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Gender disparities in aging: findings from GBD 2021

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Abstract

As the world's population ages, a clear pattern emerges: women live longer than men, leading to a "feminization" of the older population. This means the majority of elderly people, especially the very old, are women. Understanding this gender gap is essential for creating effective health and social policies that address the specific needs of older women. To explore this globally, researchers used data from the 2021 Global Burden of Disease (GBD) study. The GBD is a massive research project that tracks health trends, disease risks, and causes of death across 204 countries. For this analysis, the data was used to examine sex differences in birth and death rates across all ages. The results reveal a striking pattern. While slightly more boys are born than girls, males face higher death rates throughout life. This gap widens significantly during adolescence and young adulthood. Because more males die at younger ages, the balance shifts over time. By the time populations reach old age, women significantly outnumber men. The study also found major differences in overall disease burden, measured as Disability-Adjusted Life Years (DALYs), between males and females. These findings highlight that men and women not only have different lifespans but also face different health challenges as they age. To promote healthy aging for everyone, we must move toward "gendered medicine"—developing precise healthcare strategies that recognize the distinct biological and social experiences of men and women throughout their lives.

Plain Language summary

As the world’s population gets older, a clear trend has emerged: women tend to live longer than men. This means that the majority of older people—especially those over 80—are women. Understanding why this happens is important for creating fair and effective health policies that meet the needs of both older men and women.

In this study, researchers used data from the 2021 Global Burden of Disease (GBD) study, which tracks health trends in 204 countries. They looked at differences between males and females in birth rates, death rates, and overall health across all ages.

Key findings

- **More boys are born than girls**, but males have higher death rates at every stage of life. This gap is especially large during adolescence and young adulthood.
- Because more males die at younger ages, the number of women begins to match or exceed the number of men by middle age. After age 60, women clearly outnumber men.
- Men and women also face **different health challenges** as they age. Women live longer but often carry a greater burden of non-fatal health issues, such as dementia and other chronic conditions. Men are more likely to die earlier from injuries, certain cancers, and COVID-19.
- These differences are influenced by a mix of biological factors (like hormones and genetics) and social or behavioral factors (like smoking, drinking, or job-related risks).

Why this matters:

The study highlights the need for **"gendered medicine"**—healthcare that takes into account the different ways men and women experience illness and aging. By understanding these differences, we can develop better strategies to help everyone live longer, healthier lives.

Highlights

1Our analysis confirms that while male birth rates are higher, male mortality rates exceed female rates across the life course, with a pronounced surge during adolescence and young adulthood. This results in a demographic crossover where women constitute a larger share of the older population.

2Furthermore, a significant disparity exists not only in death rates but also in Disability-Adjusted Life Year (DALY) rates, indicating that the higher longevity of women is often accompanied by a greater burden of non-fatal health conditions.

3A comprehensive, gendered understanding of population ageing is essential for developing effective strategies to promote healthy ageing and mitigate its adverse effects.

Introduction

The recently published United Nations World Population Prospects 2024: Summary of Findings predicts that by the end of the 1970s, the global population of individuals aged 65 years and older will surpass the population of those under the age of 18, indicating a broader acceleration of the global ageing process [13]. The ageing process is accelerating globally, presenting unprecedented challenges to healthcare, pension services, and social security systems.

Surveys have shown that, under natural conditions, the birth rate of boys exceeds that of girls. On average, the birth ratio of boys to girls is 106:100 [7, 8, 11]. The study found that, at conception, there is little tendency for a skewed primary sex ratio in humans. This raises the question of why male births are more prevalent than female births, despite the initial equal ratio of male to female embryos. In 2015, a team led by American biologist Steven Orzack conducted one of the largest and most comprehensive studies on fetal sex ratios from conception to birth. The results indicate that throughout gestation, female fetuses have a higher mortality rate than male fetuses. Historically, scholars have suggested that males are physiologically more vulnerable than females. This claim is supported by the observation that males have a lower average life expectancy than females. This phenomenon parallels observations in Hong Kong, which has the longest life expectancy globally, with males living an average of 81 years and females 87 years. Additionally, the incidence of cancer is consistently higher in males than in females across various types. While disparities in certain cancers may be minimal, males sometimes exhibit a two- to threefold higher incidence than females. The exact etiology of this phenomenon remains unclear. However, it is hypothesized that it may be linked to chromosomes 15, 17, and the sex chromosomes [9,

10, 12]. Whether this phenomenon is genetically determined by humans or nature, or is merely a matter of chance, remains unresolved.

Globally, the male-to-female ratio among 70-year-olds is approximately 1:1.2, indicating that for every 100 individuals aged 70, around 45 are male and 55 are female, with women showing a slight numerical superiority. In the People's Republic of China, data from the seventh national census indicates that in 2020, the number of female centenarians was 83,700, constituting 70.4% of the total centenarian population. In contrast, the number of male centenarians was 35,100, representing 29.6% of the total. This data establishes a centenarian sex ratio of approximately 2:1. In Japan, 88.5% of centenarians were female in 2023, with a centenarian sex ratio of approximately 1:7.3; in the United States, 78.1% of centenarians were female in 2023, with a centenarian sex ratio of approximately 1:4.5 [4, 5, 6].

The process of population ageing is characterized by gender disparities, primarily evident in the greater number of older women compared to older men in terms of life expectancy, size, and proportion. This phenomenon indicates the feminization of the older population. Older women are generally in a disadvantaged position compared to older men in terms of economic income, physical and mental health, and family and social status. It is imperative to recognize the challenges faced by older women within the context of global population ageing. Addressing these issues from a gender-based perspective is crucial for effective problem-solving and response strategies.

The primary factors contributing to the observed lifespan discrepancy between the sexes include biological advantages, the protective effects of estrogen, innate physiology, and the influence of acquired factors. However, the exact reasons for this phenomenon remain unclear.

In 2021, the burden of disease was found to be higher for men than for women, as evidenced by higher disability-adjusted life year (DALY) rates for the former [14]. The mortality rate is a quantitative indicator of the proportion of the population that dies within a given period of time. Fluctuations in mortality rates directly impact the number of life years lost due to premature deaths, also known as "life years lost" (YLL). This, in turn, exerts a direct influence on the number of DALYs. Consequently, an analysis of gender disparities in mortality is conducted directly through the GBD. The findings reveal that the sex differences in DALY and mortality are distinct.

Results

1 Gender disparities in birth rates and population dynamics

Between 1950 and 2021, both global and Chinese birth rates were higher for males than for females, with the overall population increasing across various age groups globally (Figure 1A/B). However, China's population under 40 years of age exhibited a declining trend, while those over 40 demonstrated an increase, highlighting China's significant challenge with population ageing. Although the birth rate for males exceeds that of females, theoretically resulting in a higher number of males across all ages, in

practice, the female population surpasses the male population up to age 40. Beyond 40, the numbers of males and females tend to equalize, and after 60, females outnumber males (Figure 1C/D).

To further explore age-specific differences in population size, we analyzed the disparity between male and female populations by age (male population minus female population). The data indicate that up to age 25, the male population significantly exceeds the female population. Between ages 25 and 60, the male population is slightly higher than the female population, but after age 60, the female population becomes significantly larger than the male population (Figure 1E/F, Table S1). We analyzed mortality rates across different age groups. The graph reveals that before age 20, male and female mortality rates are similar, leading to parallel declines in their populations without significant changes in the gender ratio. Between ages 20 and 54, the male mortality rate is significantly higher than that of females, resulting in a gradual narrowing of the gender gap. However, after age 55, the male mortality rate becomes significantly lower than that of females, leading to a gradual widening of the gender gap and a relative increase in the number of females (Figure 1G/H, Table S1). These data indicate that men exhibit higher birth and death rates compared to women.

Consequently, the gender disparity in birth rates results in a greater male population compared to females during adolescence, whereas the female population becomes equal to or even surpasses the male population in middle and old age. The reasons for the elevated male mortality rate warrant further exploration.

2 Gender disparities in causes of death

Analyses of gender differences in causes of death indicate that the global burden of non-communicable diseases and the burden associated with non-alcoholic fatty liver disease (NAFLD) are significantly greater in women than in men. Conversely, in men, the burden of communicable, maternal, neonatal, and nutritional diseases, injuries, the burden related to hepatitis B and C, total cancers, and COVID-19 mortality was significantly higher. Furthermore, the incidence of total cancers and COVID-19 was significantly higher in men than in women (Figure 2A/B). Analyses of gender differences in causes of death in China revealed that the burden of non-communicable diseases, NAFLD, and hepatitis B was significantly higher in women than in men. Conversely, in China, the burden of communicable, maternal, neonatal, and nutritional diseases, injuries, hepatitis C, total cancers, and COVID-19 was significantly higher in men than in women (Figure 2C/D). A detailed analysis of gender differences in causes of death reveals that men and women exhibit differing mortality rates across various diseases, with men being significantly more prone to disability than women (Figure 2E/F/G/H).

An analysis of male and female mortality probabilities from 1990 to 2021 reveals that the male mortality rate is significantly higher than that of females, consistent with the overall percentage of deaths (Figure 2I/J/K/L, Table S2).

Consequently, gender disparities in birth and death rates result in a larger male population compared to females during adolescence, whereas the female population becomes equal to or even surpasses the

male population in middle and old age.

3 Gender disparities in causes associated with aging

The presence of sex differences in causes of mortality leads to variations in population size by sex, which fluctuate with age. However, the underlying reasons for these disparities remain unclear. Therefore, the subsequent study aims to investigate differences in causes of mortality throughout the aging process. Initially, data on the prevalence of various diseases across different ages was acquired from the Global Burden of Disease (GBD) database. The findings indicate that: 1) Women aged 20 to 40 exhibit a higher prevalence of infectious diseases, particularly HIV and related conditions (Figure 3); 2) Males experience a higher incidence of injuries between the ages of 10 and 40 (Figure 3); 3) Males have a higher prevalence of hepatitis B and C, with peak incidence between ages 20 and 60 (Figure 3); 4) Throughout the lifespan, women demonstrate a higher incidence of non-alcoholic fatty liver disease (NAFLD) (Figure 3); 5) The overall cancer incidence is higher among women aged 20 to 60. However, men exhibit a higher incidence of stomach, tracheal, bronchus, and lung cancers after age 50 (Figure 3, Table S3).

Therefore, the incidence of various diseases varies across different age groups, and there are notable gender differences.

4 Gender disparities in risk associated with aging

Considering the documented gender disparities in the prevalence of various diseases across age groups, it is plausible that similar disparities also exist in the risk factors contributing to these diseases. Consequently, the following analysis examined the impact of these risk factors across different age groups. Research indicates that women exhibit higher metabolic risks, while men demonstrate higher behavioral risks (Figure 4). Regarding behavioral risks, males face higher risks related to tobacco and alcohol consumption. Additionally, males are predisposed to higher occupational risks, while females face greater risks of unsafe sexual practices (Figure 4). 1) Analysis of tobacco risk by age subgroup shows that males have a higher likelihood of tobacco use from age 30, peaking around age 55, followed by a decline (Figure 4). 2) For males, the likelihood of alcohol consumption rises steadily from age 20, peaks around age 40, and then declines (Figure 4). 3) For women, the risk of unsafe sexual practices increases from age 15, peaks around age 35, and then gradually declines (Figure 4). 4) Males face higher occupational risks, especially between ages 20 and 30, during which their risk is significantly greater than that of females (Figure 4, Table S4).

Therefore, the causality of various risks varies across different age groups, and significant gender differences exist.

5 Why do women live longer than men?

Statistically, the number of women among centenarians significantly exceeds that of men, with this disparity becoming particularly pronounced from age 60 onwards, peaking around age 75, and then

gradually declining. What factors might account for the observed discrepancy in the number of centenarians between the sexes? The initial section's findings indicate that the quantitative disparity in sex-related mortality between males and females around age 55 is negligible. Therefore, the subsequent analysis focused on investigating the underlying causes of mortality in individuals beyond the ages of 55 and 85. The results indicate that women have a higher propensity to develop dementia, breast cancer, and hypertensive heart disease at age 55 and beyond age 85. Conversely, men exhibit a higher risk of cancer, particularly tracheal, bronchus, and lung cancer (Figure 5, Table S5). Consequently, the disparity in causes of death between men and women is evident. However, in percentage terms, the causes of death for men are only approximately 4 percent higher than for women (dementia: females ≈ 16 percent, males ≈ 8 percent). Regarding population counts, there will be approximately 2.6 million more women than men aged 85 and over in 2021. This substantial population discrepancy, combined with a ~5% difference in causes of death, may contribute to the higher number of female centenarians. This phenomenon may explain the preponderance of female centenarians.

Conclusions

Although gender differences in birth rates result in a surplus of males compared to females during adolescence, there are also gender disparities in mortality rates and associated risks, leading to a gradual reversal in the number of males and females as they age, ultimately resulting in a larger female population in old age, a trend that is particularly pronounced among centenarians.

Discussion

According to the World Health Organization (WHO) in 2023, the average lifespan of women is 5.1 years longer than that of men on a global scale. Sex differences have been shown to profoundly influence the trajectory of aging. Women have been found to have an advantage in longevity, yet they face a higher burden of disease. In contrast, men face a higher risk of premature death. These differences result from the complex interplay of sex hormones, chromosomal mechanisms, social roles, and behavioral patterns. In the future, precise intervention strategies will need to be developed through **gendered medicine** to balance the goals of increased longevity and healthy aging.

Gender medicine provides a precise path to healthy aging by targeting biological differences and reshaping social behaviors. In the future, technological bottlenecks (e.g., Y-chromosome repair) must be overcome, and policy innovations (e.g., gender-differentiated healthcare) must be promoted, ultimately enabling life extension to go hand in hand with improved quality of life. Projections indicate that by the year 2040, the implementation of gender-specific interventions could potentially extend the global healthy lifespan by five to seven years.

Methods

GBD publishes periodic updates, providing comprehensive estimates of risk exposure and risk attributable health loss worldwide using all relevant available data. GBD 2021 estimated relevant metrics for 23 age groups from birth to age 95 years and older; for males, females, and all sexes combined; and for 204 countries and territories grouped into 21 regions and seven super-regions [3].

1)GBD risk factor hierarchy

GBD classifies all GBD risk factors into a risk factor hierarchy with four levels, plus an overarching aggregate of all risk factors combined.

2)All-cause mortality and cause specific mortality

Mortality estimation methods have been extensively described elsewhere. Briefly, all available global data including vital registration, sample registration, household surveys, censuses, disease registries, notification systems, and police records were identified, extracted, and standardised. Standardised methods were then applied to produce internally consistent estimates of population, fertility, net migration, all-cause mortality, and cause specific mortality [1,2].

3)Data analysis

Utilising a decomposition analysis, we estimated changes in the number of patients between 1990 and 2021 that are attributable to population ageing, population growth, exposure to risk factors, and unexplained attribution. The contributions of each component were calculated based on established formulas that consider age-specific mortality rates and population proportions for different age groups across two time points. All analyses were performed with Graphpad software.

Declarations

Ethics approval and consent to participate

All data were analyzed anonymously, so ethical approval was not required

Consent for publication

All authors consent for publication

Availability of data and material

The data used in this study is available for download from the Global Health Data Exchange GBD 2021 website (https://ghdx.healthdata.org/gbd-2021). Authors affiliated with the Chinese Center for Disease Control and Prevention are available to provide information on accessing these data.

Acknowledgement

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Competing Interests

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Author contributions

Writing—original draft preparation, Huifang Sun, Yuhong Li; writing—review and editing, Huifang Sun, Yuhong Li. All authors have read and reviewed the original draft and agreed to the published the present version of the manuscript.

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Figures

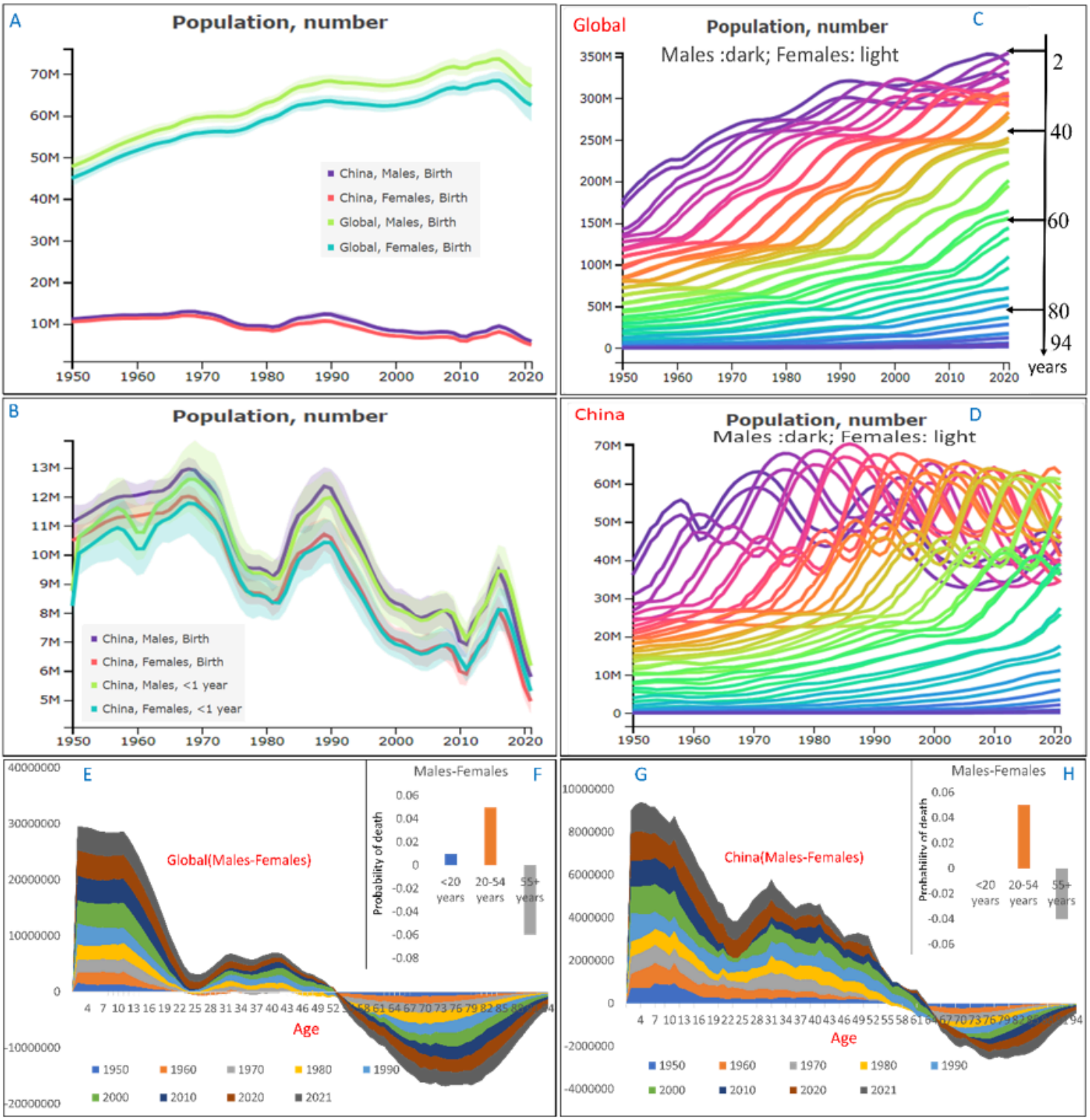


Figure 1

Age distribution of populations globally and China. A) Globally and in China, male birth rates exceed female birth rates. B) In China, both the birth rate and the number of individuals younger than one year old are higher for males than for females. C/D) This study will examine the global and Chinese populations of males and females across all age groups. E) The global difference in the number of males and females from 1950 to 2021. F) This difference reflects the number of male deaths minus female

deaths globally and across different age groups. G) The difference in the number of males and females in China from 1950 to 2021. H) The disparity in male and female deaths across various age groups in China.

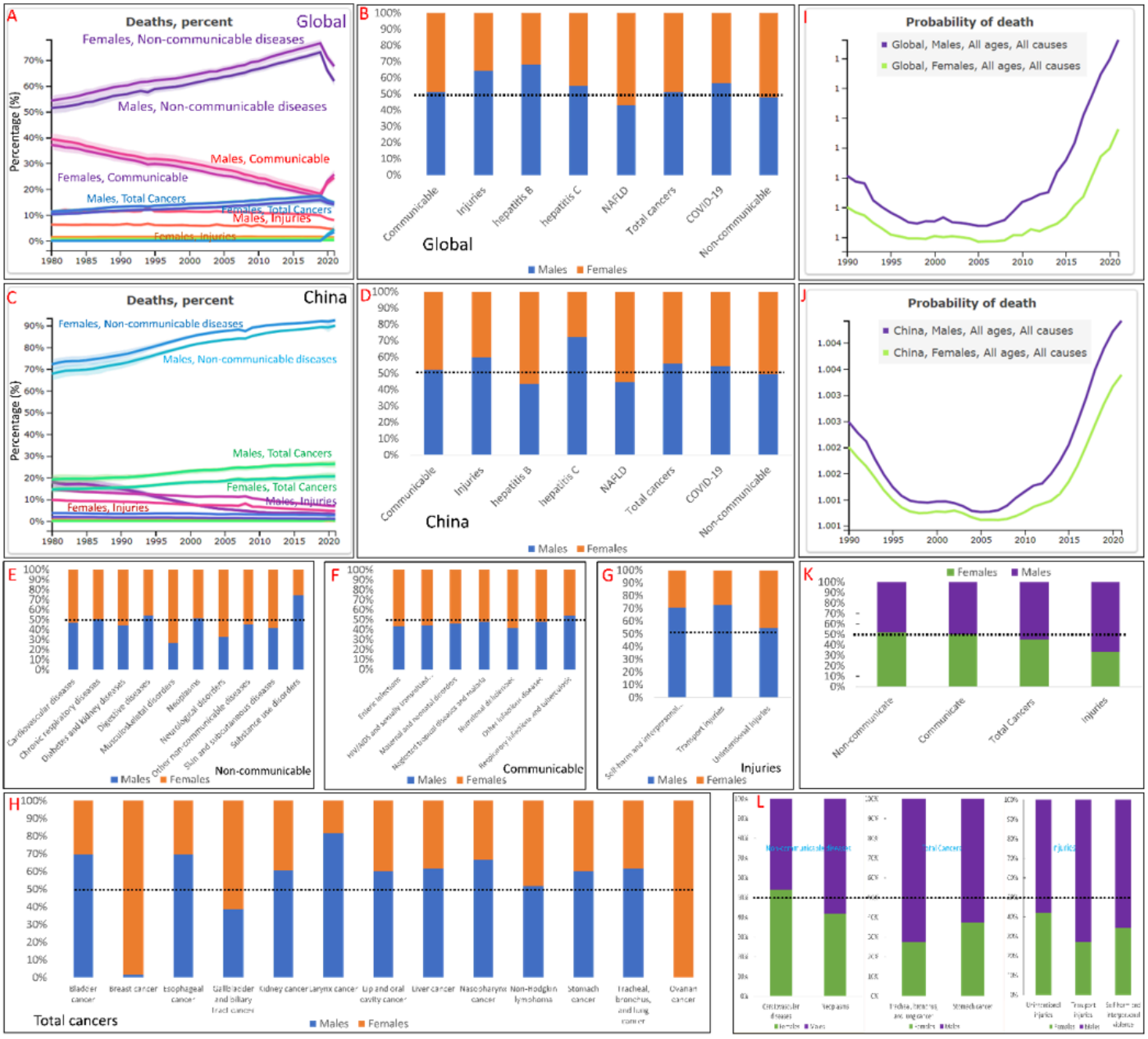


Figure 2

Gender disparities in mortality causes within the global population. A/B) Global gender differences in causes of death from 1950 to 2021; C/D) Gender differences in mortality in China from 1950 to 2021; E) Gender differences in non-communicable diseases contributing to mortality; F) Gender differences in communicable diseases contributing to mortality; G) Gender differences in injuries contributing to mortality; H) Gender differences in cancer mortality; I/J) Gender differences in global and Chinese

mortality probabilities; K) Level 1 gender differences in mortality probability; L) Level 2 gender differences in mortality probability.



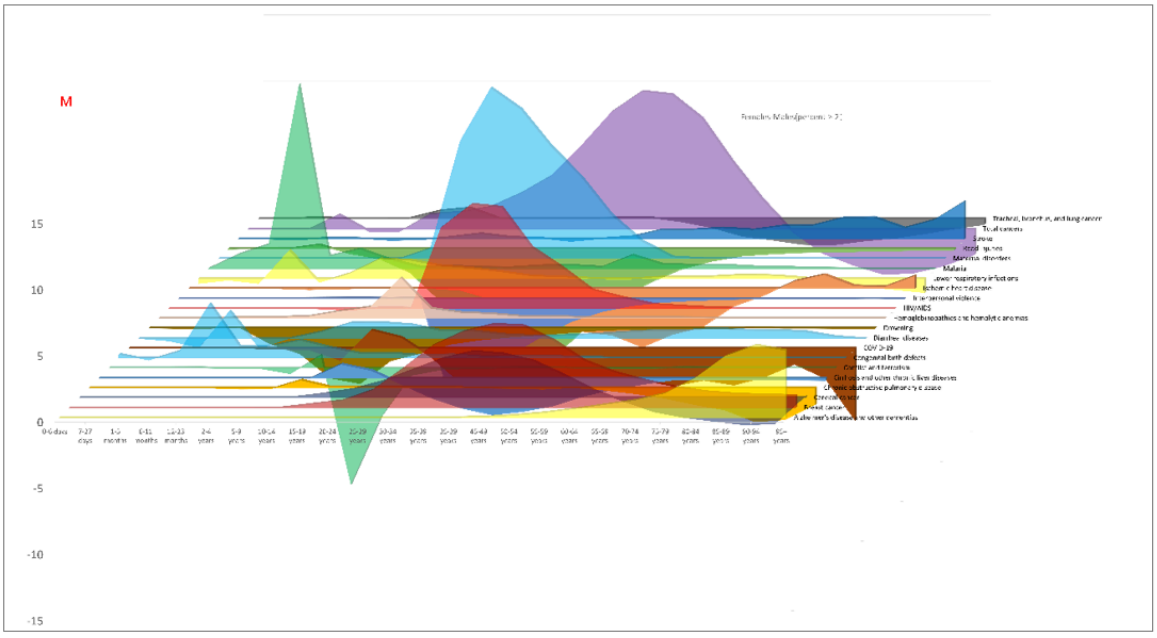


Figure 3

Gender disparities in various causes related to aging. A/B/C/D/E/F) Gender differences in primary causes; G/H/I/J/K/L) Gender differences in secondary causes; M) Gender differences in Level 3 of causes.

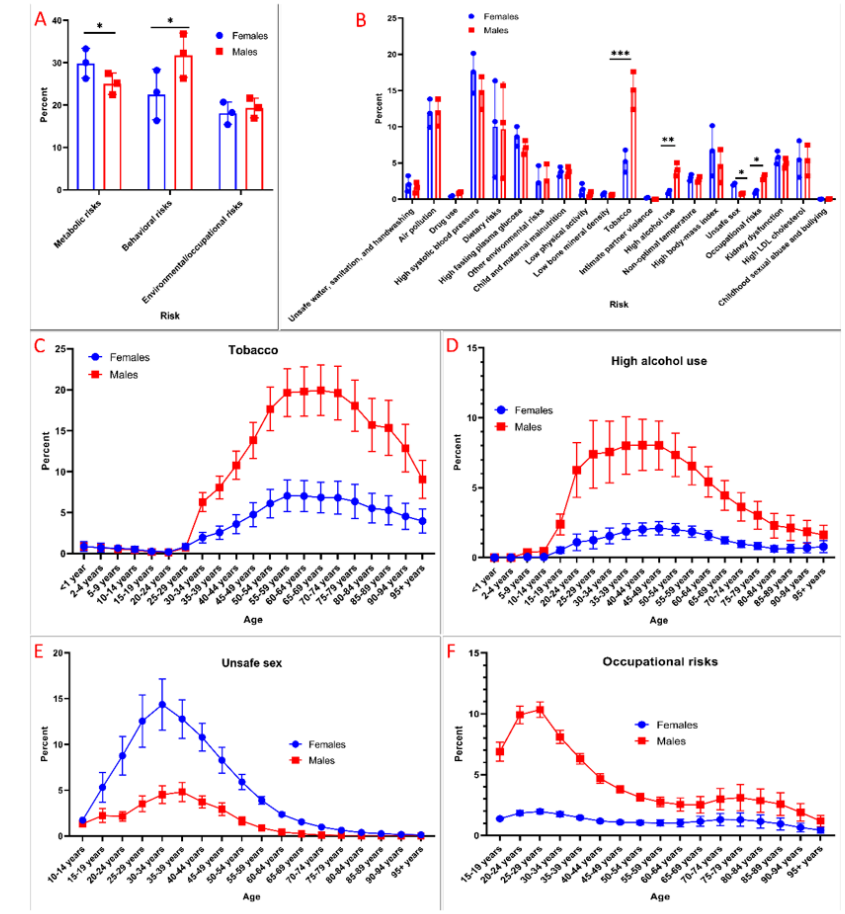


Figure 4

Gender disparities in various risks associated with aging. A) Gender differences in primary risks; B) Gender differences in secondary risks; C) Gender differences in tobacco-related risks; D) Gender differences in alcohol-related risks; E) Gender differences in risks associated with unsafe sexual practices; F) Gender differences in occupational hazards; G) Gender differences in Level 3 of causes.

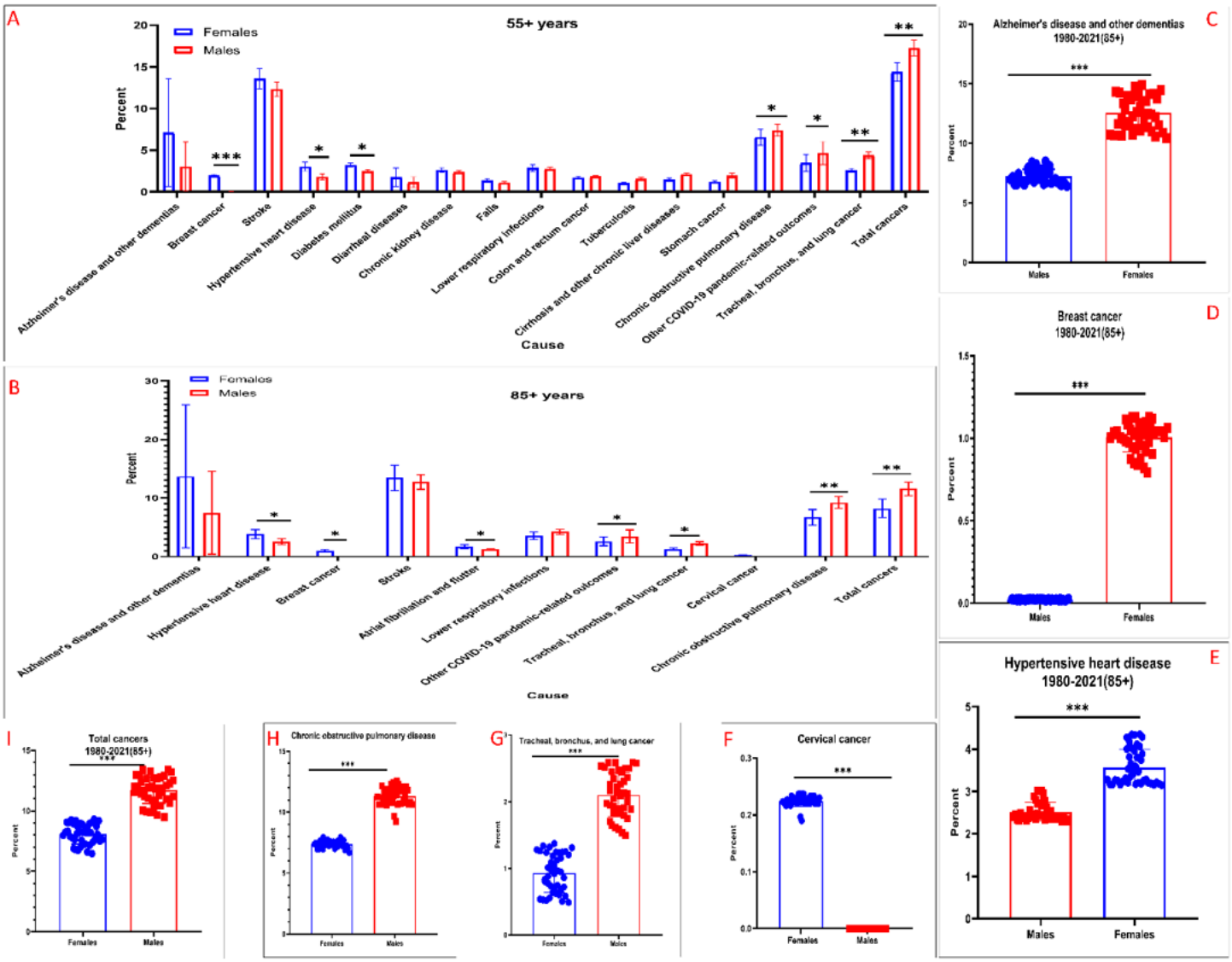


Figure 5

Gender disparities in mortality causes among the elderly population. A) Differences between men and women over 55 years old; B) Differences between men and women over 85 years old; C/D/E/F) Diseases with high incidence in women; G/H/I) Diseases with high incidence in men.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SGenderdifferences.zip
- GraphicAbstract.docx