Sex Ratios Across the Life Course

Select Topics in International Population and Health[1]

By Daniel Goodkind and Hannah Rosenblum

Released March 2023

BACKGROUND

Sex ratios of human populations—the ratio of males to females—vary considerably throughout the world. However, within any given society, there are predictable regularities in sex ratios across the life course. In the materials that follow, we describe both commonalities and variations in sex ratios, review explanations for them, and explore some of their major socioeconomic implications.

We begin with a progression of maps showing sex ratios by country across successive age groups, beginning with the moment of birth (Figure 1).

SEX RATIOS OF THE TOTAL POPULATION AND BY AGE

The sex ratios of country populations can be disproportionately male or female. As shown in Figure 1, countries with the most masculine sex ratios as of 2022 are shaded in deep blue, while those that are most feminine are shaded in deep orange, with lighter gradations between the extremes. Green shading indicates a range of sex ratios that straddle an even 50-50 split between males and females.

Sex ratios for the total population are diverse around the globe. Most areas in the Americas, Europe, Sub-Saharan Africa, Central Asia, Southeastern Asia, and Oceania are either disproportionately female or evenly balanced between the sexes. Conversely, China, India, and parts of Northern Africa and the Middle East are disproportionately male.

To understand such diversity requires a closer examination of sex ratio patterns across the life course. Figure 1 shows sex ratios by age, beginning at the time of birth. Male births typically outnumber female births by 1 to 7 percent (e.g., a sex ratio between 1.01 and 1.07). The corresponding worldwide map for sex ratios at birth is mostly solid blue. Thereafter, sex ratios tend to decline across the life course. At childhood ages (under the age of 15), the sex ratio remains excessively male, very close to the sex ratio at birth. At working ages (15–64), the map shows considerable diversity, with geographic variations similar to those for the total population.

At the age of 65 and over, however, the picture is noticeably different. Between the ages of 65 and 79, the sex ratio is less than 0.98 in most places, and at the age of 80 and over many countries have only 65 or fewer males for every 100 females. Exceptions include Sudan and South Sudan, estimates that reflect the excessively masculine sex ratios of adults over the age of 40 reported in the 2008 census, a distortion that may indicate reporting anomalies.
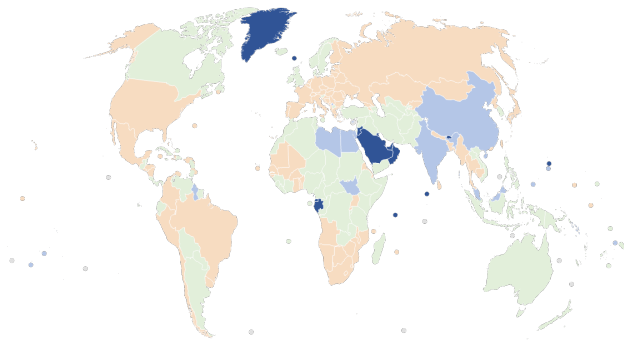
U.S. Department of Commerce
U.S. CENSUS BUREAU
census.gov

United States Agency for International Development
www.usaid.gov

Figure 1.
Sex Ratio of Total Population and Age: 2022

Ratio of males to females

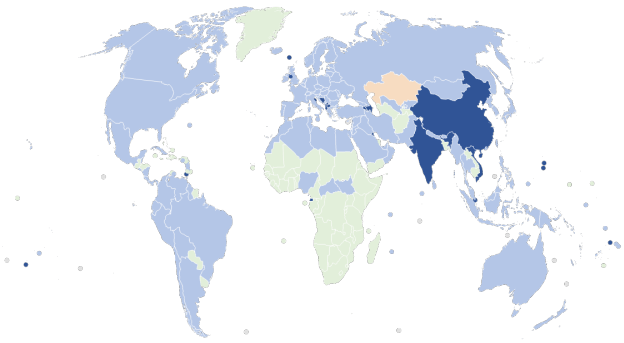■ >1.070   ■ <1.070   ■ <1.039   ■ <0.979   ■ <0.799   ■ <0.650
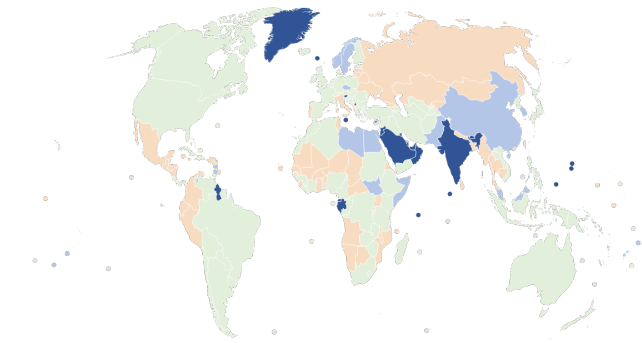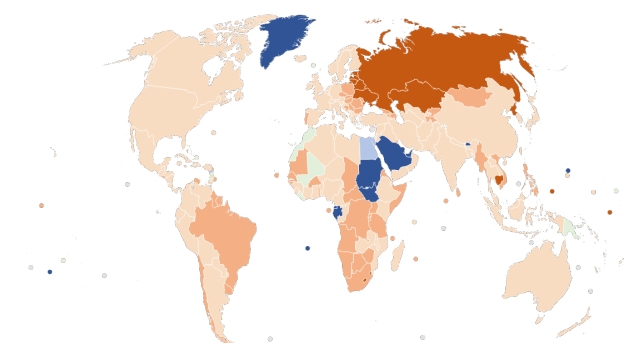
Total Population
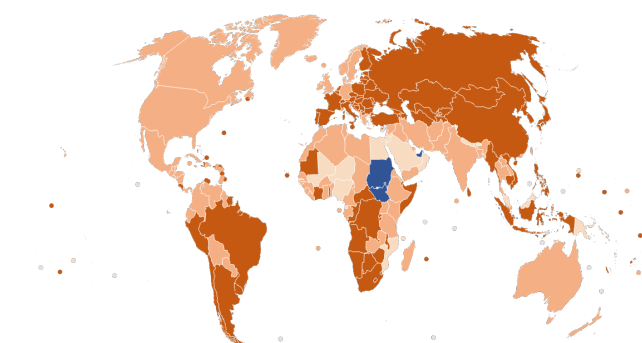
At Birth
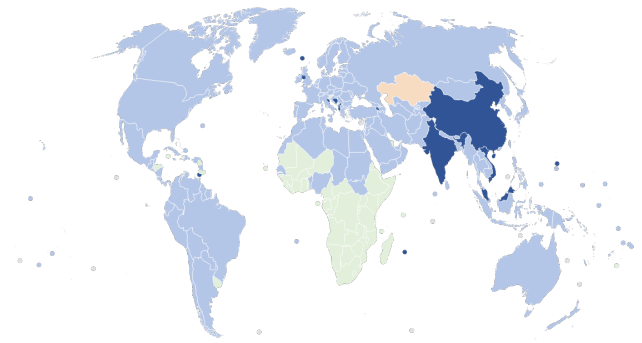
Aged 0 to 14

Aged 15 to 64

Aged 65 to 79: 2022

Aged 80 and Above

Source: U.S. Census Bureau, International Database, 2021.

Thus, the excess number of males at birth tends to be followed by a gradual reversal to excess females followed by a steep increase in excess females at older ages. The following are a variety of biological, environmental, behavioral, and sociocultural factors that may contribute to these patterns.

WHAT CAUSES SEX RATIO IMBALANCES ACROSS THE LIFE COURSE?

Factors Affecting Sex Ratio at Birth

The Sex Ratio From Conception to Birth: Biological and Environmental Influences

As noted earlier, Figure 1 indicates an excess of male births throughout the world, yet the extent of that excess varies. Much of Sub-Saharan Africa shows the lowest sex ratios at birth (typically less than 104, [e.g., a 4-percent excess of males compared to females]) or even lower (Morse and Luke, 2021), while areas of Asia tend to exhibit the highest (107 or more). Yet, there are exceptions to these patterns within these two regions. We now turn to explaining the reasons for such differences, as well as the typical masculinity of sex ratios at birth.

The earliest stage of the life course that sex imbalances may begin is at conception. Given widespread observance of excess mortality of male infants and children, most experts assumed that male fetuses should also be more frail and less likely to survive than their female counterparts. If so, the sex ratio at conception would have to be even higher than the sex ratio at birth, which would gradually normalize somewhat due to excess male fetal deaths.

Based on a recent comprehensive review of available evidence, other experts concluded that the sex ratio at conception is instead 50-50, with survival advantages in utero thereafter shifting back and forth (Orzack et al., 2015). The evidence reviewed suggests a slight female advantage in fetal survival during the first week and final 2 months of gestation that is counteracted by a more pronounced male advantage between the first and 20th weeks sufficient to produce a masculine sex ratio at birth. The dynamics of such apparent changes in fetal frailty by sex are not yet well understood.

Biological factors may account for some portion of the cross-country differences, such as consistently low sex ratios at birth in Sub-Saharan Africa. Those factors could include both genetic predispositions and other environmental circumstances that interact with human biology.

For instance, stressors during pregnancy (such as malnutrition or lack of prenatal care) might reach such a magnitude in some societies that they impact male and female fetuses equally. That said, other behavioral and social factors may also be responsible for such discrepancies.

### *Individual and Policy Factors: Sex Selection and Reporting Anomalies*

As fertility rates fall to low levels—i.e., below two births per woman—parents determined to have a son may use prenatal sex selection, a practice most often occurring when they have one or more daughters. In some societies, the sex ratio at birth has peaked at 114 or above (e.g., Azerbaijan, Armenia, South Korea, most of China, and the northern states of India), an elevation due both to sex-selective abortion and its interaction with the tendency to stop childbearing after the birth of a son. Thereafter, son preference tends to decline as those societies develop, resulting in a less distorted sex ratio at birth or the elimination of distortions altogether. However, even if sex ratios at birth normalize, the excessive masculinity of prior birth cohorts will carry forward into the life course for decades to come.

In addition to prenatal sex selection, other reporting anomalies may contribute to observed sex ratio distortions. In China, for instance, due to the punitive nature of birth limitations in decades past, a newborn daughter might be less likely to be reported than a son. Albeit harder to document, reporting anomalies in other countries could also contribute to sex differences. For instance, if the birth of an infant of a particular sex is less likely to be reported, its death may also go underreported and vice versa. Another possible factor in multiethnic societies could involve interethnic couples, whose sex ratios at birth could be affected if the ethnic identification of a child of a particular sex was chosen based on the ethnicity of the corresponding spouse of that sex (Brunsma, 2005).

Some combination of these biological and volitional factors may explain sex ratio variations across countries, as well as among ethnic groups within them. Such differentials often persist over long periods of time. In the United States, for instance, Black and American Indian communities have for many decades reported lower sex ratios at birth of about 103.5 and 102.5, respectively, compared to about 105 for White and 106–107 for many East and Southeast Asian communities (Mathews and Hamilton, 2005). Similarly, in multiethnic Malaysia, those of Asian- Indian heritage report lower ratios than majority

Figure 2.
Death Rates in Cambodia by Age for Males and Females (Log Scale): 2022
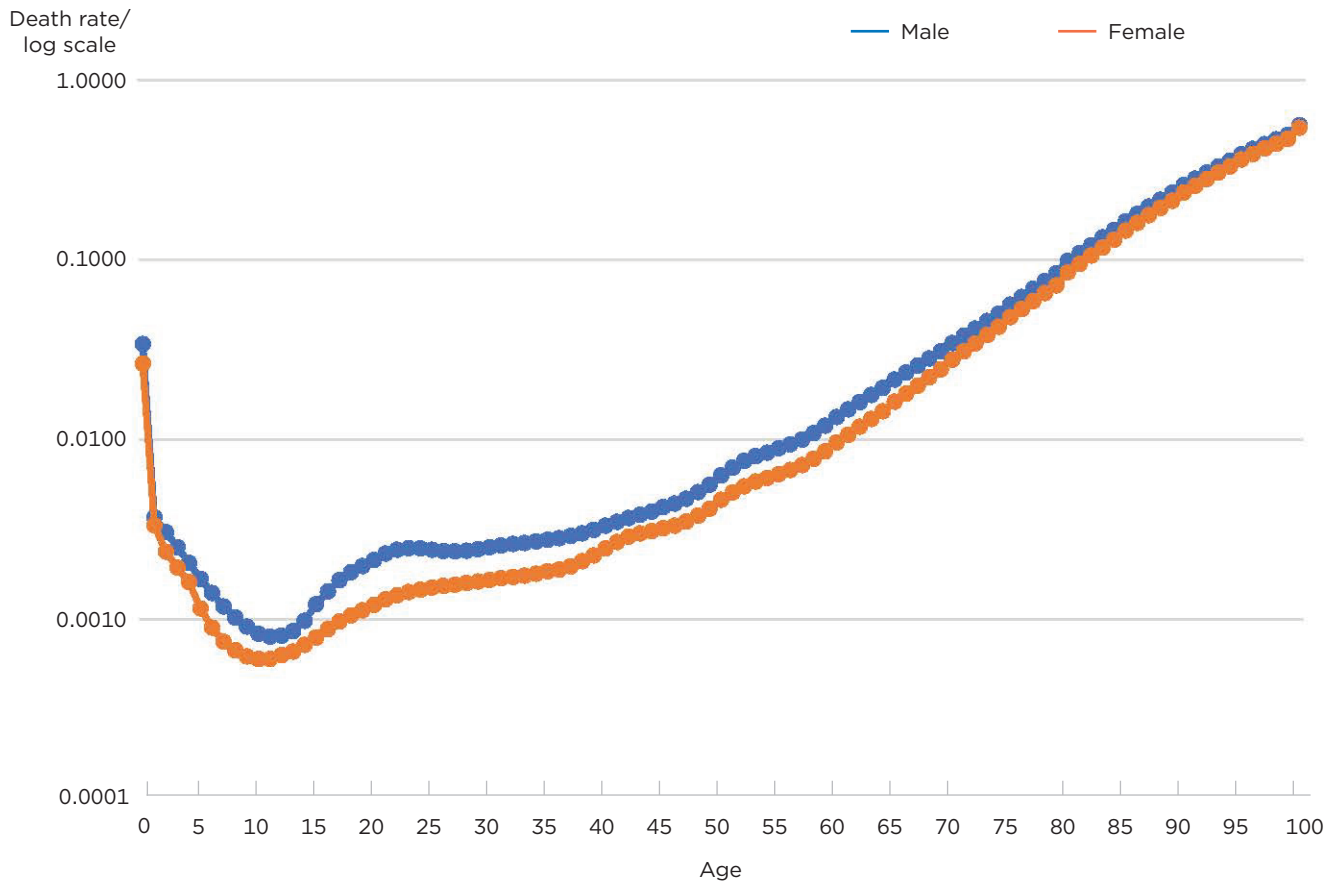
Source: Life Table Corresponding to U.S. Census Bureau, International Database, 2021.

Malays, who in turn report lower ratios than Chinese. In both cases, the more disadvantaged socioeconomic groups report the lowest sex ratio at birth. Such variations could reflect health disparities, but could also be due to genetics or the aforementioned reporting patterns.

One challenge to disentangling all the potential explanations is that ratios have wide statistical bands of uncertainty. Given that tens of thousands of births are needed to confirm differences and trends in overall sex ratios, reported births are often not numerous enough (or contain enough additional details) to isolate the contribution of each factor.

Factors Affecting Sex Ratios Among Infants and Young Children

Death rates by age usually exhibit a J-shaped age pattern, as illustrated for Cambodia in 2022 (Figure 2). Mortality is relatively high among infants and young children, declines in late childhood and young adulthood, and remains low for many years before gradually rising at older ages.

After birth, death rates among males typically exceed that for females at every age. Among infants, male mortality tends to be 10–40 percent higher. For young children, that excess is about 10–20 percent. The excess of male child mortality may be due in part to biological reasons, as identified earlier. However, other social and behavioral factors may contribute to excess male mortality such as accidents, violence, and suicides.

In some societies, the expected excess in mortality among male children can be dampened or even reversed. For example, prior to the availability of prenatal sex detection technology (discussed in the previous section), parents with son preference might discriminate postnatally against young daughters through differential care, especially if they had congenital disorders. Although such practices may continue or even be enhanced when parents want fewer children, the availability and use of prenatal selection has tended to substitute for such discrimination (Goodkind, 1999; Bongaarts and Guilmoto, 2015). Even where discriminatory behaviors persist, the impact on

Figure 3.
World Sex Ratios by Age: 2022

Sex ratio
(males/females)
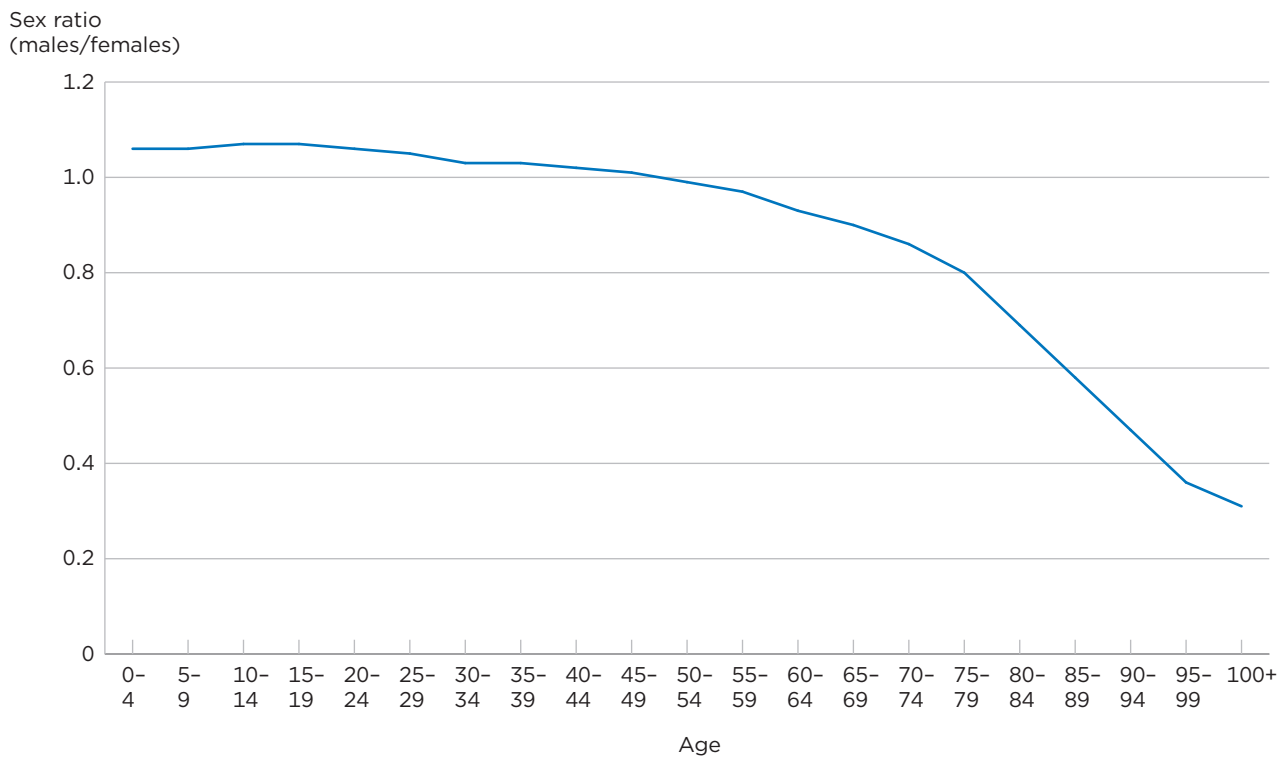
Source: U.S. Census Bureau, International Database, 2021.

child sex ratios tends to be minor. In less developed societies, given that about 96 percent of all those born survive to age 5, sex differences in mortality must be very pronounced among the minority who die for child sex ratios to be substantially affected.

Factors Affecting Sex Ratios at Working Ages

Excess mortality among males continues at working ages (Crimmins et al., 2019), the reasons include behavioral factors (i.e., violence, drinking, smoking, suicides) and occupational factors (e.g., men are more likely to work in factories or join the military). The only potential countervailing factor is maternal mortality, which may raise female death rates above those of males at childbearing ages in societies where birth rates are high or maternal health care is limited.

Because death rates tend to be very low in later childhood through age 50 (typically between 0.1 and 0.5 percent per year), excess mortality among males will not bring the proportion of males and females into balance until mid- to late-adulthood. As of 2022, the global average age that sex ratios reach equality is around 50 (Figure 3). After these ages, and given rising death rates, excess male mortality causes a more rapid decrease in sex ratios. Between

the ages of 80–84, there are only 69 males for every 100 females, a ratio that declines to 31 males per 100 females at 100 years and over.

Work and occupational patterns can also have a major impact on sex ratios at certain age groups. In places where males are more likely to leave (or arrive) for work, sex ratios at younger to mid-adult ages can be distorted. Examples include rural areas in many countries, from where young males tend to migrate to urban areas; and Gulf States, where international male immigrants constitute a large proportion of the resident population. In migration sending areas, return migration of males at older age groups may dampen the decline in sex ratios caused by excess male mortality.

Factors Affecting Sex Ratios of the Older Population

After the age of 40 or 50, sex ratios become noticeably more feminine. For every 100 women of a given age, there are about 90 men in their 60s, 65 men in their 80s, and 30 men by the age of 100. As noted earlier, the reasons for the rising distortions include excess male mortality, rises in death rates, and shifts in causes of death (cancers, heart disease, etc.) where older men are at greater risk.

Figure 4.
Population in South Korea by Age and Sex: 2022
(In millions)
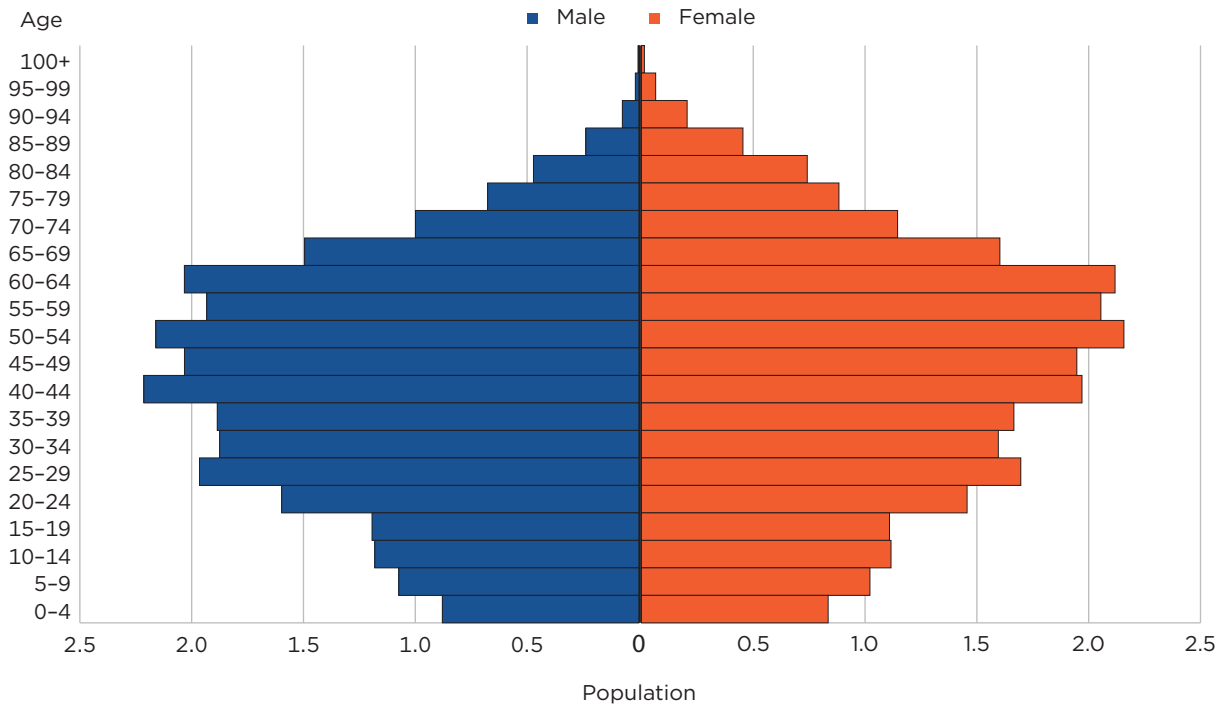
Source: U.S. Census Bureau, International Database, 2021.

SOME IMPLICATIONS OF SEX RATIO IMBALANCES ACROSS THE LIFE COURSE

Marriage Squeeze

Excessively masculine sex ratios among children carry over into young adulthood when marriage is most common. Thus, within any given age band, there will be an excess of potential husbands for each cohort of brides. Compounding this imbalance is the fact that husbands tend to marry younger brides (Akers, 1967), and the low fertility that accompanies sex selection causes the traditional pyramid shape of population structure to become more rectangular, or even vase-shaped. Thus, would-be husbands must seek brides from a smaller cohort of younger women.

The severe imbalance that can result from these two factors is illustrated below in the case of South Korea (Figure 4). Sex ratios at birth peaked in South Korea from roughly 1990–2000, along with a sharp decline in birth rates. This cohort, now mostly in their 20s as of 2022, exhibits a distorted, vase-shaped population structure under the age of 30. The sex ratio of those approaching peak ages of marriage (males aged 20–29 vs. females aged 15–24) is 1.39, an imbalance in marked contrast to cohorts born before and after them (Figure 5). In this generation, many men seeking brides will have no choice but to postpone marriage to later ages, marry brides of the same (or an older) age, or forego marriage altogether. In contrast, most women will have more options, including to marry early, select among multiple potential suitors at peak marital ages, or even postpone marriage until later ages when there will still be a pool of husbands from which to choose.

### Feminization of Poverty at Older Ages

Given that brides tend to be younger than their husbands and have lower mortality at any given age, women are far more likely than men to be widowed and will live a much longer period of their older years without a spouse. Thus, rising majorities of females at older ages (Figure 1) suggest a feminization of poverty, particularly in societies where women don't work outside the home and are dependent on their husbands for financial support (Stone, 1989). Managers of older age pensions and social security systems, as well as programs focused on poverty alleviation, need to keep these dynamics in mind.

Figure 5.
Sex Ratio in South Korea of Males by 10–Year Age Groups vs. Female 5 Years Younger: 2022
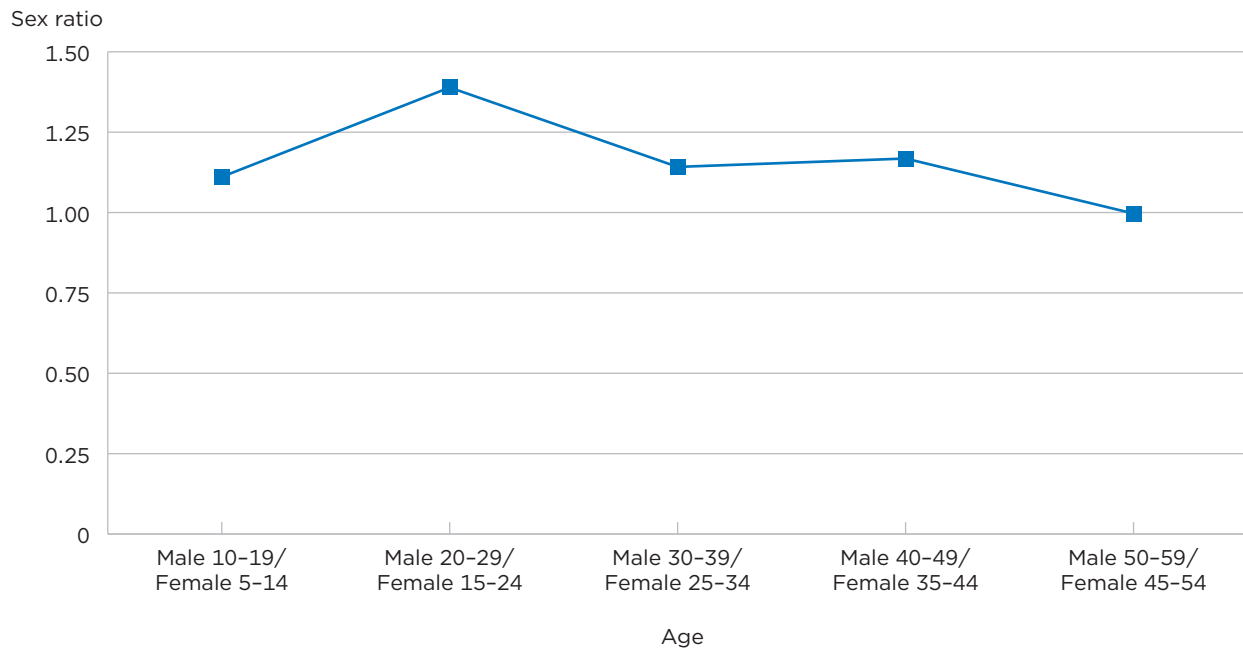
Sex ratio

Source: U.S. Census Bureau, International Database, 2021.

Figure 6.
Sex Ratios in India by Age Group

Sex ratio
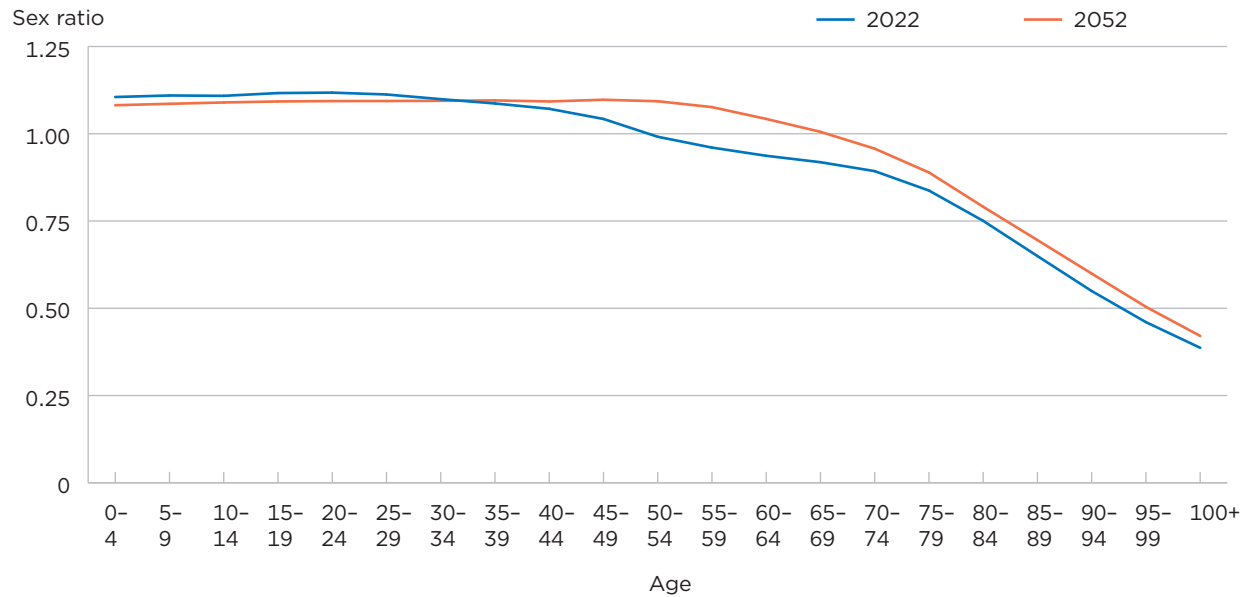
Source: U.S. Census Bureau, International Database, 2021.

Demographic Constituencies Across the Life Course

In any society, the age and sex distribution of the population across the life course indicates constituencies with distinct concerns (e.g., education, jobs, and old age security). Disparities between the numbers of males and females, particularly among adults, may steer government decision-making and resource allocations in various ways (Igielnik, 2020; Institute for Democracy and Electoral Assistance, 2022). In India, for instance, the excessively masculine sex ratio of children in recent years will carry over as this cohort advances through adult ages. In 2022, the number of females exceeds the number of males beginning at the age of 50–54, whereas by 2052, the tipping point between the sexes will not occur until the age of 70–74 (Figure 6).

SUMMARY

In this report, we documented both cross-country regularities in sex ratio dynamics across the human life course, from more masculine to more feminine, as well as variations in sex ratio differences at specific age groups. In addition to these regularities and variations, we reviewed explanations for why they occur as well as some of the key social implications.

REFERENCES

Akers, Donald S, "On Measuring the Marriage Squeeze," *Demography*, 1967, 4(2), pp. 907–924, <https://read. dukeupress.edu/demography/article/4/2/907/172628/ On-Measuring-the-Marriage-Squeeze>.

Bongaarts, John and Christophe Z. Guilmoto, "How Many More Missing Women? Excess Female Mortality and Prenatal Sex Selection 1970–2050," *Population and Development Review*, 2015, 41(2), pp. 241–269, <www. jstor.org/stable/24639357>.

Brunsma, D. L.,"Interracial Families and the Racial Identification of Mixed-Race Children: Evidence From the Early Childhood Longitudinal Study," *Social Forces*, 2005, 84(2), pp. 1131–1157, <www.jstor.org/ stable/3598493>.

Crimmins, E. M., H. Shim, Y. S. Zhang, and J. K. Kim, "Differences Between Men and Women in Mortality and the Health Dimensions of the Morbidity Process," *Clinical Chemistry*, 2019; 65(1), pp. 135–145, <https://doi. org/10.1373/clinchem.2018.288332>.

Goodkind, Daniel, "Should Prenatal Sex Selection be Restricted? Ethical Questions and Their Implications for Research and Policy," *Population Studies*, 1999, 53(1), pp. 49–61, <www.tandfonline.com/doi/ abs/10.1080/00324720308069>.

Igielnik, Ruth, "Men and Women in the U.S. Continue to Differ in Voter Turnout Rate, Party Identification," *Fact Tank*, Pew Research Center, August 18, 2020, <www. pewresearch.org/fact-tank/2020/08/18/men-and-women-in-the-u-s-continue-to-differ-in-voter-turnout-rate-party-identification/>.

Institute for Democracy and Electoral Assistance, Gender Quotas Database, University of Stockholm, 2022, <www.idea.int/data-tools/data/gender-quotas>.

Mathews, T. J. and Brady E. Hamilton, "Trend Analysis of the Sex Ratio at Birth in the United States," *National Vital Statistics Reports*, Centers for Disease Control and Prevention, Division of Vital Statistics, 2005, 53(20), pp. 1–20, <www.cdc.gov/nchs/data/nvsr/nvsr53/ nvsr53_20.pdf>.

Morse, A. and Nancy Luke, "Foetal Loss and Feminine Sex Ratios at Birth in Sub-Saharan Africa," *Population Studies*, 2021, 75(2), pp. 239–254, <www.tandfonline. com/doi/abs/10.1080/00324728.2021.1877793?journalC ode=rpst20>.

Orzack, S. H., J. W. Stubblefield, V. R. Akmaev, P. Colls, S. Munné, T. Scholl, D. Steinsaltz, and J. E. Zuckerman, "The Human Sex Ratio From Conception to Birth," *Proceedings of the National Academy of Science*, 2015, 112(16), E2102-11, <www.pnas.org/doi/epdf/10.1073/ pnas.1416546112>.

Stone, R.I., "The Feminization of Poverty Among the Elderly," *Women's Studies Quarterly*, 1989, 17(1/2), pp. 20–34, <www.jstor.org/stable/40003975>.