Outline

Sex ratio

Understanding the Sex Ratio

The sex ratio refers to the proportion of males to females in a population.

- Variation Across Species: The ratio can vary due to factors such as genetics or environmental conditions.
  - In mammals, the sex ratio at birth is often slightly biased towards males. This is consistent across many species, including rodents, non-human primates, and some carnivores.
  - In certain polygynous bird species (where one male mates with multiple females), a male-biased birth ratio is also observed.

Sex ratio

Human sex ratio dynamics

Although the sex ratio at birth is generally consistent across human populations, with **approximately 105 male births for every 100 female births**, several factors can influence this ratio.

- Influencing Factors:
  - Parental Age: Older parents are more likely to have daughters, leading to a lower sex ratio at birth. Similarly, younger siblings tend to be female.
  - Ethnic Differences: In the United States, Black populations typically have a lower sex ratio at birth compared to White populations.
- Despite these observed variations, the precise biological mechanisms driving these differences remain unclear.

Sex ratio

Some explanations

The slight male bias at birth, with approximately 105 boys for every 100 girls, raises an intriguing question: Why are more boys born than girls?

- Higher Male Vulnerability:
  - Males have higher prenatal and early-life mortality rates compared to females. This increased vulnerability may result from genetic factors, developmental differences, and a greater susceptibility to certain diseases and complications.
- Evolutionary Perspective:
  - Natural selection may favor a higher number of male births to compensate for their higher mortality rates, ensuring population stability over time.

Sex ratio

Sex ratio over the human life span

Although at the begining, there are more males than females (105 per 100), that changes later in life.

- Shifting Dynamics: this ratio begins to shift after age 20 due to higher male mortality rates.
- Advanced Age: In very advanced age groups, the sex ratio can decline significantly, often reaching as low as 1 male for every 5 females.

Sex ratio

Factors Contributing to Higher Male Mortality

Occupational Hazards:

- Men are overrepresented in jobs with physical and chemical risks, such as construction and mining. Working in environments with toxins and pollutants contributes to chronic health problems and respiratory diseases.
- Elite law enforcement units, such as special forces and SWAT teams, predominantly consist of men, which can increase exposure to high-risk situations.

Social and Environmental Factors:

- Men are more likely to experience homelessness, increasing their exposure to harsh conditions and health risks.
- Higher rates of involvement in armed conflicts (wars) lead to greater mortality.
- Men have higher mortality rates in epidemics due to intrinsic biological factors.

Sex ratio

Factors Contributing to Higher Male Mortality

Biological Factors:

- Men's immune systems may be less robust, influenced just by maternal genes.
- Higher levels of testosterone in men are linked to risk-taking, which can contribute to higher mortality.

Behavioral Factors:

- Men often engage in riskier behaviors and jobs, leading to more accidents and injuries.
- Healthcare Utilization: Men are less likely to seek preventive medical care, resulting in later diagnoses and poorer health outcomes

Sex ratio

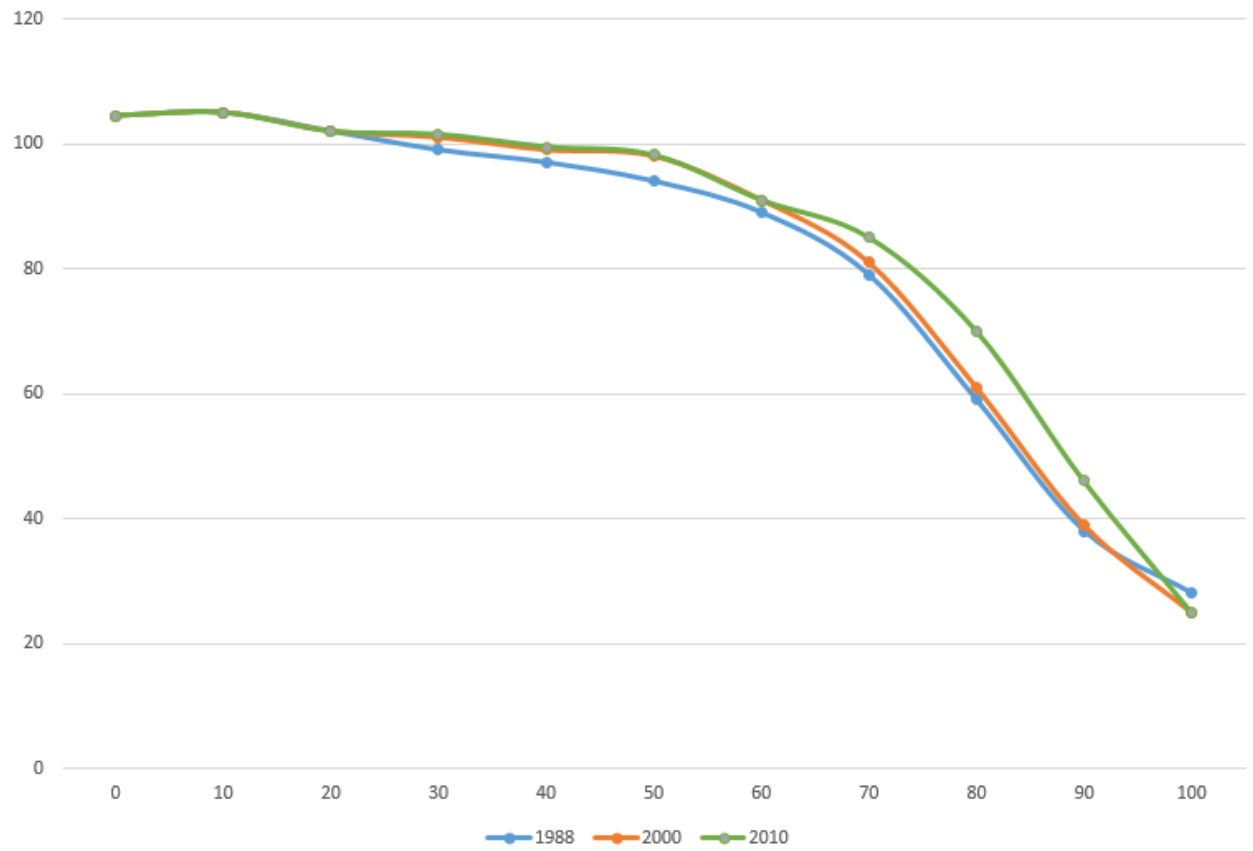

Figure: 5. US sex ratio for 1988, 2000 and 2010. Data from US Bureau of the Census.

Sex ratio

Highest males mortality at all ages

The sex ratio is significantly influenced by higher male mortality rates across all age groups, including the prenatal stage.

- External Influences: Migration and war can impact sex ratio trends, causing fluctuations due to demographic changes and social events.
- Modern Influences: Recent cultural shifts, medical advancements, improved preventive measures, and lifestyle changes have contributed to a slower decline in the sex ratio with age compared to earlier periods.

Sex ratio

Sex ratio: What for?

Understanding the sex ratio is not just about observing demographic patterns—it helps inform critical decisions in healthcare, public policy, and research.

Sex ratio

Planning Healthcare for Aging Populations

Women tend to outlive men, leading to a predominantly female population in old age. This impacts:

- Healthcare demand: More geriatric care and specialized services for women.
- Pensions and social security: Longer lifespans among women require financial adjustments.
- In Japan, demographic projections based on Sex Ratio are crucial for planning long-term healthcare facilities and ensuring adequate pension resources for a growing elderly population.

Sex ratio

Biodemography

Understanding why women live longer involves demographic and biological analyses.

- The Sex Ratio in advanced ages provides insights for:
  - Genetic and hormonal research: Exploring estrogen's protective effects.
  - Evolutionary biology: Exploring whether natural selection influences differential male and female longevity.
- Comparative studies in Scandinavian countries have used changes in the Sex Ratio at older ages to investigate genetic versus lifestyle contributions to longevity.

Sex ratio

Comparative Studies Across Species

Comparative studies help us to better understand our own biological mechanisms behind human sex-ratios.

- Hormonal influence: Hormonal levels during conception in mammals could affect the sex ratio at birth.
- Studies show that high-ranking female primates tend to have more male offspring, suggesting that maternal condition may influence sex determination.
- In macaques, maternal dominance and age influence the sex ratio of offspring, highlighting the role of maternal condition.
  - Dario Maestripieri, *Maternal Dominance Rank and Age Affect Offspring Sex Ratio in Pigtail Macaques*, Journal of Mammalogy, Volume 83, Issue 2, May 2002, Pages 563–568.

Sex ratio

Migration and Regional Sex Ratio Shifts

Migration often has a strong gender component, affecting regional Sex Ratios.

- Rural vs. Urban Impact:
  - Rural areas: Male migration leaves a predominantly female population.
  - Urban areas: An influx of male workers can temporarily skew the ratio.
- In rural Mexico, the migration of young men to urban centers or abroad disrupts community structures and impacts labor availability, leading to a need for policy interventions to support rural economic stability.

Sex ratio

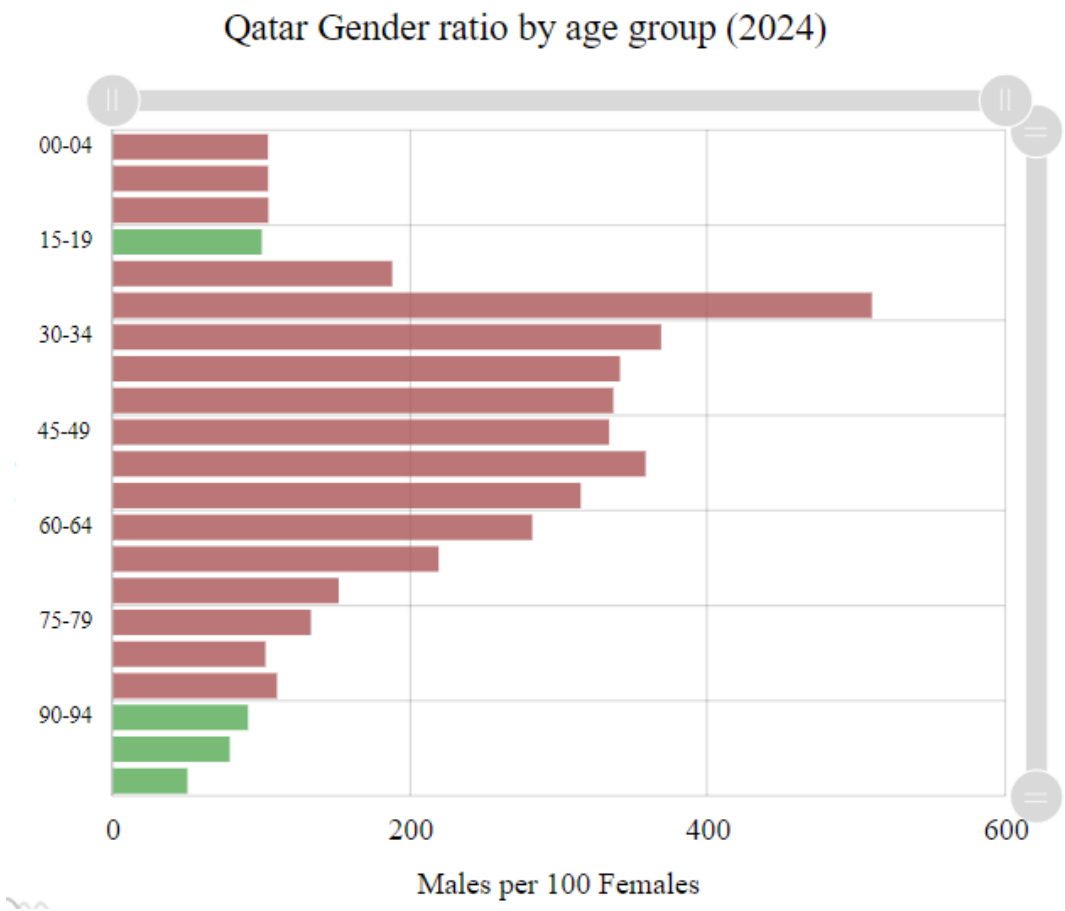

Figure: 6. Qatar sex ratio, 2024. Data from *statisticstime.com*

Sex ratio

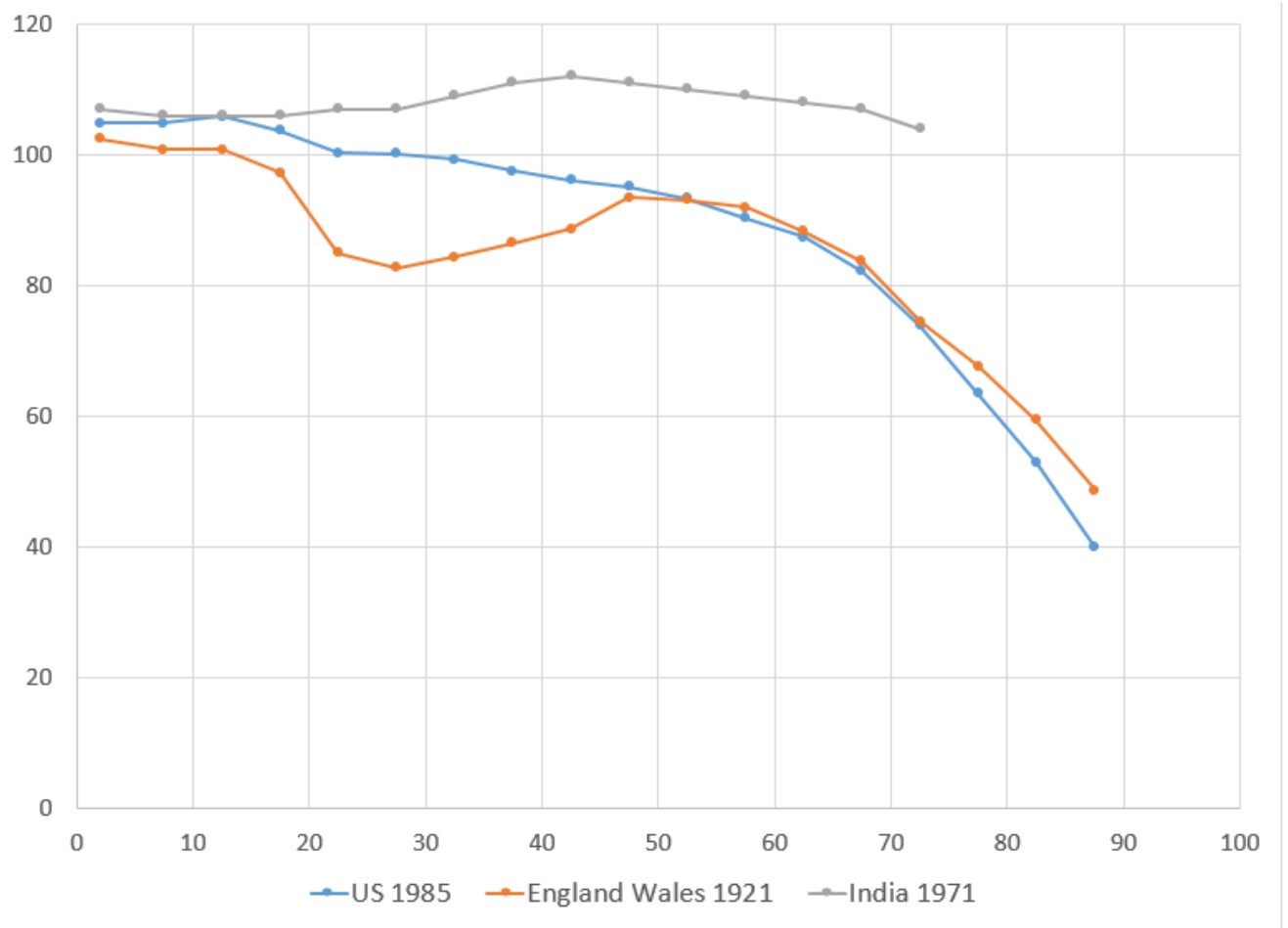

Figure: 7. Sex ratio for the US ('85), England and Wales ('21) and India ('71).

Sex ratio

Describing sex ratios

- For US '85, the trend is just that expected according to a lower female mortality within populations.
  - As age increases, the sex ratio decreases.
- For England and Wales '21, the trend shows the effect of high mortality among young adult males during the WW1
  - Numbers for 25-29 and 30-34 are particularly low.
  - Patterns like this can also be caused by heavy migration.

Sex ratio

Describing sex ratios

Regarding India in 1971, this pattern is typical of high-mortality countries in South and East Asia, as well as parts of Africa:

- Malnutrition: Young females often suffered from worse nutritional conditions, which led to higher mortality rates among them.
- Maternal Health Risks: Health risks associated with pregnancy and childbirth significantly contributed to female mortality.
- Healthcare Disparities: Limited access to healthcare, combined with gender bias, resulted in higher mortality rates for females.

Sex ratio

Bottomline: determinants of the sex ratio

In summary, while genetics, geographic factors, and other subtle influences play a role, the overall sex ratio is primarily determined by:

- 1. The Sex Ratio at Birth: The natural proportion of males to females born, which typically favors males.
- 2. Sex Differences in Mortality: Variations in mortality rates between males and females at different ages, often resulting in higher male mortality.
- 3. Differential Migration: Differences in migration patterns, where one gender may predominate due to economic, social, or political factors.

Outline

Dependency ratios

Some other interesting ratios

In addition to the sex ratio, other ratios are useful for describing populations, commonly known as dependency ratios.

- Strictly speaking, a dependency ratio measures the proportion of economically active individuals compared to economically inactive individuals within a population.
- However, when data is lacking or when defining economic activities is challenging in some countries, an alternative approach using age groups is often adopted.

Dependency ratios

Some other interesting ratios

The dependency ratio, in terms of age groups, is defined as

$$\text{Dependency ratio} = \frac{\text{Children} + \text{Elderly}}{\text{Working ages}}$$

- Sometimes, the ratio is multiplied by 100 for easier interpretation, though this is optional.
- This ratio represents the number of dependents (children and elderly) relative to the number of working-age individuals, essentially indicating the number of dependents per working-age adult.

Dependency ratios

Defining young and old

Defining “children” and “elderly” is crucial for calculating dependency ratios.

- Generally, "children" are defined as individuals under 15 years old, and "elderly" are those over 65 years old.
- For example, in 1985, estimates for England and Wales indicated there were 10.3 million children, 30.6 million working-age adults, and 9.1 million elderly individuals. The dependency ratio was calculated as:

$$\frac{10.3 + 9.1}{30.6} * 100 \approx 63$$

- This means there were approximately 63 dependents for every 100 working-age adults, indicating that the working-age population exceeded the number of dependents at that time.

Dependency ratios

Splitting up the dependency ratio

The dependency ratio can sometimes be divided into components for young and elderly populations.

- Let D represent the overall dependency ratio. When distinguishing between youth and elderly dependents, the youth dependency ratio is calculated as follows

$$D_Y = \frac{P_{0-14}}{P_{15-64}},$$

while the elderly ratio is

$$D_E = \frac{P_{65+}}{P_{15-64}}.$$

Dependency ratios

Splitting up the dependency ratio

- In the case of England and Wales, 1985, both indices were $D_Y = 10.3/30.6 \approx 0.34$, and $D_E = 9.1/30.6 \approx 0.29$.
- These indices indicate that, within the total dependency ratio, there are 34 youth dependents and 29 elderly dependents per 100 working-age adults.
- This distinction is important because the needs of youth and the elderly differ significantly.

Dependency ratios

	Northeast	*Midwest*	*South*	*West*
Rural				
Youth	36.7	39.6	38.8	39.2
Elderly	16.2	18.0	17.3	14.8
Both	52.9	57.6	56.1	54.0
Urban				
Youth	30.5	33.6	33.6	32.9
Elderly	19.2	17.1	17.1	14.8
Both	49.7	50.7	50.7	47.7

Table: 2. Dependency ratios for US regions. US Bureau of the Census, 1980.

Dependency ratios

Some observations

Key Observations:

- Across various regions in the US, the dependency ratio is consistently higher in rural areas compared to urban areas.
- The proportion of elderly individuals, P_{65+}, relative to the working-age population, $P_{(15-64)}$, appears similar in both rural and urban settings.
- The primary difference is observed in the youth dependency ratio:
  - The percentage of youth, P_{15-}, relative to the working-age population, $P_{(15-64)}$, is higher in rural areas than in urban areas.
  - This suggests a higher total fertility rate in rural areas compared to urban areas.

Labor force

More indexes

Other indices can be defined to describe the economic participation of a population.

- The **Labor Force participation** is the proportion of the population in working age actively in the labor market, whether working or looking for a job

$$L_f = \frac{E + U}{P_{15-64}},$$

where E is people employed, U is people unemployed (but looking for a job).

- Tipically, it is multiplied by 100 for easy reading.

Labor force

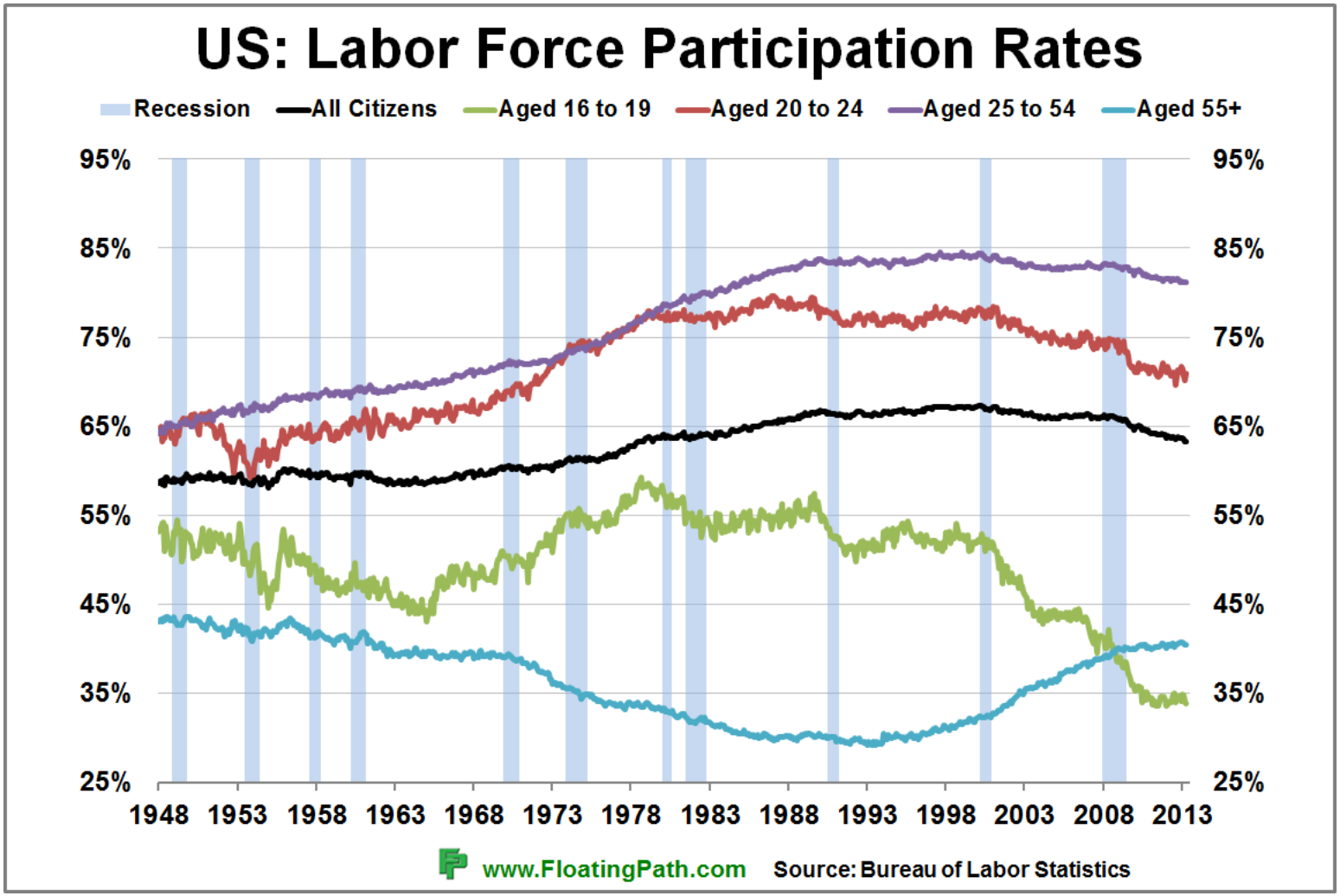

Figure: 8. US Labor force participation, from 1948 to 2013.

Labor force

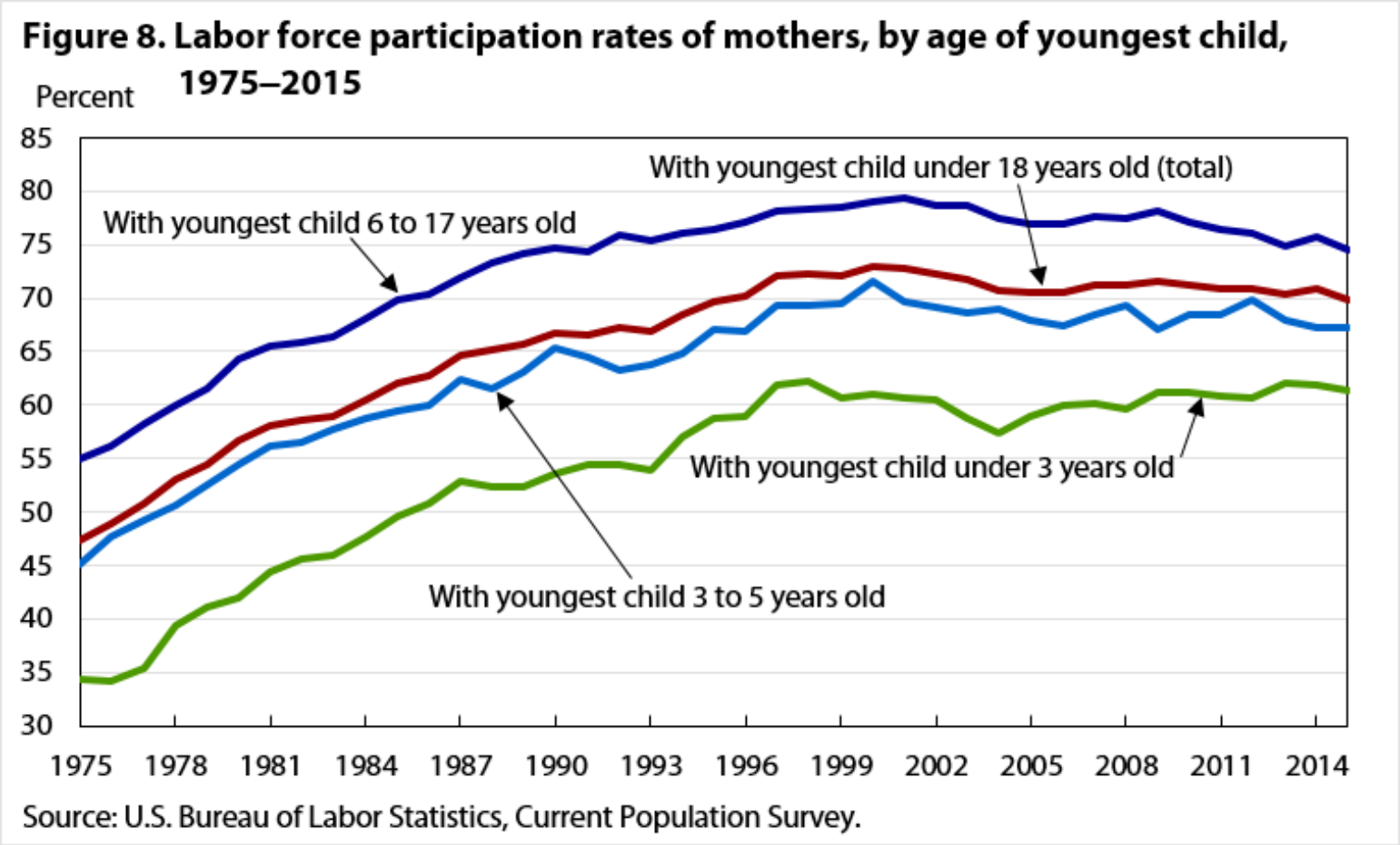

Figure: 9. Labor force participation of mothers, by age of youngest child.

Labor force

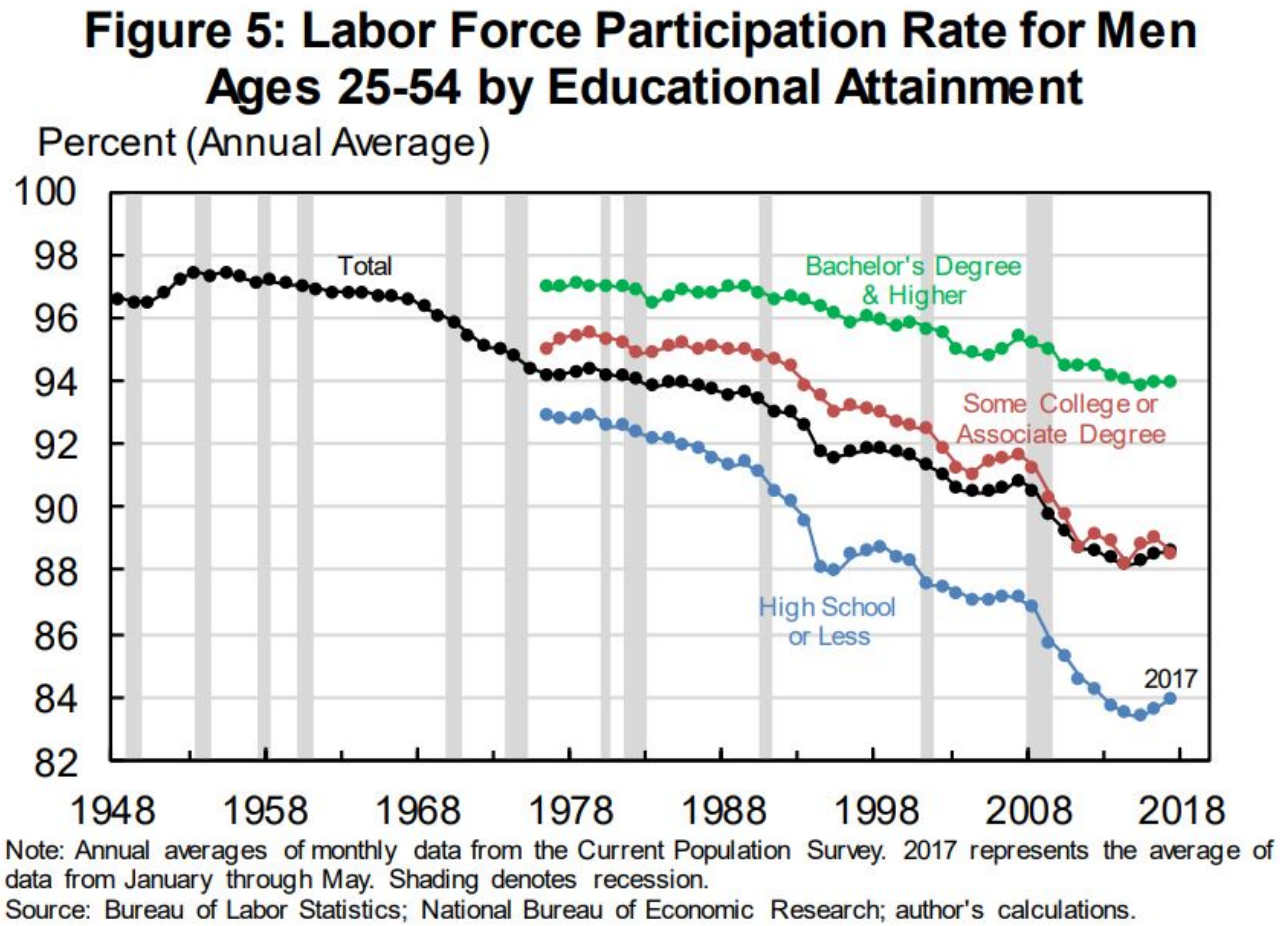

Figure: 10. Labor force participation for men, ages 25-54, by education level.

Indicators of population aging

Population aging indices

Ratios for Assessing Population Aging:

- Proportion of Older Ages: This metric measures the percentage of the population that is aged 60+, 65+, or 80+, compared to the total population. It helps to understand the relative size of the older age groups within the entire population.
- Median Age: The median age is the point that divides the population into two equal halves. Half of the population is younger than this age, while the other half is older. It provides insight into the overall age distribution and aging trends.

Indicators of population aging

Population aging indices

Ratios are also valuable for assessing population aging:

- Old-Age Support Ratio (or Potential Support Ratio): This ratio indicates the number of individuals aged 15 to 64 for every person aged 65 or older. It reflects the potential economic support burden on the working-age population.
- Aging Index: The aging index is the number of individuals aged 65 and older for every person aged 0 to 14. It illustrates the relative size of the elderly population compared to the younger population, highlighting the aging dynamics within a society.

Several indicators

How is the world getting older?

Explore the following sites to get an idea of the median age in various countries and regions:

- Median age: https://ourworldindata.org/grapher/median-age
- Median age, a comprehensive list of countries: https://www.cia.gov/the-world-factbook/field/median-age/country-comparison/
- Additionally, you might find www.gapminder.org\tools or www.indexmundi.com useful.
  - These platforms provide valuable insights and data on health, economics, and demographic characteristics of populations worldwide.

Outline

Age and sex structure on vital events

Determinants of Age Structure

Fertility and Age Groups:

- Initial Impact: Lower fertility reduces the base of the population pyramid.
- Gradual Impact: A sustained decline in fertility may lead to a more balanced age distribution as younger cohorts gradually age[a].
- Long-Term Consequences: Aging population, straining the workforce and public services.[b].

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[a] However, if fertility drops abruptly, the population may age rapidly, leading to a sharp increase in the proportion of older individuals and potential workforce shortages.

[b] If fertility rates remain consistently below 2.1 children per woman, this could lead to extinction in the very long term; it would take several decades or even centuries for such extreme outcomes to materialize.

Age and sex structure on vital events

Impact of Mortality on Age Structure Infant Mortality:

Mortality and Age Groups:

- Younger Age Groups: Higher mortality among infants and children due to vulnerability to diseases.
- Gradual Impact on Older Groups:As healthcare, nutrition, and living conditions improve, mortality rates decline for younger age groups first. Over time, this shift extends to older age groups as health advancements take longer to benefit adults and the elderly.
- Developing Countries: In developing nations, mortality can disproportionately affect specific age groups, such as children during famines or the elderly during epidemics.

Age and sex structure on vital events

Migration and Its Effects Migration Patterns

Migration and Age Structure:

- Emigration Effects: Loss of young adults accelerates population aging.
- Immigration Effects: A younger age structure, with an increase in the number of children and young adults. This helps to counteract the effects of an aging population.
- Sex-Selective Migration: Migration patterns can be sex-selective, with differing rates of emigration or immigration between men and women. This can impact the gender ratio and age distribution within the population.

Age and sex structure on vital events

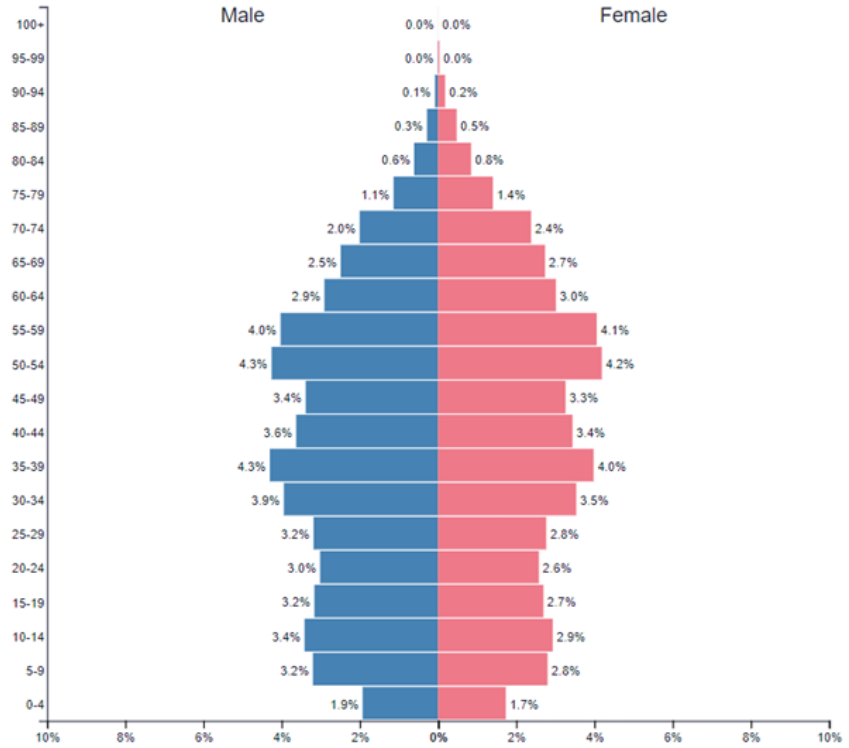

Figure: 11. China's population pyramid as of 2024. Population: ~ 1419 millions.
Source: populationpyramid.net.

Age and sex structure on vital events

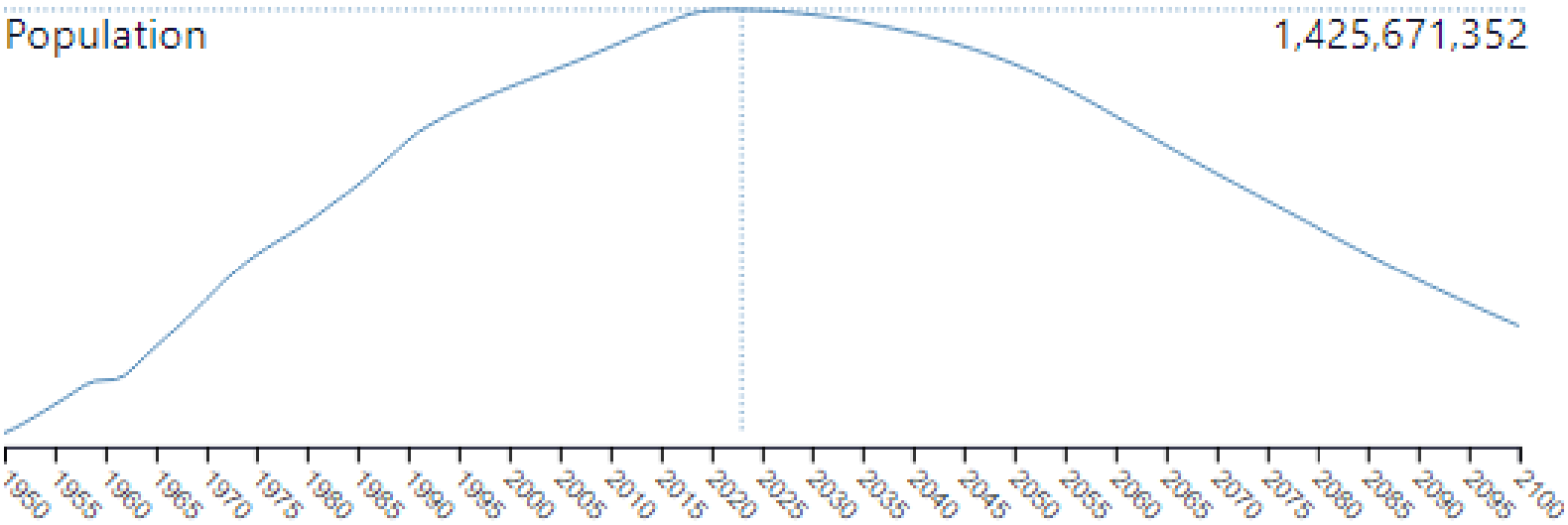

Figure: 12. China's population from 1950-2100. In 2100, China is expected to be back at the same population level of 1957. The difference is that in 2100, its population will be old, not young, as in 1957. Source: populationpyramid.net.

Age and sex structure on vital events

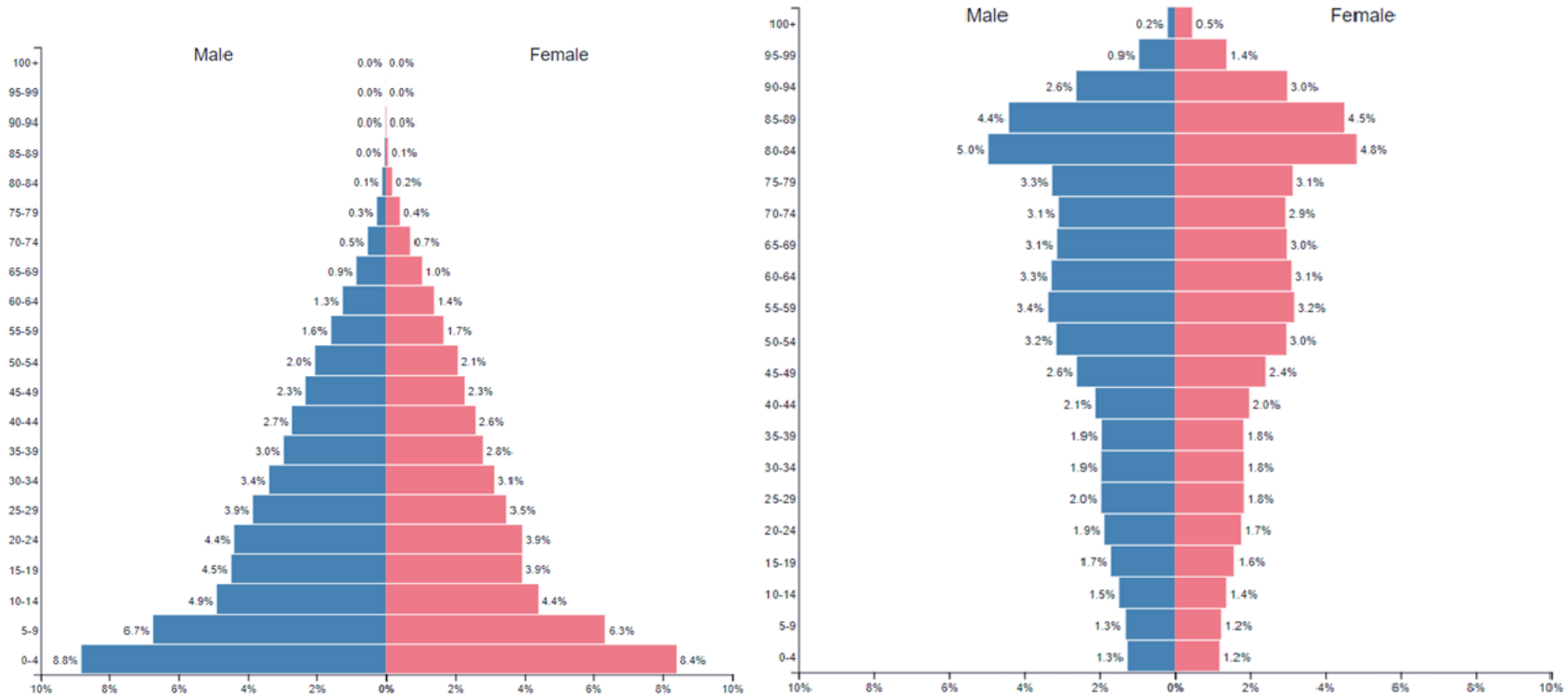

Figure: 13. In 2100, China is expected to be back at the same population level of 1957 (left), at around 633 millions. The difference is that in 2100, its population will be quite old, not young, as in 1957. Source: populationpyramid.net.

Age and sex structure

China: From 1957 to 2100 - A Profound Demographic Shift

- 1957: ~ 630 million inhabitants, classical expansive pyramid with a broad base of people under 15 and even 10 years old. A young population.
- 2100: ~ 633 million inhabitants (56% reduction from 2024). Inverted pyramid, with a median age around 60 - 65 years old.

Age and sex structure

China: From 1957 to 2100 - A Profound Demographic Shift

This transformation presents enormous economic and social challenges:

- Labor force: A significant reduction that could limit the country's economic dynamism and productive capacity.
- Social security: A potentially unsustainable system due to the high proportion of elderly people.
- Cultural impact: Changes in traditional family structures and increased burden on younger generations.

Age and sex structure

Demographic momentum

Demographic Momentum refers to the phenomenon where a population continues to grow even after birth rates decline, due to the large proportion of young people already in the population. This youthful demographic ensures that a significant number of individuals will reach reproductive age in the coming years, leading to sustained population growth.

- Demographers can predict with considerable confidence that populations in most developing countries will continue to grow in the near future, even if fertility, mortality, or migration trends change.

Age and sex structure

Demographic momentum

- China, 1957 - High Fertility: Large young cohorts ensured continuous population growth.
- China, 2100 - Low Fertility & Aging Population: Even with a potential rise in fertility, population aging becomes an irreversible brake on growth. Despite a posible higher fertility, it will take decades for the effects to show, and the imbalance will persist in the short term.
  - Key Insight: Population growth (or slower decline) continues in the near future due to the existing age structure, but the full impact of any changes in fertility will only be seen much later, making the aging issue a long-term challenge.