Masculinization of populations reverses sex difference in fertility

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Population structures show a growing male surplus around the globe as a consequence of declining mortality, narrowing sex differences in mortality, and sex selective abortions in some countries. Population structures are important determinants of marriage markets and childbearing. In this study, we estimate the past, current and future difference between the male and female total fertility rates around the world using an established indirect demographic approach on data from the UN World Population Prospects. Our results indicate a crossover from historically higher male fertility to increasingly higher female fertility, which occurs globally in 2024. This shift is not toward parity, but rather reflects a growing disparity driven by the increasing male surplus in populations, which exerts downward pressure on male fertility rates relative to those of females. The difference is expected to grow to up to 20% in countries like China and India, where sex selective abortion has caused sex imbalances in population structures. Overall, we highlight the growing sex inequalities in reproduction and call for more research on sex differences in fertility.

Demography | sex-selective abortion | male fertility | marriage markets | sex differences

Significance Statement

Reproductive behavior is typically analyzed using data for women, yet demographic shifts are altering the gender composition of populations, underscoring the need to better understand male fertility dynamics. Declining mortality, artificially high sex ratios at birth, and narrowing sex differentials in mortality contribute to a masculinization of population structures which leads to a cross-over from higher TFR for men to higher TFR for women over time. Our analysis identifies the year when global fertility levels between men and women diverged – around 2024 – as male fertility declined from approximately 5.7 in 1950 to 2.2 in 2024, while female fertility remained higher. We do not expect a return to parity within the current projection period. These emerging disparities may have far-reaching implications for demographic balance and social stability.

Fertility is a fundamental demographic process that shapes population structures and profoundly influences individual well-being. Fertility is commonly measured for women but not for men. For instance, statistical offices routinely report the average number of children per women. Focusing only on women can be misleading in populations with imbalanced population structures, because it does not truly reflect the reproductive behavior of the entire population. While previous studies have demonstrated a strong synchrony between male and female fertility trends globally (1, 2), notable deviations emerge in high-fertility contexts (3) or in populations with marked sex imbalances (2, 4, 5). Despite these observations, the historical evolution and future trajectories of sex disparities in fertility remain poorly understood at the global scale.

Sex differences in fertility arise from two interrelated factors: sex-specific population structures and differential fertility timing. Because fertility is defined as the number of births relative to the population exposed to childbearing, imbalances in the sex ratio of the reproductive population can lead to divergent fertility estimates between sexes. Moreover, men typically exhibit a broader reproductive age window and have children later compared to women, which can result in higher observed fertility rates among men in young and growing populations (3, 6). These patterns are further modulated by demographic shocks—such as abrupt fertility transitions or mortality crises—that alter the age and sex composition of the population, thereby influencing the observed sex gap in fertility (1, 2, 4, 7).

Sex differences in fertility may indicate imbalanced mating markets in which the more abundant sex faces structural constraints on partnership formation, and may affect union compositions in terms of age gaps between partners and bargaining power (8–12). Another concern is the effect on fertility and childlessness, as cohorts exposed to sex differences in fertility face a structural constraint to childbearing, potentially leading to increased childlessness among men and women (2, 13, 14). Furthermore, sex differences in partnering and fertility may have downstream implications for social and health outcomes, including increased violence, the spread of sexually transmitted diseases, particularly among unpartnered and childless individuals, who may suffer from loneliness and have fewer kin to care for them at older ages (15–21). Finally, a surplus of men in a population is postulated to increase economic vulnerability as well as violence and conflict (20, 22–25).

This study presents a global analysis of male and female total fertility rates (TFRs). The TFR indicates the average number of children born at the end of the reproductive period to a women or men subject to the age-specific fertility rates from a year. We examine historical trends and future projections of sex differences

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in fertility across countries and areas, building on regression-based prediction of the TFR of men as suggested by Keilman et al. (26) and leveraging data from the United Nations World Population Prospects 2024 (27). We also use classic demographic standardization to assess the impact of the population structure on sex differences in fertility, removing the impact of age differences in partnering. Our findings reveal a striking temporal shift: while male TFRs (TFR_m) historically exceeded female TFRs (TFR_w) in most nations, a crossover has occurred in recent decades, with TFR_w now surpassing TFR_m in an increasing number of countries and areas. This reversal reflects underlying changes in population structure driven by sex-specific mortality and sex ratios at birth. By disentangling these demographic forces, we demonstrate how shifts in the sex composition of reproductive-age populations—particularly through differential survival and sex-selective birth patterns—have fundamentally reshaped the sex-specific dynamics of fertility over time.

Declining male fertility

Populations overall transition from higher TFR_m in the past to higher TFR_w in the future, see Figure 1, showing a reversal of the sex inequality in reproduction. In 1950, TFR_m used to exceed the TFR_w around the world, see Figure 1. In 1950, 96.2% of the countries and areas showed higher TFR for men than for women. However, the decline in TFR_m has been steeper than that in TFR_w, resulting in a mixed pattern in 2025, with some countries and areas exhibiting higher TFR_m and others higher TFR_w. In 2025, 47.5 per cent of countries and areas have higher TFR_m, but by 2100 this share is expected to fall sharply to only 9.8 per cent.

The difference between the TFR_m and the TFR_w can be substantial and range between -61.6% (Qatar, 2009) and +131.01% (Turks and Caicos Islands, 1975). Extreme cases are often found in smaller countries and areas, where a modest change in mortality or migration affecting only one sex can greatly alter the relative size of the male and female populations. Yet, even in countries and areas with large populations—such as China, India, and the Republic of Korea—marked differences between male and female TFRs have also been observed. Figure 2 shows the relative difference between the male and female TFR and reveals a cross-over in China in 1996, in India in 2020 and in the Republic of Korea already in 1994. Moreover, these countries will reach the minimum of the relative difference in the 2020s and 2030s, respectively, indicating that sex disparities in fertility are likely to become more pronounced in the near future.

The time point when TFR_w first exceeds TFR_m for the world occurs in the year 2024, but the timing of these fertility cross-overs varies across geographic regions, see Figure 1. For the majority of European and Northern American countries, this cross-over happened in the past, especially in the 1960s and 1970s. In the Latin American countries, those cross-overs happened mainly in the recent past. Northern Africa, Eastern Asia, Oceania and Central Asian Countries are expected to experience the majority of crossovers in the near future. Sub-Saharan Africa is expected to have crossovers in the long-term future, and many of those countries will not have a crossover before 2100.

We use demographic standardization to show the impact of gender differences in the population on sex differences

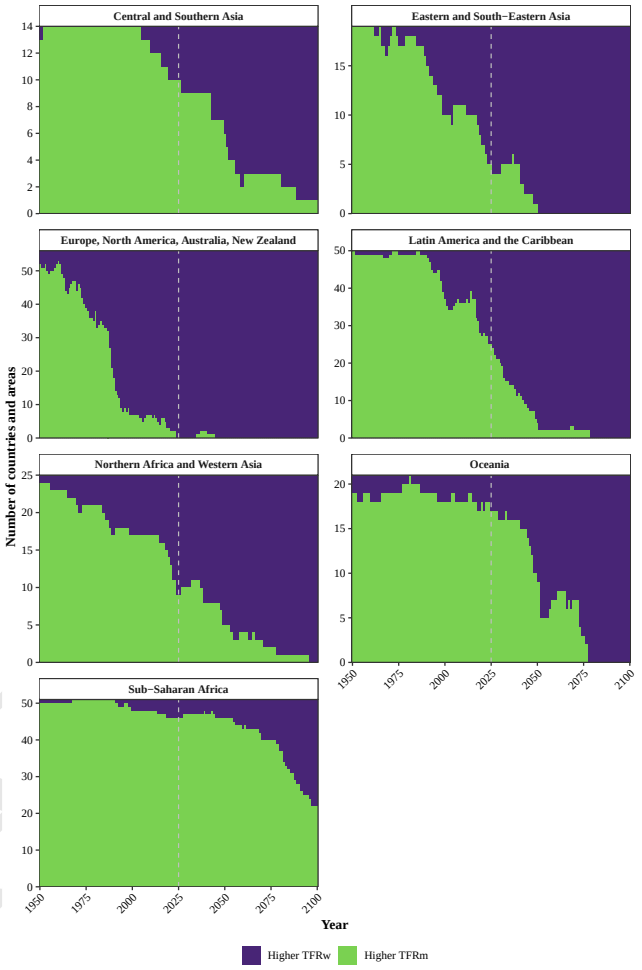

Fig. 1. The number of countries and areas with a higher TFR_m in green and the number of countries with a higher TFR_w in blue in a specific year by SDG-region.

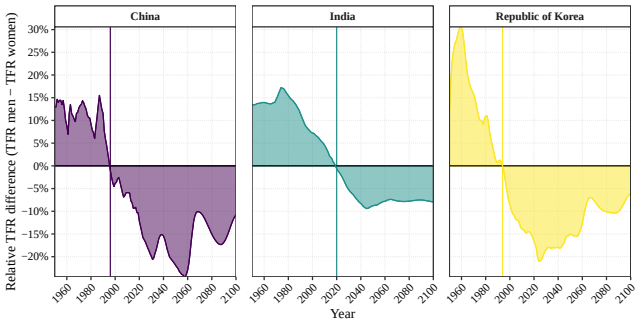

Fig. 2. Percentage difference in male to female TFR (y-axis) in the period between 1950 to 2100 (x-axis) using the regression-based approach. Positive values indicate a higher TFR among men and negative values indicate a lower TFR among men. The vertical lines indicate the crossover from higher male TFR to higher female TFR.

in fertility in the absence of age gaps between parents (see *SI Materials and Methods* Section 1). The standardization results corroborate the regression-based results, showing that male TFR declines relative to the female TFR over time, which indicates that population sex ratios are the main driver of differences between the TFR_m and the TFR_w. However, two noticeable differences emerge between the regression-based and the standardization approaches. First, fewer crossovers occur in the standardization results than in the regression-based results. Second, the sex difference in fertility in the past is weaker and more muted. Both observations may be related to the fact that not just sex differences in population structures drive the sex differences in fertility, but also larger age differences between fathers and mothers and high population growth rates offset the impact of male skewed population at reproductive age (3).

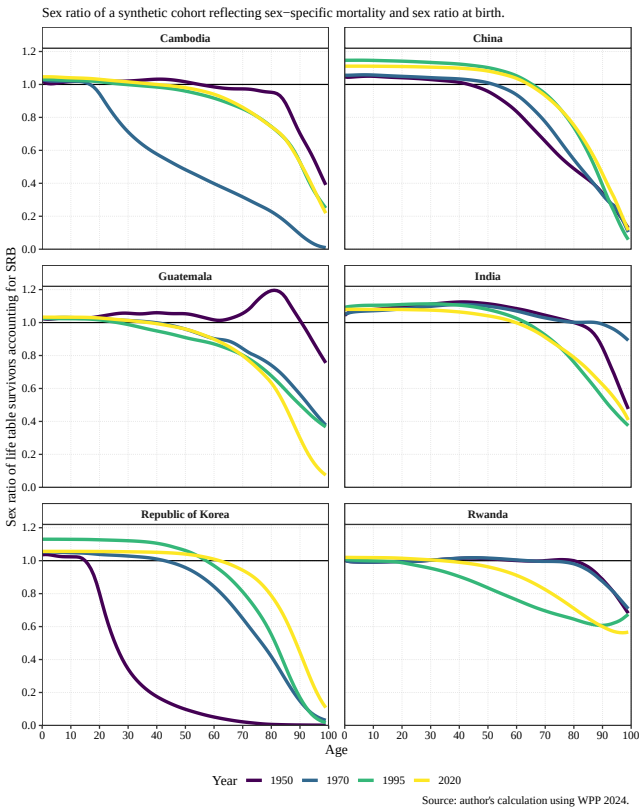

Fig. 3. The sex ratio in a population (y-axis) reflecting period mortality rates and the sex ratio at birth at different ages (x-axis), e.g. excluding migration. Values above one indicate a male population and values below one indicate a female population.

Untangling the demographic drivers. Figure 3 illustrates how the sex ratio at birth and sex differences in mortality shape the population sex ratio in Cambodia, China, India, Guatemala, the Republic of Korea and Rwanda. It shows that both the rising sex ratio at birth and changing mortality patterns contributed to the observed crossover in fertility and pose a secular trend towards more masculine populations. In 1950, women began to outnumber men around age 50 in all countries and areas, except in Guatemala and the Republic of Korea, where male survival was lower due to the excess male mortality caused by the war. The upward shift in the age at which women outnumber men is driven by higher sex ratios at birth (reflected in the increased intercept on the y-axis), overall declines in mortality, and narrowing sex differences in mortality (both indicated by the flattening of the curves). By 2020, this crossover occurred at around age 65 in China, India and the Republic of Korea. India is a special case showing sustained excess men related to the continuously high sex ratio at birth and narrow gender gap in mortality (due to comparatively high female mortality).

Notably, the cases of Cambodia (1950s to 1960s and 1960s to 1990s), Guatemala (late 1960s and 1970s), the Republic of Korea (early 1950s), and Rwanda (early 1990s) highlight the acute and lasting impact of conflict-related mortality. In these country-years, the sex ratio curves exhibit sharp, transient dips—reflecting elevated male mortality during periods of war and violence. For example, in 1950 the Republic of Korea, a cohort exposed to wartime mortality would have exhibited a sex ratio of 30 men per 100 women at age 30, had mortality rates remained constant. These temporary shocks leave enduring imprints on population structure, skewing the age-sex composition for decades and affecting subsequent fertility, marriage, and labor market dynamics.

Discussion

This article examined the difference in average reproduction between women and men in the past, the present and the future around the world. While men used to have higher fertility than women in the past in Europe and Northern America, male-skewed population structures deflate reproduction numbers for men in the future, particularly in Eastern Asia. A universal force leading to these sex imbalances in reproduction is declining mortality, which sustains the male-skewed sex ratio at birth longer throughout life (28). A narrowing sex difference in mortality may also contribute to a masculinization of populations at the reproductive ages. In some East Asian countries, this effect is reinforced by sex selective abortion (29).

Male fertility historically exceeded female fertility, which is in line with previous findings (2, 3). With the onset of the fertility decline and as fertility reaches lower levels, the male and female TFRs cross, and female fertility begins exceeding male fertility. The timing of the crossover depends on the progress of the fertility transition. Crossovers occur first in Europe (1960s) and later in other contexts. In sub-Saharan Africa, some countries are not expected to have a fertility crossover before 2100, highlighting the implications of recent fertility stalls (30, 31).

Male and female fertility can differ substantially, as the gap ranges between -60% and +130%. Extreme cases of very high male TFRs relative to female TFRs (+100% or above) are mainly observed in the 1950s and 1960s in small populations like Lesotho, Tokelau, and Turks and Caicos Islands. Extreme cases of very low male TFRs to female TFRs are observed mainly in the 2020s and 2030s in countries like Qatar, the United Arab Emirates, the Maldives and Oman.

The secular trend behind the crossover of male and female TFRs is the masculinization of populations related to declining mortality levels, narrowing sex gap in mortality, and in some countries artificially imbalanced sex ratios at birth. The impact of mortality on the masculinization of populations has been observed for Western countries before (2, 28) and the missing women have been raised by Sen (29).

Beyond the secular trends driving masculinization of populations, conflicts pose a strong and lasting counterforce on the sex ratio in populations, leading to a female surplus. Dependent on the intensity and duration of conflicts, population structures can be altered with potential implications for childbearing. Using period mortality rates for the Republic of Korea and Cambodia, there would be 30 or 70 men per 100 women at age 30 respectively, if conflict mortality lasted for a cohort. The feminization of population structures may have positive effects on gender equality and participation of women, but also renders reproduction and partnering more difficult and selective for women.

The crossover marks the beginning of a new demographic reality, which will come with new opportunities and challenges. There is evidence suggesting that increasing levels of male childlessness and excess number of men have subsequent social and economic consequences. U.S. based research indicates implications for marriage rates and fertility (9, 32). Research on Finland shows that excess number of men increases the levels of male childlessness and steepens the socio-economic gradient of childlessness (2). Moreover, in East Asian countries excessive male populations were linked to increased crime, and sexually transmitted diseases (17, 33, 34). Another risk is a cultural backlash regarding progress in gender equality.

Another finding of this study is that male fertility can be readily approximated with a regression-based approach using adult sex ratios and female TFR. While Keilman et al. (26) suggested this approach and found only a lower model fit ($R^2 = 0.83$), we obtain excellent model performance statistics ($R^2 = 0.97$) and out of sample prediction error ($RMSE = 0.041$), especially with a model accounting for age-gaps between partners. We encourage future research to fine-tune this model further. Moreover, we contend that systematically measuring male fertility across all countries and areas is crucial for obtaining a comprehensive understanding of reproductive behavior.

Limitations. The study has two major limitations. First, male fertility is not directly observed, but approximated through various indirect methods using population structures and female fertility rates. While these approximations yield a high out-of-sample fit (see *SI Demographic Scenarios* Section 1) and observed data on male fertility have problems itself (35, 36), the models assume a certain relationship between female TFR and population structure to male TFR, which may not hold. For instance, our results deviate in special cases such as the United Arabic Emirates or Qatar from the results reported in (3), because male-dominated labor migration leads to changing population structures, but not fertility, rendering our approximation imperfect. Secondly, we only estimate average fertility, e.g. total fertility rates, and do not study age- and/or parity-specific fertility. Previous research indicates that subnational population imbalances in Finland mainly affect childlessness of the abundant sex (2), but this may play out differently in other contexts.

Outlook. Our results suggest a growing sex differences in fertility as a result of masculinization of populations, which will come with challenges and opportunities. The challenges are mainly posed on those men who may remain childless, which is often associated with worse health and growing dependence on professional care at old age. We propose the following specific policy recommendations to address sex differences in fertility and their consequences (e.g., male childlessness, marriage market imbalances): strengthened position of women in societies to prevent artificially high sex ratios at birth, better education and creation of jobs to give childless and single men opportunities for a career and to reduce susceptibility for organized crime, and technical solutions for singles and childless individuals - friendship groups and legalization of artificial reproductive technologies. Failing to address the needs of these men will risk a cultural backlash regarding sex equality and societal conflicts.

Materials and Methods

Data. We use data on age-sex specific population counts, annual birth counts by sex, and female TFRs from the United Nations World Population Prospects 2024 (WPP2024), but male TFRs are not included and will be estimated indirectly (3–5). WPP2024 provides comprehensive, internally consistent time series of population counts by single age and sex, births, deaths, and international migration for all countries and areas from 1950 to 2100. The dataset is freely accessible at https://population.un.org/wpp/. It integrates diverse data sources—including civil registration systems, sample registration, censuses, surveys, and national estimates—while explicitly accounting for biases such as under-coverage, under-enumeration, and differential registration quality across age groups and regions (37). The population estimates are derived using the cohort component method, which reconstructs population dynamics through the population balancing equation. This approach ensures temporal consistency and enables reliable projections to 2100. Fertility and mortality indicators-—including TFR_w and adult mortality—-are generated via Bayesian hierarchical modeling that synthesizes heterogeneous data sources, adjusts for known measurement errors, and propagates uncertainty appropriately (38–40). This methodological framework enhances the reliability of estimates, particularly in data-sparse regions.

For male fertility, we use country- and time-specific TFR estimates derived from multiple sources: Schoen, Schubert and Dudel (1, 4, 5) applied classical demographic methods to vital statistics; whereas Schoumaker (3) employed the own-child method using data from the Demographic and Health Surveys (DHS) (41). These estimates are harmonized to ensure comparability across countries and time periods.

In the main analysis, we use the Medium-scenario for the population, fertility and mortality projections. In a robustness check, we exploited the different demographic scenarios estimated by the WPP2024 to understand the impact of assumptions on fertility, mortality, and migration on sex differences in fertility (see *SI Demographic Scenarios*). If fertility would drop to zero below age 18 across the world, there would be lower TFR ratios mainly in high fertility contexts like Sub-Saharan Africa, Oceania and Latin America, where teenage fertility is still frequent. If fertility would be at replacement level instantly, TFR ratios in lower fertility countries would increase, and TFR ratios in higher fertility countries would drop, highlighting the impact of the TFR on TFR ratios.

Estimating male fertility. We measure fertility using the total fertility rate for men (TFR_m) and for women (TFR_w). The total fertility rate is a period measure of fertility intensity, and provides the average number of children a women would have at the end of a reproductive period if she was subject to the age-specific fertility of a given year. The TFR_w is obtained from the WPP2024, but the TFR_m is not readily available or is subject to data deficiencies (35, 36), and therefore needs to be estimated.

The estimation of the TFR_m follows Keilman et al. (26) and exploits a theoretical relationship of TFR_m to adult sex ratios and TFR_w. The TFR_m follows the TFR_w usually closely (1), but unbalanced population structures can affect the reproduction of the abundant sex (3, 5). Therefore, the TFR_m is logarithmically

Table 1. Regression table presenting the results from regression in equation 1. The predictor variables are the total fertility rate for women (logarithm) and the sex ratio at age 20 to 39 (logarithm). The outcome variable is the total fertility rate for men (logarithm). The top panel presents the regression coefficients and the bottom panel the model metrics.

	Dependent variable:		
	log TFR men		
	(1) Baseline	(2) Postponement	(3) Age gap
log TFR women	1.182*** (1.175, 1.190)	1.197*** (1.190, 1.205)	1.101*** (1.095, 1.107)
log SR (20-39)	−0.887*** (−0.922, −0.852)		
log SR (25-44)		−0.849*** (−0.884, −0.814)	
log $\frac{\text{men}_{25-44}}{\text{men}_{20-39}}$			−0.661*** (−0.675, −0.646)
Intercept	−0.092*** (−0.098, −0.086)	−0.114*** (−0.119, −0.108)	−0.078*** (−0.082, −0.074)
Observations	4,024	4,024	4,024
R^2	0.968	0.968	0.983
Adjusted R^2	0.968	0.968	0.983
Note:			*p<0.1; **p<0.05; ***p<0.01

related to the overall fertility level (TFR_w) and the sex difference in the size of the population at reproductive age (SR). The estimation follows:

$$log(TFR_m) = \alpha + \beta_1 log(TFR_w) + \beta_2 log(SR) + \epsilon \quad [1]$$

where $log(TFR_m)$ is the logarithm of the TFR for men, $log(TFR_w)$ is the logarithm of the TFR for women, and $log(SR)$ is the logarithm of the sex ratio at reproductive age.

We estimate three distinct models that differ in how they account for population sex ratios. The *baseline model* (model 1) uses the sex ratio in the ages 20 to 39, consistent with the approach previously employed by Keilman et al. (26). The *postponement model* (model 2) adjusts for fertility postponement by estimating the sex ratio within the age group 25 to 44 (42, 43). The *age-gap model* (model 3) further refines this approach by accounting for the observed pattern of later childbearing among men: it calculates the sex ratio using men aged 25–44 and women aged 20–39, thereby capturing the age gap between partners at the time of childbirth (3, 44). While Models 1 and 2 compare sex ratios within the same age groups, Model 3 introduces a temporal shift in the male age group to better reflect the demographic realities of partner age differences in contemporary fertility.

Model results. All three models reach a better fit relative to the model in Keilman et al. (26) and the *age-gap model* performs best. The *baseline* and *postponement models* yield a robust fit, as the R^2 are at 0.969 and 0.97 respectively, while the R^2 in Keilman et al. (26) was only 0.83. The *age-gap model* performs best with a R^2 of 0.984. Furthermore, we perform out-of-sample validation using high-quality data from the Human Fertility Collection (1) to evaluate the performance of the regression models and assess the problem of overfitting. Overall the fit is good reaching a root mean squared error ($RMSE$) of around 0.05. The best model fit is again found for model 3 accounting for the age gap, which has an $RMSE$=0.041. The 90%-prediction intervals are conservatively calibrated as they include 98% of the TFR_m observations.

The regression results are displayed in Table 1, indicating a positive correlation of the TFR_w with the TFR_m and a negative correlation of the adult sex ratio (SR) with the TFR_m across models. The coefficients across the regression models in Table 1 are statistically significant, as opposed to results in Keilman et al. (26), because of a larger sample size (n) and/or the better model fit (R^2=0.983). Hence, we use the complete regression equation for the approximation of TFR_m. We now present the results for model 3, which is the best-performing model. If the population is balanced (sex ratio=1) and the TFR_w is at replacement level (TFR_w=2.1 births per woman), TFR_m is predicted to be slightly lower at 2.09 births per man. However, if there are twice as many women in the reproductive age ranges (sex ratio=0.5), TFR_m is predicted to increase to 3.31. If there are half as many women than men (SR=2), TFR_m drops to 1.32, holding the TFR_w at replacement level. Holding the population balanced, the impact of the TFR_w is negative, which implies that at a lower TFR_w of 1.0, TFR_m equals 0.92, and if the TFR_w increases to 3 births per woman, the TFR_m reaches 3.1 births per man.

In a robustness check, we accounted for fundamental uncertainty in the regression model and used 90% prediction intervals, which blurred the picture a bit (see *SI Prediction Intervals*). The TFR differences for Caribbean, Central America and the Less developed regions became indistinguishable from zero due to prediction uncertainty, but cases in high-income countries, Sub-Saharan Africa and Eastern Asia remained robust.

Standardization. Beyond the regression-based approach, we employ demographic standardization to isolate the impact of sex-specific population structures on observed sex differences in total fertility rates (TFRs). Standardization is a widely used technique to disentangle the influence of population composition—such as age and sex structure—on aggregate demographic indicators (45). Here, we apply the distribution of births by maternal age to the male population structure, effectively estimating what male TFR would be if men experienced the same fertility schedule as women, but were exposed to the actual age distribution of the male population. The standardized TFR is computed as:

$$\text{TFR}_{std} = \sum_{x=15}^{55} \frac{B_x}{P_x^m}, \quad [2]$$

where B_x denotes the number of births to mothers aged x, and P_x^m is the male population aged x in the reproductive age range (15–55 years). This approach implicitly assumes that the fertility schedule is identical across sexes — a simplification that does not hold in reality. While empirical evidence shows that male fertility schedules are typically shifted to older ages, exhibit a broader reproductive window, and decline more gradually after the peak compared to female schedules (3, 6), the standardization reveals how much of the observed difference in TFR between men and women is attributable solely to the skew in sex ratios within age-groups at reproductive age. For selected countries, we also conducted further analyses accounting for the age differences between men and women, based on data from Dudel and Klüsener (1). The findings match the regression results very closely (see *SI Age-gap approach*).

Untangling the demographic drivers of sex imbalances. To disentangle the contributions of sex ratios at birth and sex-specific mortality to changing population structures, we leverage sex-specific life tables and sex ratios at birth from the WPP2024. We construct age-specific sex ratios by applying a synthetic-cohort approach: starting from the sex ratio at birth (e.g., the number of male births per 100 female births), we project the survival of males and females through each age group using the corresponding sex-specific life tables (the probability to survive to the next age, $p(x)$). Specifically, we set the radix for males to the observed sex ratio at birth (e.g. 105 males per 100 females), while setting the radix for females to 100, and then we apply the cumulative product of age-specific survival probabilities,

$$SR(x) = 100 \cdot \frac{\frac{B_m}{B_w} \cdot \prod_{i=0}^{x} p_m(x)}{\prod_{i=0}^{x} p_w(x)} \qquad [3]$$

where B_m and B_w is the number of male and female births, $p(x)$ is the age-specific probability to survive to the next age. This approach allows us to compute the age-specific sex ratio – the number of men per 100 women – at each age, reflecting the cumulative impact of imbalanced sex ratios at birth and sex-specific mortality across the life course. By using this approach, we effectively isolate the demographic forces shaping the sex composition of the reproductive-age population, neutralizing the influence of international migration, which is not directly modeled in this decomposition.

Data availability

All code and data required to replicate the main and supplementary results of the article can be found here: https://github.com/Henrik-Alexander/global_birth_squeezes.

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1. Christian Dudel and Sebastian Klüsener. Male–Female Fertility Differentials Across 17 High-Income Countries: Insights From A New Data Resource. *European Journal of Population*, 37(2):417–441, April 2021. ISSN 0168-6577, 1572-9885. .
2. Henrik-Alexander Schubert and Christian Dudel. Too many men? Subnational population imbalances and men's childlessness in Finland. *Population Studies*, 0:1–21, 2025. ISSN 0032-4728. .
3. Bruno Schoumaker. Male Fertility Around the World and Over Time: How Different is it from Female Fertility? *Population and Development Review*, 45(3):459–487, September 2019. ISSN 0098-7921, 1728-4457. .
4. Robert Schoen. Population growth and the birth squeeze. *Social Science Research*, 14(3): 251–265, September 1985. ISSN 0049089X. .
5. Henrik-Alexander Schubert and Christian Dudel. Subnational Birth Squeezes? Male-Female TFR Differences across Eight High- and Middle Income Countries over Time, 2025.
6. W. John Paget and Ian M. Timæus. A Relational Gompertz Model of Male Fertility: Development and Assessment. *Population Studies*, 48(2):333–340, July 1994. ISSN 0032-4728, 1477-4747. .
7. Nicolas Brouard. Évolution de la fécondité masculine depuis le début du siècle. *Population (French Edition)*, 32(6):1123, November 1977. ISSN 00324663. .
8. H V Muhsam. The Marriage Squeeze. *Demography*, 11(2):291–299, 1974.
9. Donald S. Akers. On Measuring the Marriage Squeeze. *Demography*, 4(2):907–924, 1967. .
10. Ran Abramitzky. The effect of redistribution on migration: Evidence from the Israeli kibbutz. *Journal of Public Economics*, 93(3-4):498–511, April 2009. ISSN 00472727. .
11. Carol Mulford Albrecht. Sex Ratio and Family Structure in the Nonmetropolitan United States. *Sociological Inquiry*, 71(1):67–84, January 2001. ISSN 0038-0245, 1475-682X. .
12. Andreas Filser and Kai P. Willführ. Sex ratios and union formation in the historical population of the St. Lawrence Valley. *PLOS ONE*, 17(6):e0268039, June 2022. ISSN 1932-6203. .
13. Øystein Kravdal. Sex Differences in Childlessness in Norway: Identification of Underlying Demographic Drivers. *European Journal of Population*, 37(4-5):1023–1041, November 2021. ISSN 0168-6577, 1572-9885. .
14. Thomas Klein. Die Geburt von Kindern in paarbezogener Perspektive / Fertility in Male-Female Partnerships. *Zeitschrift für Soziologie*, 32(6):506–527, December 2003. ISSN 2366-0325. .
15. Joshua D Angrist. How Do Sex Ratios Affect Marriage And Labor Markets, 2000.
16. Thérèse Hesketh. Too many males in China: The causes and the consequences. *Significance*, 6(1):9–13, 2009. ISSN 1740-9713. .
17. Lena Edlund. Sex and the City. *The Scandinavian Journal of Economics*, 107(1):25–44, 2005. ISSN 1467-9442. .
18. Therese Hesketh and Zhu Wei Xing. Abnormal sex ratios in human populations: Causes and consequences. *Proceedings of the National Academy of Sciences*, 103(36): 13271–13275, September 2006. ISSN 0027-8424, 1091-6490. .
19. Joseph D Tucker, Gail E Henderson, Tian F Wang, Ying Y Huang, William Parish, Sui M Pan, Xiang S Chen, and Myron S Cohen. Surplus men, sex work, and the spread of HIV in China. *AIDS*, 19(6), 2005.
20. Josh Angrist. How do Sex Ratios Affect Marriage and Labor Markets? Evidence from America's Second Generation. *Quarterly Journal of Economics*, pages 997–1039, 2002.
21. Monica Das Gupta. China's Marriage Market and Upcoming Challenges for Elderly Men, 2010.
22. Henrik Urdal. A Clash of Generations? Youth Bulges and Political Violence. *International Studies Quarterly*, 50(3):607–629, September 2006. ISSN 0020-8833. .
23. Gudrun Østby and Henrik Urdal. Demographic Factors and Civil War. In Edward Newman and Karl DeRouen, editors, *Routledge Handbook of Civil Wars*. Taylor & Francis Group, Oxford, 2014.
24. Nicolás Corona Juárez, Henrik Urdal, and Krishna Chaitanya Vadlamannati. The significance of age structure, education, and youth unemployment for explaining subnational variation in violent youth crime in Mexico. *Conflict Management and Peace Science*, 39(1): 49–73, January 2022. ISSN 0738-8942, 1549-9219. .
25. Bilal Barakat and Henrik Urdal. *Breaking The Waves ? Does Education Mediate The Relationship Between Youth Bulges And Political Violence ?* World Bank, November 2009. .
26. Nico Keilman, Krzysztof Tymicki, and Vegard Skirbekk. Measures for Human Reproduction Should Be Linked to Both Men and Women. *International Journal of Population Research*, 2014(1):908385, 2014. ISSN 2090-4037. .
27. United Nations Department of Economic and Social Affairs. World Population Prospects 2024: Methodology of the United Nations population estimates and projections. 2024.
28. Thomas Spoorenberg. On the masculinization of population: The contribution of demographic development – A look at sex ratios in Sweden over 250 years. *Demographic Research*, 34:1053–1062, June 2016. ISSN 1435-9871. .
29. Amartya Sen. Mortality as an Indicator of Economic Success and Failure. *The Economic Journal*, 108(446):1–25, 1998.
30. Bruno Schoumaker. *Quality and Consistency of DHS Fertility Estimates, 1990 to 2012*. ICF International, USA, 2014.
31. John Bongaarts. Fertility Transitions in Developing Countries: Progress or Stagnation? *Studies in Family Planning*, 39(2):105–110, 2008. ISSN 1728-4465. .
32. Tim Dyson. Introduction. In *Population and Development: The Demographic Transition*. Bloomsbury, 2010.
33. Lena Edlund, Hongbin Li, Junjian Yi, and Junsen Zhang. Sex Ratios and Crime: Evidence from China. *The Review of Economics and Statistics*, 95(5):1520–1534, December 2013. ISSN 0034-6535, 1530-9142. .
34. Catherine Tucker and Jennifer Van Hook. Surplus Chinese Men: Demographic Determinants of the Sex Ratio at Marriageable Ages in China. *Population and Development Review*, 39(2):209–229, June 2013. ISSN 00987921. .
35. Kara Joyner, H. Elizabeth Peters, Kathryn Hynes, Asia Sikora, Jamie Rubenstein Taber, and Michael S. Rendall. The Quality of Male Fertility Data in Major U.S. Surveys. *Demography*, 49(1):101–124, February 2012. ISSN 0070-3370, 1533-7790. .
36. Christian Dudel and Sebastian Klüsener. Estimating men's fertility from vital registration data with missing values. *Population Studies*, 73(3):439–449, September 2019. ISSN 0032-4728, 1477-4747. .
37. Peter Johnson, Thomas Spoorenberg, Sara Hertog, and Patrick Gerland. Method protocol for the evaluation of census population data by age and sex. Technical report, United Nations Department of Economic and Social Affairs, Population Division, New York, 2022.

38. Fengqing Chao, Patrick Gerland, Ivan Williams, Sara Hertog, Lubov Zeifman, Helena Cruz, Sehar Ezdi, Giulia Gonnella, Danan Gu, Yumiko Kamiya, Pablo Lattes, Joseph Molitoris, Thomas Spoorenberg, and Mark Wheldon. Estimating levels and trends in adult mortality rates in countries with high HIV prevalence from 1950 to 2023. Technical report, United Nations Department of Economic and Social Affairs, Population Division, New York, 2025.
39. Fengqing Chao, Vladimira Kantorova, and Giulia Gonnella. Estimating age-specific fertility rate in the World Population Prospects: A Bayesian modelling approach. Technical report, United Nations Department of Economic and Social Affairs, Population Division, New York, 2023.
40. Population Division United Nations Department of Economic and Social Affairs. World Population Prospects 2024. Technical Report 3, 2024.
41. Bruno Schoumaker. Measuring male fertility rates in developing countries with Demographic and Health Surveys: An assessment of three methods. *Demographic Research*, 36:803–850, March 2017. ISSN 1435-9871. .
42. E Beaujouan. Latest-Late Fertility? Decline and Resurgence of Late Parenthood Across the Low-Fertility Countries. *POPULATION AND DEVELOPMENT REVIEW*, 46(2):219–247, June 2020. ISSN 0098-7921. .
43. Éva Beaujouan and Tomáš Sobotka. Late Motherhood in Low-Fertility Countries: Reproductive Intentions, Trends and Consequences. 2017.
44. Christian Dudel, Yen-hsin Alice Cheng, and Sebastian Klüsener. Shifting Parental Age Differences in High-Income Countries: Insights and Implications. *Population and Development Review*, 49(4):879–908, 2023. ISSN 1728-4457. .
45. Samuel H. Preston, Patrick Heuveline, and Michel Guillot. *Demography: Measuring and Modeling Population Processes*. Blackwell, Oxford, 9. [pr.] edition, 2001. ISBN 978-1-55786-214-3.