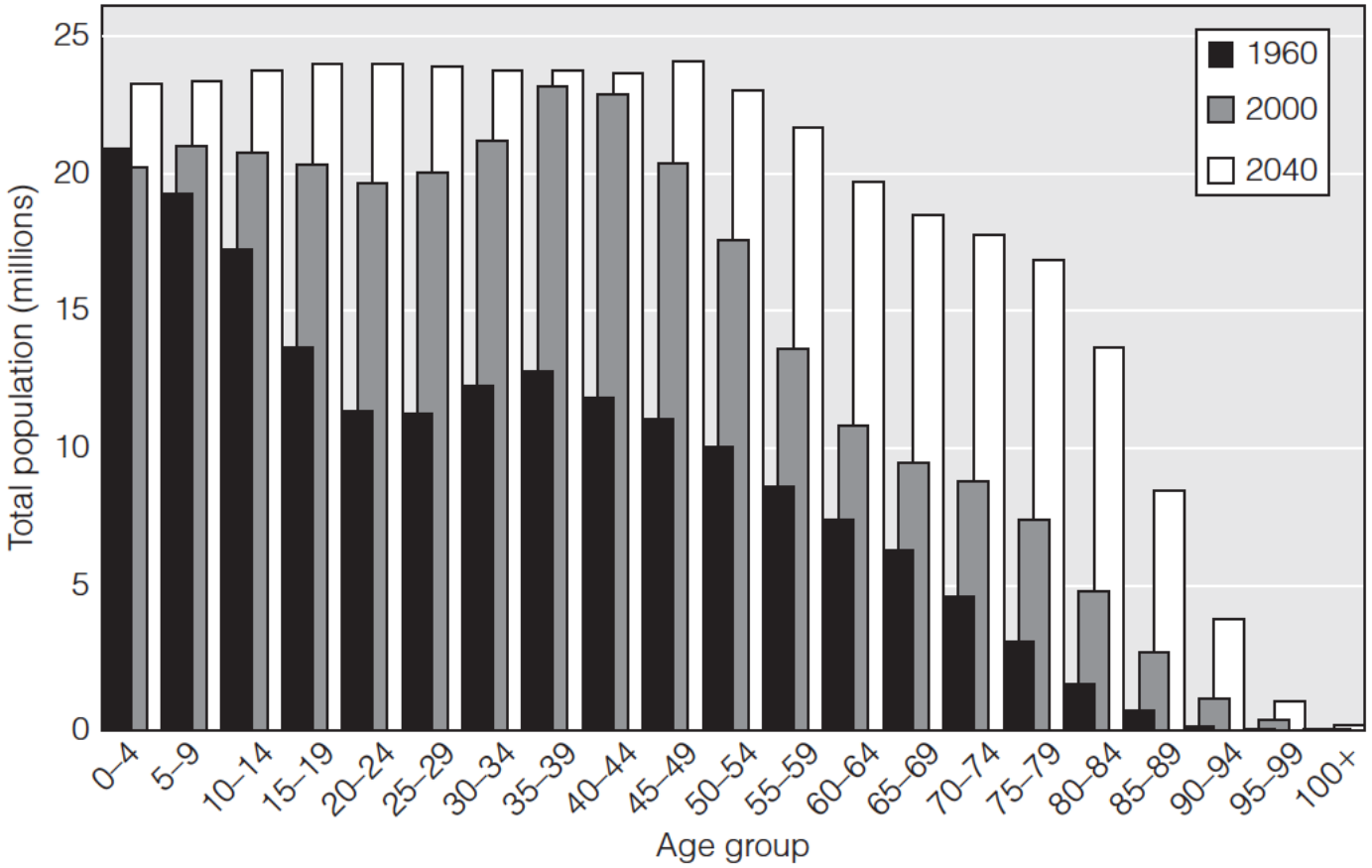


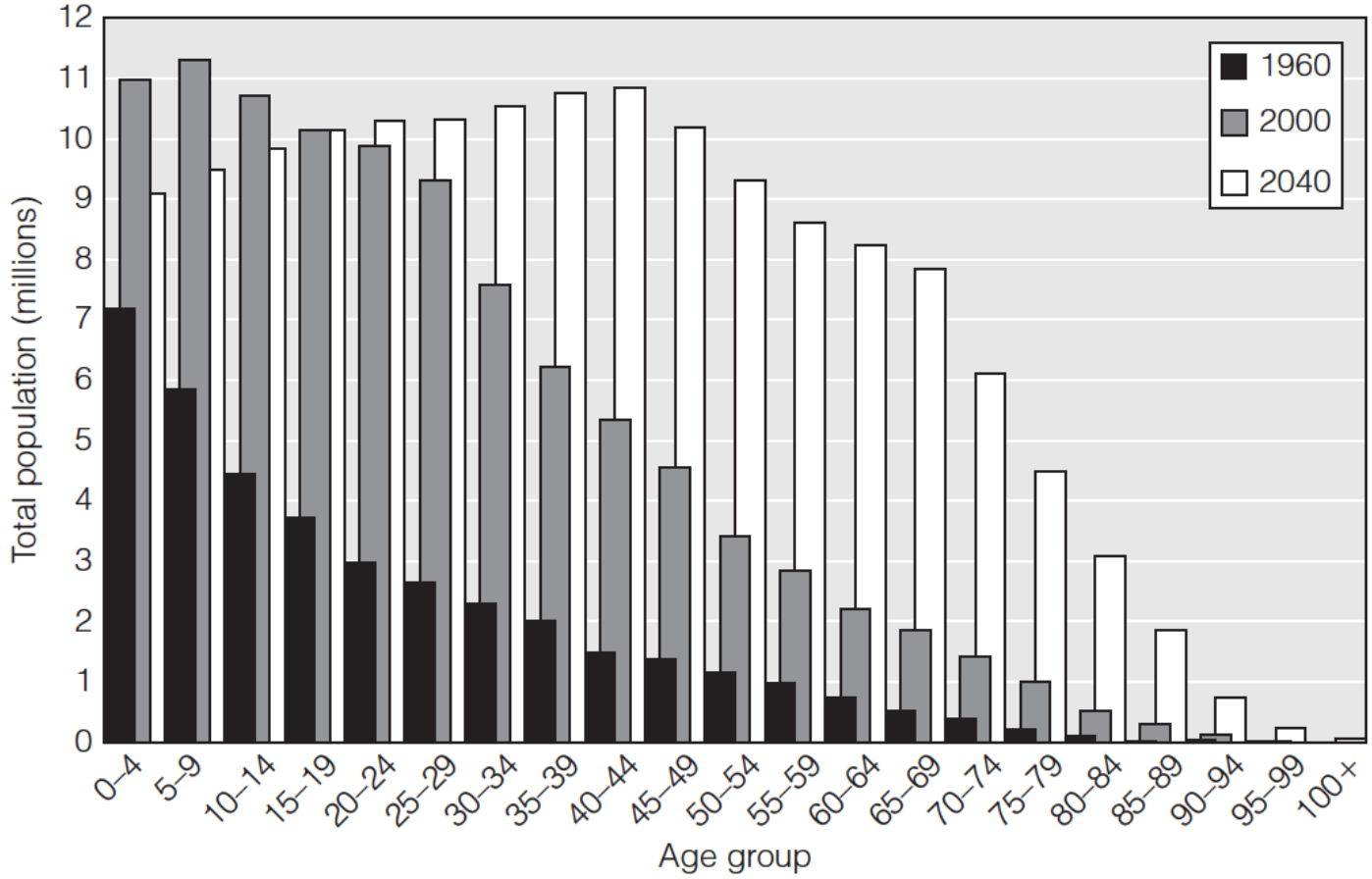
Annual growth rates by age, China and India, 1980 to 2000



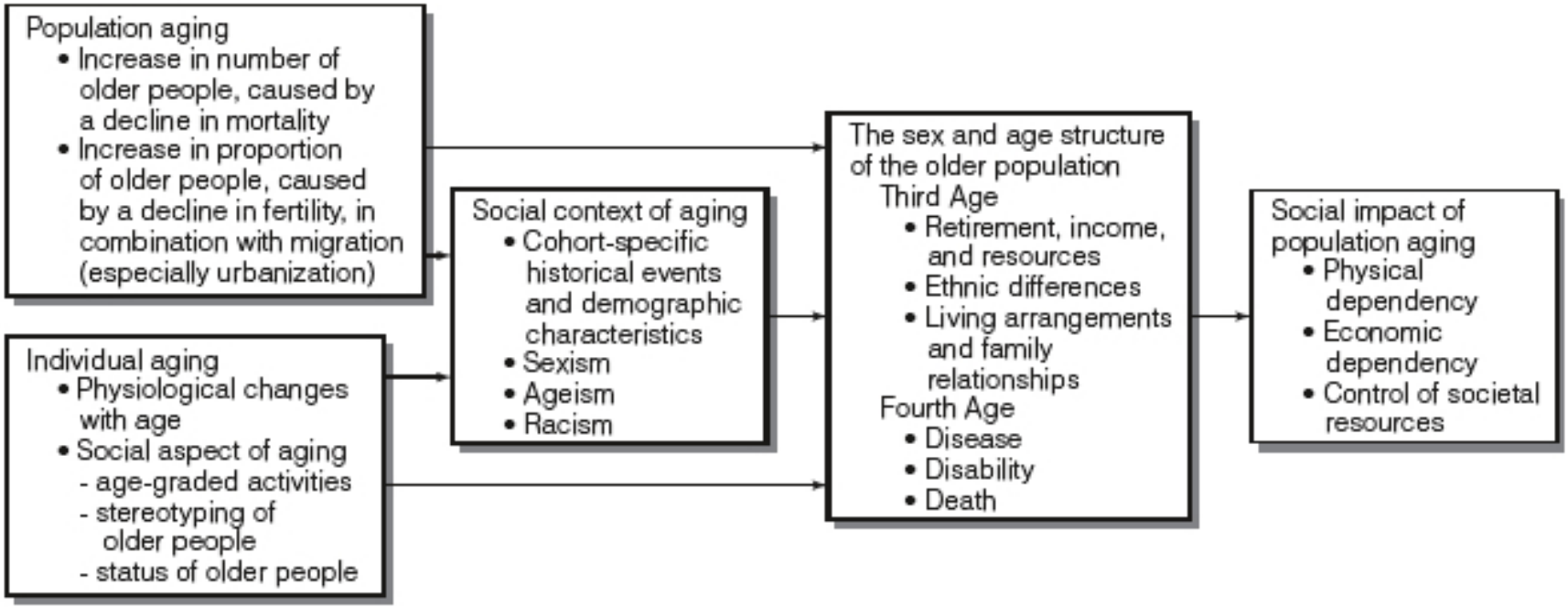
Age transition in the United States



Age transition in Mexico



Population aging as part of age transition

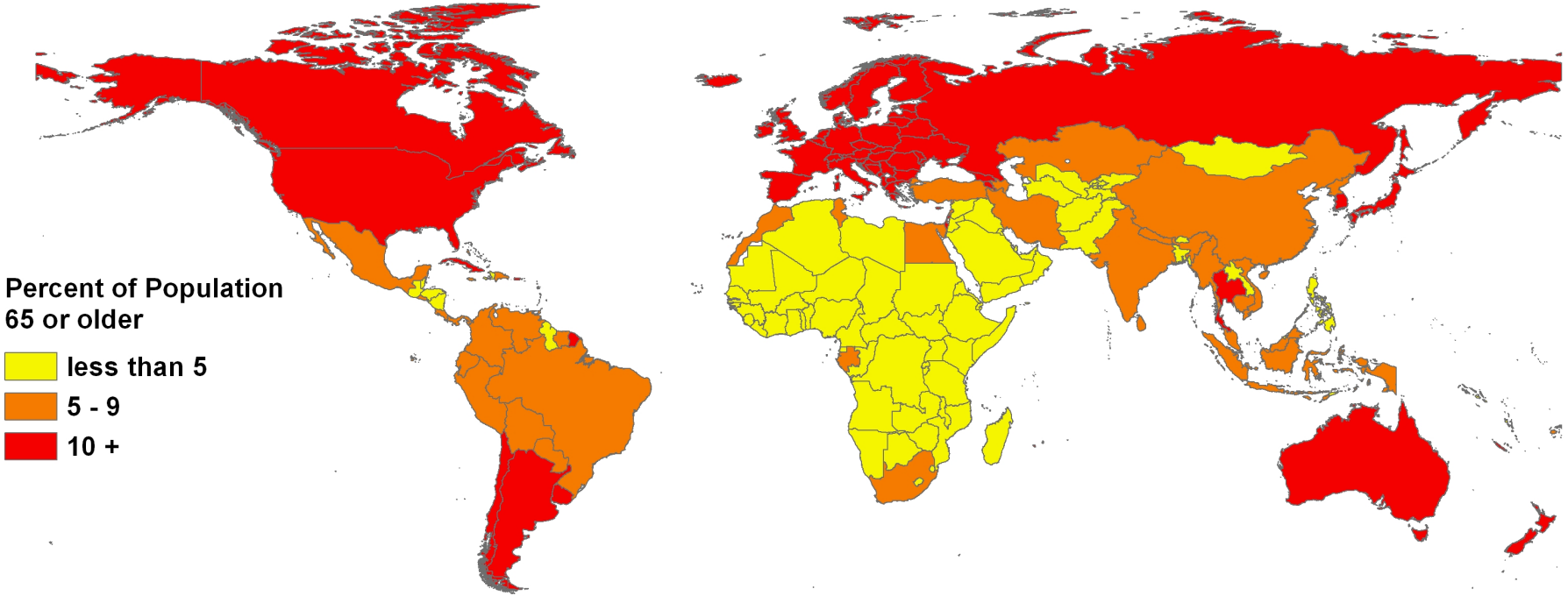


Percent of population 65+
is determined more by fertility than mortality

Life expectancy at birth	Total fertility rate (TFR)				
	2	3	4	5	6
30	a	a	a	3.9	2.8
40	a	a	5.6	3.8	2.7
50	a	8.8	5.5	3.7	2.6
60	15.0	8.8	5.4	3.6	2.5
70	16.5	9.2	5.7	3.7	2.6
75	18.0	9.9	6.1	4.0	2.8

a: no calculation because this would be depopulation

Percent of population 65+, 2015



2015

Top 10 Countries in Terms of Percentage Aged 65 and Older:

Rank	Country	Number 65+ (thousands)	Percent 65+
1	Japan	33,533	26.4
2	Italy	13,292	21.7
3	Germany	17,706	21.4
4	Finland	1,112	20.4
5	Greece	2,251	20.2
6	Sweden	1,935	20.0
7	Bulgaria	1,414	19.9
8	Portugal	2,055	19.4
9	Croatia	808	19.0
10	France	12,171	18.7

2015

Top 10 Countries in Terms of Number of People Aged 65 and Older:

Rank	Country	Number 65+ (thousands)	Percent 65+
1	China	132,457	9.5
2	India	70,059	5.5
3	United States	47,692	14.7
4	Japan	33,533	26.4
5	Russia	18,762	13.2
6	Germany	17,706	21.4
7	Brazil	16,330	8.0
8	Indonesia	13,875	5.4
9	Italy	13,292	21.7
10	France	12,171	18.7

Is 65 the beginning of old age?

- "Third age"—roughly ages 65-84
  - A time when we are still healthy enough to engage in all of the normal activities of daily life
  - We are able to be free of regular economic activity
- "Fourth age"—roughly ages 85+
  - When the rest of our life will be increasingly consumed by coping with the health effects of old age, including susceptibility to senescence

Population projections

- Calculation of the number of persons we can expect to be alive at a future date
  - Given the number now alive
  - Given reasonable assumptions about age-specific mortality, fertility, and migration rates
  - Age structures help reading the future
- Population projections are based on a conditional future
  - This is what will happen if a certain set of conditions are met

Limitations of projections

- **Population forecast** is a statement about what you expect the future population to be
- **Population projection** is a statement about what the future population could be under a given set of assumptions
- Our ability to guess the future correctly is better
  - Over the short term than the long term
  - For larger than for smaller countries
  - For more developed than for less developed nations
- Demographic theory is not sophisticated enough to be able to predict futures shifts in demographic processes, especially fertility and migration

Population projections' methods

- Extrapolation methods
  - Utilizes total population of at least two dates
- Components-of-growth method
  - Adaptation of balancing equation
  - It is hard to know the number of births, deaths, and migrants
- Cohort component method
  - Information by age and sex: base population, mortality structure (e.g. life table), fertility pattern (e.g. ASFR), net migration pattern
    - Demographic Analysis and Population Projection System (DAPPS) by U.S. Census Bureau
    - PADIS-INT – A web-based population projection software by China Population and Development Research Center (CPDRC)

Population momentum

- How big would the future population be compared to now, if fertility immediately dropped to replacement?
  - Large fraction of women in reproductive ages would contribute many additional babies even at replacement level
  - Older population would stop growing faster
- Population growing at a rate of 3% per year (Guatemala)
  - TFR would have to drop from 4.3 to 2.1 children per woman
  - 1.7 times larger if replacement achieved immediately
  - 3.9 times larger if the drop took 28 years
  - 7.7 times larger if it took as long as 56 years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Projection of Veteran population

- Project the Veteran population from 2014 to 2024 and their geographic distribution
  - Surveys collect information on Veterans, but no full national accounting since 2000 Census
- Describe demographic characteristics of Veterans
  - Age, sex, race/ethnicity, service era, geographic distribution

Source: RAND Health 2015, Chapter 3, pp. 31–56.

Data

- 2000 Census is used as the baseline Veteran population
  - Age, sex, race/ethnicity, service era
- U.S. Defense Manpower Data Center (DMDC)
  - Age, sex, race/ethnicity, location of accession, anticipated loss date
- American Community Survey (ACS)
  - 5-year estimates: 2005–09, 2009–13

ACS undercounts Veterans

- ACS does not accurately measure the number of Veterans in the population
  - If we apply mortality to the 2000 Census Veteran population up to 2013, we get roughly the same estimates as the 2013 ACS
  - ACS undercounts the number of new Veterans who entered the population from 2000 to 2013
- We assume ACS captures the distribution of Veteran characteristics (age, sex, race/ethnicity, service era)
- The analysis also uses ACS to determine Veteran geographic distribution and migration patterns

Projections for each service era

- Pre-1950
- Korean War: July 1950–January 1955
- Pre-Vietnam: February 1955–July 1964
- Vietnam: August 1964–April 1975
- Post-Vietnam: May 1975–July 1990
- Gulf War: August 1990–August 2001
- Post-9/11: September 2001 or later

Population projection

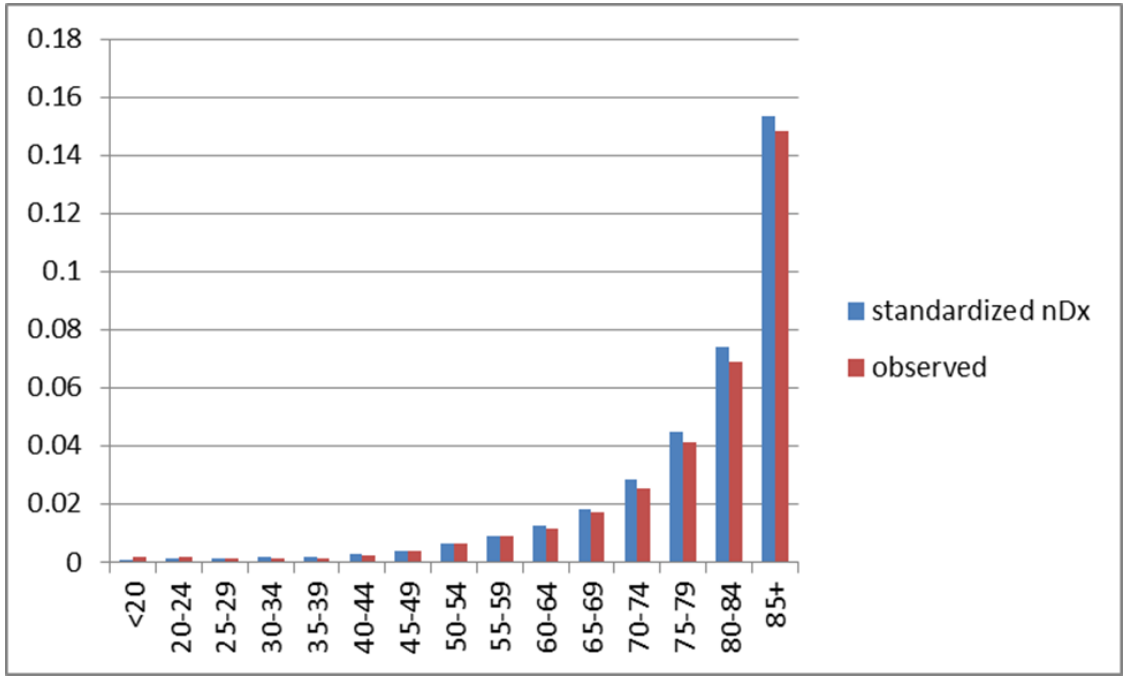
- Standard cohort component model
  - U.S. Census Bureau's Rural and Urban Projection (RUP) Program
  - 2000 Census provides counts of Veterans
- "Births" and mortality
  - New Veterans (DMDC): 2000–24
  - Apply mortality rates (VA, CDC): 2000–24
  - Estimate national Veteran population: 2005–24
- Distribute national projections into PUMAs
- Adjust initial projections by migration

Mortality rates

- 2014 Veteran population mortality rates
  - By age, sex, but not race/ethnicity
  - From Department of Veterans Affairs (VA)
- 2011 standardized national mortality rates
  - By age, sex, race/ethnicity
  - From Centers for Disease Control and Prevention (CDC)
- Derive race/ethnicity rates based on CDC that reflect VA overall rates

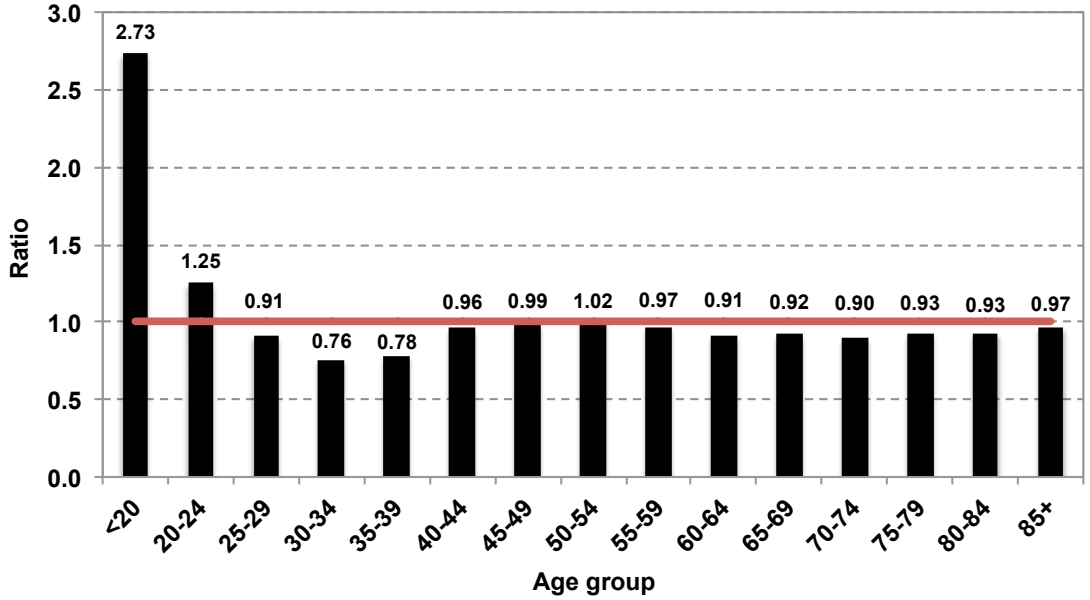
Veteran and national mortality

- We compare observed Veteran mortality to the standardized national rates



Ratio of Veteran to national rates

- Higher rates for Veterans at younger ages than overall population
  - Use this ratio to adjust CDC mortality rates and apply to Veterans
  - Assume that inflation/deflation ratio at each age is the same for each race/ethnicity



“Births” and mortality

2000 Census & 2000 DMDC Population data

Each cell has number of Veterans by 5-year age group, sex, race/ethnicity, service era

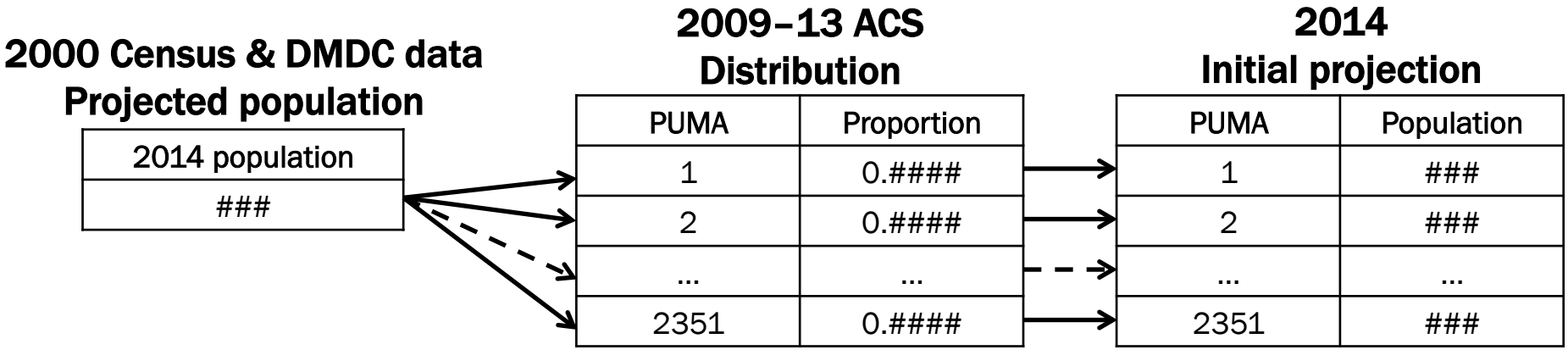
2000 population
###

- Apply mortality rates from 2000 to 2001
- Add DMDC data in 2001
- Apply mortality rates from 2001 to 2002
- Add DMDC data in 2002

…

2001 population	…	2014 population	…	2024 population
###	…	###	…	###

Distribute national projection into PUMAs: 2014 example



- Assumption: ACS captures geographic distribution
- By 5-year age group, sex, race/ethnicity, service era

Migration: gravity models

- Disaggregate PUMA groups in previous year
  - Correspondence files in IPUMS-USA website
- Convert 2009–11 PUMAs into 2010 codes
  - Engine by Missouri Census Data Center
- Zero-inflated Poisson regressions (2009–13)
  - Function of age, sex, race/ethnicity, service era, distance, populations at origin and destination
- Apply predicted rates to 2014 projection
  - Generate number of in- and out-migrants
  - Adjust in-migrants to generate null net migration

Migration: final projection

2014
Number of in-migrants
(estimated with ACS rates and initial projection)

PUMA	Number of in-migrants
1	###
2	###
…	…
2351	###

2014
Number of out-migrants
(estimated with ACS rates and initial projection)

PUMA 1-year ago	Number of out-migrants
1	###
2	###
…	…
2351	###

2014
Initial projection

PUMA	Population
1	###
2	###
…	…
2351	###

2014
Final projection
(after migration)

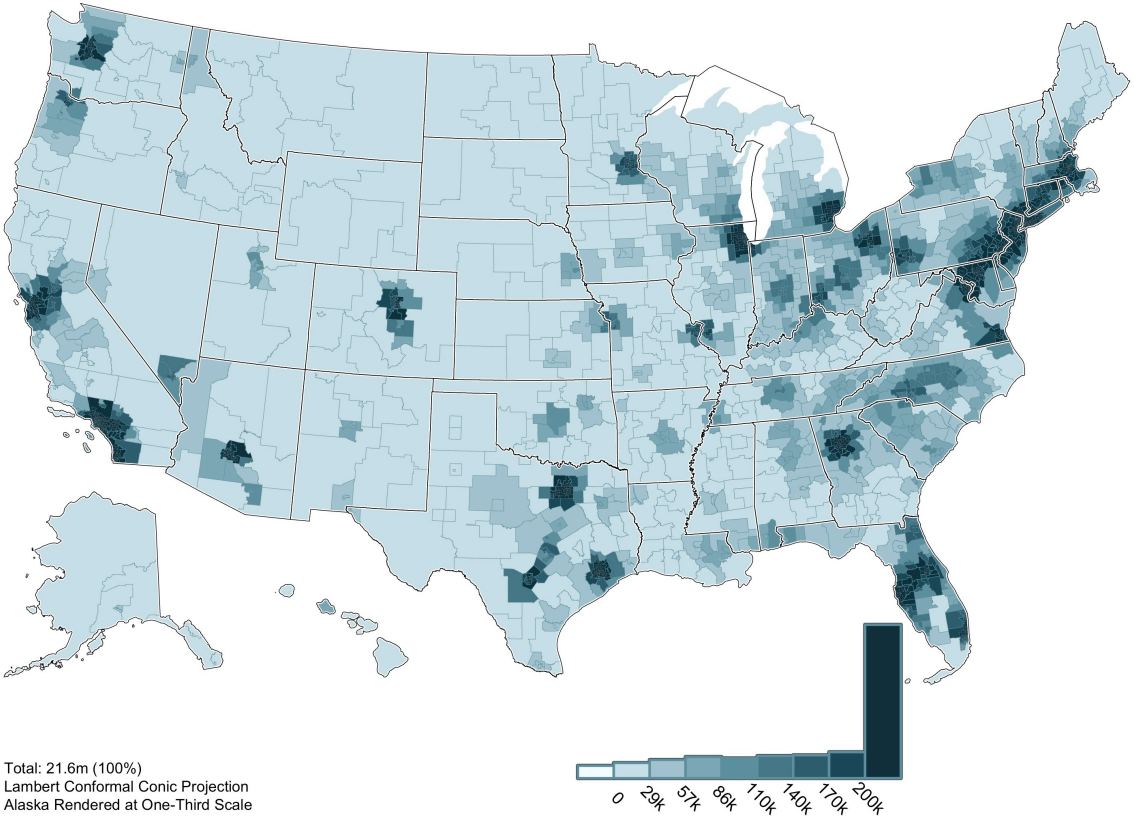
PUMA	Population	Net migration	Population after mig.
1	###	+/- ###	###
2	###	+/- ###	###
…	…	…	…
2351	###	+/- ###	###

- Iterate this process for subsequent years
- Use final 2014 projection as baseline for 2015
- Apply migration to get final 2015 distribution
- Adjust marginal counts with weight calibration: iterative proportional fitting (raking)
- Process continues through 2024

Main results

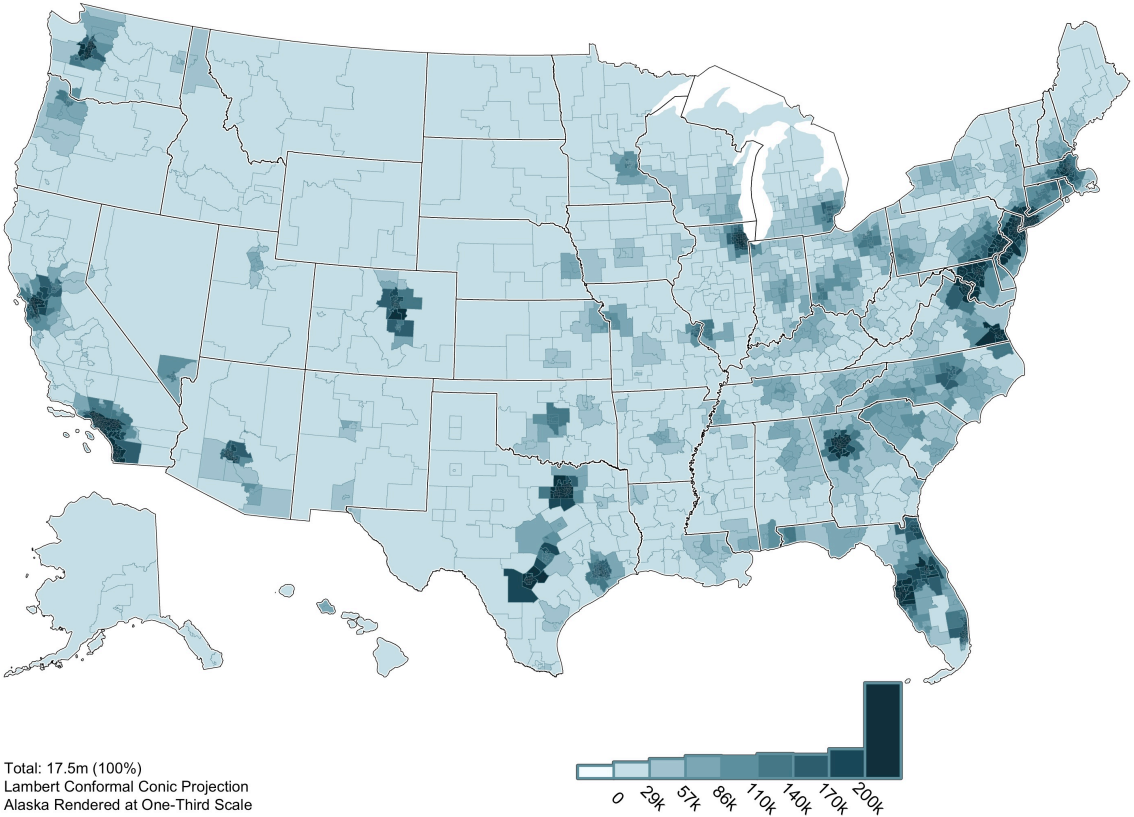
- Veterans will decrease by 19%
  - 21.6 million (2014), 17.5 million (2024)
- Mean age will increase slightly
  - Higher proportion of both older and younger
- Modest changes by sex and race/ethnicity
  - Males: 92% (2014), 89% (2024)
  - White: 80% (2014), 74% (2024)
- Service era composition will change
  - Vietnam: 32% (2014), 29% (2024)
  - Gulf War, Post-9/11: 26% (2014), 41% (2024)

Total Veteran population, 2014



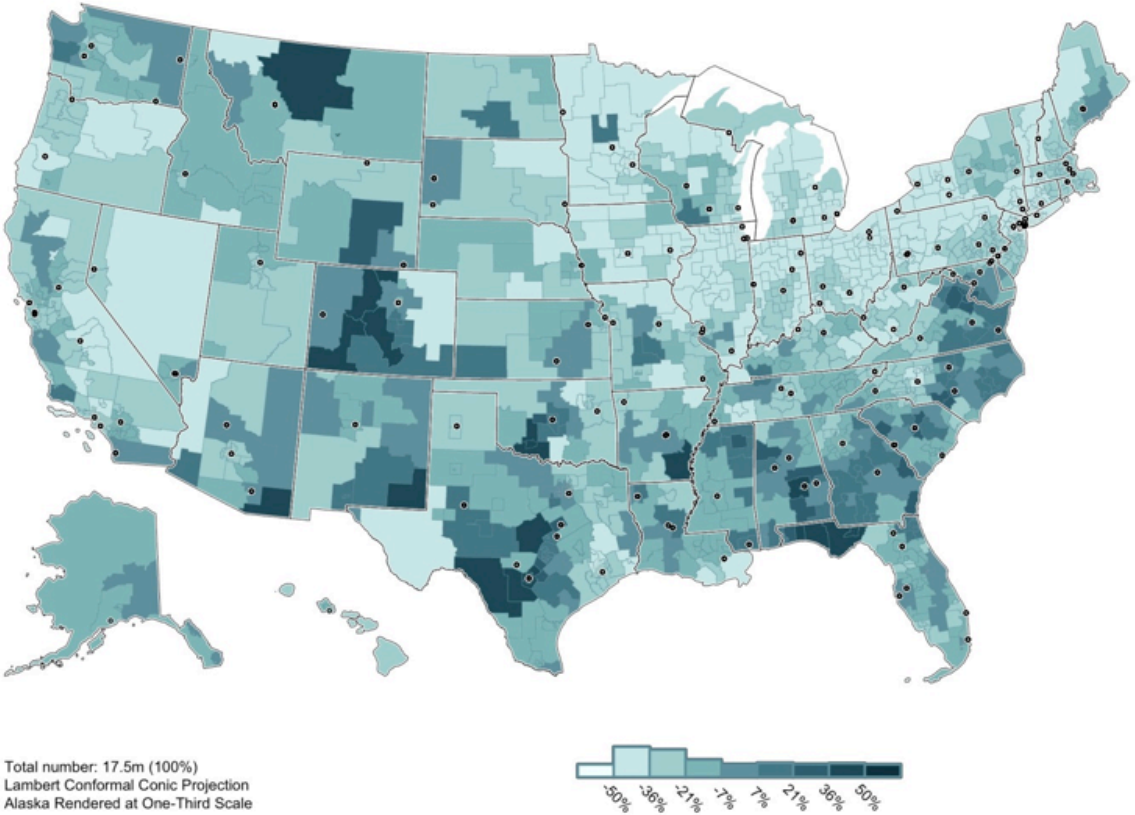
Source: RAND Health 2015, p. 41.

Total Veteran population, 2024



Source: RAND Health 2015, p. 42.

Percent Veteran population change and VA medical centers, 2014–24



Source: RAND Health 2015, p. 54.

Final considerations

- Concentration in urban areas
  - Ohio River Valley and upper Midwest: proportion of Veterans will diminish
  - Southwest will not be well matched by existing VA medical centers
- Migration is less frequent among Veterans than non-Veterans
  - Will not play substantial role in 2014–24 geographic distribution
- Projection methods can be applied to other contexts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