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ABSTRACT

Too Many Men, Too Short Lives: The Effect of the Male-Biased Sex Ratio on Mortality

Using a natural experiment in Taiwan, this paper shows that exposure to male-biased sex ratios at the marriageable ages is associated with a greater likelihood of death in later life. Half a million soldiers from Mainland China who retreated to Taiwan after a civil war in the late 1940s were subject to a marriage ban. When the ban was lifted in 1959, the great influx of the soldiers into the marriage market suddenly tipped the balance in favor of women. We have found that men subject to this massive marriage market squeeze exhibited higher mortality rates at age 50–64. Surprisingly, the deadly effect, albeit of a much smaller magnitude, is also found among women. We show that this is likely driven by the widowhood effect—women's mortality rate increased after their husbands' deaths.

JEL Classification: I1, J1
Keywords: sex ratio, mortality, marriage market, widowhood effect

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1. Introduction

Mating is an integral part of human life, and disturbances in the balance of sex ratio (ratio of men to women) in the marriage market can have lasting and far-reaching effects. An emerging body of literature has examined the economic and social consequences of male-biased sex ratios among the young cohort on savings (Wei and Zhang 2011a), entrepreneurship (Wei and Zhang 2011b; Chang and Zhang 2015), housing (Wei, Zhang, and Liu 2017), household financial decisions (Li et al. 2020), crime (Edlund et al. 2013; Cameron, Meng, and Zhang 2019), and cultural attitudes (Grosjean and Khattar 2019). Yet health consequences remain relatively unknown. To fill the gap, this paper focuses on the long-term effect of the male-biased sex ratio on mortality.

In a marriage market with excess men, heterosexual men must compete harder to attract potential female partners. As implied by recent laboratory experiments, heightened mating competition likely results in more stress among men (Bucket et al. 2017; Zhong et al. 2018). Since stress is a well-known risk factor for many health problems, for example, high blood pressure, coronary heart disease, and cancer (Sterling and Eyer 1981; Price et al. 1994; Gilbert et al. 2009; Thoits 2010), it is plausible that exposure to an extremely competitive marriage market could have a deadly effect in later life.

Moreover, there are winners and losers at the end of marriage competitions. In the context of male-biased sex ratios, the losers remain bachelors for the rest of their lives. A multitude of studies have shown that unmarried men tend to have a higher mortality risk than their married counterparts (see Wang et al. 2020 for a recent systematic review). Even for those men fortunate enough to be married and who seem to be winners, the existence of a larger number of bachelors poses an external threat to their marriages and thus reduces their intra-household bargaining power. Facing a disadvantageous position within the household, husbands may have to do more to keep their wives happy, which constitutes a source of constant stress (Angrist 2002; Chang, Connelly, and Ma 2016). This could further exacerbate the effects of stress on men's mortality in the long term.

However, several challenges exist in identifying the effects of sex-ratio imbalance on mortality. First, large-scale sex-ratio imbalances can result from events that can directly affect adult mortality without operating through sex ratio per se. For example, warfare and gender-specific advancements in medical technology could have a direct impact on gender difference in mortality while also distorting sex ratios. It is thus difficult to separate the effect of sex-ratio imbalance from the direct effect of warfare or technology. Second, the advent of ultrasound sex-identification technology has led to distorted sex ratio at birth in some Asian countries. Since the ultrasound technology became widely used in these countries only in the 1980s, it is still too early to discern the effect of sex-ratio imbalance on mortality in late adulthood for this cohort in this part of the world (see Lin et al. 2014). Finally, it is unethical and probably impossible to conduct laboratory or field experiments on human subjects to directly test the effect of sex-ratio imbalance.

Our paper attempts to addresses these challenges by using the removal of the marriage ban on soldiers in Taiwan in the late 1950s as a natural experiment. In the late 1940s, about half a million of Chiang Kai-shek's soldiers, mostly unmarried young men, retreated to Taiwan after a civil war against Mao Zedong's People's Liberation Army (PLA) in Mainland China. The local Taiwanese civilian population was only six million at the time. Upon their arrival in Taiwan, Chiang's soldiers were immediately deployed in every county throughout the island to defend against the PLA's attacks from the west side of the Taiwan Strait.

For a long time, to keep up their morale and their determination to recover the Mainland, soldiers were confined to military compounds and not allowed to marry. The marriage ban was ultimately lifted in 1959, injecting a large number of bachelors into the marriage market in Taiwan. This large-scale natural experiment in Taiwan—under rather homogeneous cultural and institutional environments across counties—resulted in both geographical and temporal variations in the sex ratios in local marriage markets. The intensity of marriage market competition differed across counties mainly due to variations in the military deployment in each county. A spike in sex ratio (more men relative to women) intensified competition among men but reduced women's competitive pressure in the marriage market.

This exogenous variation in the sex ratio six decades ago has enabled us to identify the long-term impact of fierce mating competition on adult mortality. We tracked the mortality of the affected cohort and other cohorts in the past six decades, and we found that young men subject to this massive marriage market shock exhibited a higher death rate at age 50–64. Surprisingly, the male-biased sex ratio also had a deadly effect on women in later life, although the magnitude was much smaller. We show that this is likely due to the widowhood effect—women's mortality rate increased after their husbands' deaths.

Our findings predict an elevated likelihood of death in late adulthood for men born after the 1980s in China, India, and other Asian countries, where sex ratios have become skewed since then (Sen 1992; Coale and Banister 1994; Das Gupta 2005; Bulte, Heerink, and Zhang 2011; Li, Yi, and Zhang 2011). The problem of missing women in many parts of Asian countries, as highlighted by Sen (1992), yields an unintended deadly consequence for men in later life.

The rest of the paper is arranged as follows. The next section introduces the background of the marriage policy in Taiwan and the construction of sex ratios, while section 3 discusses the data sets used in the analyses. Section 4 presents the empirical analyses of the effects of exposure to sex-ratio imbalances during marriageable age on mortality for men and women in later adulthood. We discuss potential mechanisms in section 5, and section 6 provides a conclusion.

2. Historical Background

In China, the Chinese Nationalist Party (also known as the Kuomintang), led by Chiang Kai-shek, and the Chinese Communist Party (CCP), led by Mao Zedong, fought each other in a civil war between 1945 and 1949. With the defeat of the Kuomintang, a great influx of immigrants, including about half a million young, unmarried male soldiers, retreated to Taiwan in the late 1940s (Barclay 1954; Jacoby 1967; Ho 1978; Chen and Yeh 1982; Liu 1986; Lin 2002). At the time, the local population in Taiwan numbered merely six million. In this group of civil war immigrants, men outnumbered women by four to one (Francis 2011). Upon their arrival in Taiwan, Chiang's soldiers were immediately deployed in every county throughout the island to defend against the CCP's attacks.

For a long time after their arrival, the soldiers were confined to their military bases and not allowed marry to ensure that they remain vigilant and ready for any potential warfare (Lin 2002). In 1952, the marriage ban was formally written into a law called the Military Marriage Ordinance (MMO). The MMO forbade most active military personnel from marrying, except for military officers and technical sergeants. However, in August 1959, the ban was relaxed for most soldiers, except for male soldiers younger than 25, female soldiers younger than 20, and all soldiers who had served fewer than three years. This relaxation essentially made the MMO nonbinding for most immigrant soldiers, who were either already older than 25 or had served more than three years by 1959. This meant that they could finally marry, roughly 10 years after their arrival in Taiwan. Most of them were already over 30 years old. With a sudden injection of about half a million bachelors into the marriage market, the sex ratio in the age group 25–40 immediately became skewed in favor of women.[1]

[1] Ong et al. (2019) show that there is a "left-over women" phenomenon in Mainland China, despite the increasing number of men in the marriage market in the past several decades due to elite women's inclination to marry richer men. If this holds true for Taiwan, the existence of "left-over women" would further reduce the

We define county sex ratios at ages 30 and 35, respectively, as the ratios of men to women who were aged 25–34 and 30–39 and resided in the county in the year when each individual reached ages 30 and 35. We used the county sex ratios to measure the intensity of marriage competition at the respective ages. The choice of age range in calculating the sex ratios assumes that each man competed against other men within a five-year age range. As a robustness check, we also extended the age range to 15–49 and found similar results.

The Taiwanese government tracks its population through a household registration system, and every citizen is required to register starting at birth. The registration data record detailed information regarding birth, relocation, marriage, and education etc. for each member within a household. However, active military personnel, including soldiers from Mainland China, were excluded from this registration system until 1969. Since some of our study cohorts reached age 30 before 1969, we had to impute the county sex ratios to include those soldiers. We followed the method proposed by Chang (2012) and used the population data administered by the Department of Household Registration under the Ministry of Interior.

Figure 1 illustrates the sex ratios at age 30 and 35 by birth cohort. The declining trends show that the older cohorts experienced much more imbalanced sex ratios than the younger cohorts. For instance, there were as many as 126 men for every 100 women (sex ratio is 1.26) in the age range 30–39 when the 1931 cohort reached age 35. In stark contrast, the ratio dropped to only 105 men for every 100 women for the 1939 cohort.

The sex ratios also vary greatly across counties. Figure 2 shows the average county sex ratio (averaged across birth cohorts) at age 30 in panel (A) and 35 in panel (B). The sex ratio at age 30 was 1.17 in Miaoli County, in comparison to 0.98 in Taichung City. Overall,

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number of available women in the marriage market, creating more intensive competitive pressure for men, particular those with lower social status.

the large variation in sex ratios at age 30 and 35 over cohorts and across counties provides a good opportunity to examine the impact on people of being exposed to sex ratio disturbance in their 30s on mortality a few decades later.

3. Data

We studied the birth cohorts born from 1931 to 1950 who reached age 30 between 1961 and 1980. To facilitate our empirical analysis, we used several data sources described in detail below.

Mortality Data

We imputed age-specific mortality rates by gender and county by using death counts from the national death registry data from 1981 to 2014 and population at risk from the 1980 Population and Housing Census in Taiwan. The national death registry is maintained by the Ministry of Health and Welfare. It registers deceased individuals' sex, year of birth and death, and county of household registration (encoded in the first digit of the national ID number), which are reported by the hospital where the individual was last treated or the Prosecutors Office if the individual was dead on arrival. The Population and Housing Census was administered by the Ministry of Interior and enumerated information regarding sex, year of birth, and county of residence for all residents in Taiwan at the end of 1980.

Under two assumptions stated below, these two data sources allowed us to impute mortality rates at ages 50–54, 55–59, 60–64, and 50–64 by sex and county for all birth cohorts who were born from 1931 to 1950 and still alive in 1980. For instance, the mortality rate at age 50–54 for men of the 1931 birth cohort in county c is defined as the number of men of this birth cohort who died from 1981 to 1985 in county c, divided by the total number of men of this birth cohort who were still alive in 1980 in county c. The imputation is made under two assumptions: first, that an individual's county of residence in 1980 is the same as his or her county of household registration, and second, that there is no migration during this period. Any violation of the two assumptions could cause measurement errors in the mortality rate, which is our key dependent variable. We assume that the potential measure errors in the mortality rate are orthogonal to the covariates included in the right-hand-side of the regression equation. It is unlikely that the right-hand-side variables, especially the imputed sex ratios, are correlated with the measurement errors in the imputed mortality rate.

Other Data Sources

We also used several additional data sources described below.

The Health and Living Status of the Middle-Aged and Elderly Survey (HLSMES) in Taiwan is a longitudinal survey conducted by the Health Promotion Administration under the Ministry of Health and Welfare. The survey collected detailed information of the survey participants including demographics and various health outcomes. This allowed us to examine a variety of chronic conditions and depression for the birth cohorts born from 1929 to 1953. We combined two nationally representative samples separately drawn in 1996 and 2003 to form our analysis sample of 4,061 individuals. Their health outcomes were evaluated in 1996 and 2003 respectively.

To estimate the sex-ratio effect on bachelorhood, we used the Population and Housing Census in 1990, when our study cohorts were at least 40 years old. The key variables from the Census included gender, marital status, birth year and county of residence. The sample consisted of 3,547,498 individuals.

To construct our instrumental variable, we used the number of Mainland Chinese men in each county interacted with gender differential in mortality rate in Taiwan or in the world. We calculated the number of Mainland Chinese men in each county by using the Population and Housing Census of 1956. We calculated the gender difference in mortality in Taiwan by year and sex from the Abridged Life Table published by the Ministry of Interior, while we drew the world data from the Abridged Life Table for Male and Female in the World Population Prospects 2019, which is published by the Population Division, Department of Economic and Social Affairs, United Nations.[2]

4. Empirical Analysis

Ordinary Least Squares Regressions

Mortality rate in middle age may be driven by cohort-specific or county-specific unobserved factors. We ran a multivariate regression as below to control for county and birth cohort fixed effects.

$$M_{cba}^{g} = \beta^{g} S_{cb} + \gamma_b + \delta_c + \varepsilon_{cba}^{g}, \quad (1)$$

where M_{cba}^{g} is the county-level mortality rate for males ($g = m$) or females ($g = f$) at age a for birth cohort b in county c, S_{cb} is the sex ratio when cohort b was at age 30 or 35, γ_b is cohort fixed effect, δ_c is county fixed effect, and ε_{cba}^{g} is an error term. We used robust standard errors clustered at county for statistical inferences.

We visualized all point estimates with 95% confidence interval in the figures below. Unless otherwise noted, we use circles and crosses to denote estimates for men and women respectively. Tables of all estimation results are provided in the appendix.

Figure 3 shows the ordinary least squares (OLS) estimates of the sex-ratio effect on age-specific mortality rates. Throughout all age ranges, both men's and women's mortality rates appear to be positively associated with sex ratios. Nonetheless, the effects associated with men are generally three times that of the effects associated with women. For example, during ages 50–64 (panel D), if the sex ratios increase by one standard deviation (about 0.1 or

[2] Taiwan's Abridged Life Tables were available at https://www.moi.gov.tw/stat/node.aspx?cate_sn=&belong_sn=5992&sn=6028. The World Population Prospects 2019 data were available at https://population.un.org/wpp/.

10 extra men per 100 women), men's mortality rate would increase by about 1.5 percentage points. In comparison, for the same increase in sex ratios, women's mortality rate during ages 50–64 would increase by only about 0.5 percentage points.

Measurement Errors & Instrumental Variables

Measurement errors in the mortality rates and sex ratios could arise due to the imputation and the imperfect matching of the mortality rates and sex ratios across year and county because of migration. Consequently, the above OLS estimates may be biased. In response, we adopted the instrumental variable approach to mitigate the potential measurement error bias.

To construct our instrumental variable, we interacted two variables that influenced the county sex ratios but were arguably unrelated to the measurement errors: the number of Mainland Chinese men who retreated to Taiwan and the gender difference in mortality before our study cohorts entered the marriage market. We use the *actual* number of Mainland Chinese men in each county in the 1956 Population and Housing Census, which was the first census conducted after Chiang Kai-shek's government relocated to Taiwan and also the earliest data available. For the sake of confidentiality, these Mainland Chinese men in the census did not include those soldiers from Mainland China. The presence of the Mainland Chinese men in each county in 1956 was partially correlated with the county sex ratios in the 1960s, 1970s and 1980s with the influence gradually phasing out. Nevertheless, the number of Mainland Chinese men in 1956 only varied across counties.

The second factor we used is the national gender differential in mortality at ages 0–14 in Taiwan when each of our study cohorts reached age 20. Note that this variable only varied by birth cohort by construction. The national gender differential in mortality would have to some extent shaped the sex ratio at age 30 or 35 faced by our study cohorts in every county. Since the mortality differential occurred long before our study cohorts entered the marriage market, it could not be a direct result of the marriage competition among our study cohort. Moreover, we argue that it was unrelated to the measurement errors either. At last, we interact the log of Mainland Chinese men with the national gender differential in mortality at ages 0–14 to construct our main instrumental variable for the county sex ratio.

There is still a possibility the gender differential in mortality rate at ages 0–14 might be correlated with unobserved macroeconomic or health factors in Taiwan which also shaped gender-specific mortality rate in later adulthood. Thus, as a robustness check, we used the interaction of the log of Mainland Chinese men with the worldwide gender differential in mortality rate at age 20 when the cohort reached age 20 as an alternative instrumental variable, which is unlikely to be determined by the unobserved factors in Taiwan, if any.

Two-Stage Least Squares Results and Robustness Checks

With the above constructed instrumental variables, we further conducted two-stage least squares (2SLS) estimations. Table A2 in the Appendix displays results of the first-stage regressions for sex ratios using two different instrumental variables, the interaction of the log of Mainland Chinese men with the gender differential in mortality rate at ages 0–14 in Taiwan or with the worldwide gender differential in mortality rate at age 20 when the cohort reached age 20. Both instrumental variables are correlated with sex ratios at ages 30 and 35, with the significance level at 1%.

Figure 4 presents the 2SLS estimates using the interaction of the log of Mainland Chinese men with the gender difference in mortality rate during ages 0–14 in Taiwan when each birth cohort reached age 20. The 2SLS estimates show similar patterns observed in Figure 3 but are generally 1.5 to 2 times that of the OLS estimates. For example, one standard deviation increase in the sex ratios would lead to an increase in men’s mortality during ages 50–64 by about 3 percentage points. For women, the effect is less than one percentage point.

To check whether our 2SLS estimates are sensitive to the choice of instrumental variable, we constructed another instrument using the interaction of the log of Mainland Chinese men with the gender difference in global mortality at age 20 when each birth cohort reached age 20. The new 2SLS estimates are presented in Figure 5. In general, the results are similar to those in Figure 4, although the effects on women appear to be larger.

So far, we defined sex ratios with an age range within five years above and below cohort members' ages. As another robustness check, we extended the age range to 15–49, which is supposed to cover most active participants in the marriage market. Both the OLS (panels A–D) and 2SLS (panels E–H) results are shown in Figure 6. Again, the patterns observed are consistent with previous results.

5. Mechanisms

Other Health Outcomes

Although we have been examining only mortality, it is natural to suspect that sex ratios may also have impacts on other health outcomes. We investigated a variety of chronic conditions using data from the Health and Living Status of the Middle-Aged and Elderly Survey in Taiwan. The sample consists of individuals born from 1929 to 1953. We observed their health outcomes in 1996 and 2003. The outcomes include Center for Epidemiologic Studies Depression Scale (CES-D) scores, cancers, heart diseases, high blood pressure, stroke, and diabetes. Figures 7 and 8 respectively show the OLS and 2SLS estimates of these chronic conditions. The CES-D ranges from 0 to 30, with a higher value indicating more severe depression. All other chronic conditions are dummy variables indicating if a person self-reported having the condition in question.

A shown in Figure 7, the OLS estimates do not reveal any clear sex-ratio effect on these outcomes. However, the 2SLS estimates in Figure 8 show that after facing higher sex ratios in their 30s, men tend to have a greater chance of having cancers and high blood pressure in a later stage of life, while none of the results for women is statistically significant. Since cancers and high blood pressure have been leading causes of death in Taiwan,[3] the findings are consistent with the gender difference in mortality outcomes we observed in the previous section.

Bachelorhood

As discussed, one channel through which the imbalanced sex ratio can leave a long-term fatal effect is by increasing bachelorhood. A high sex ratio implies more men would be lifelong bachelors, which could be detrimental to their health (see Wang et al. 2020 for a recent systematic review). We used the 1990 Population and Housing Census to examine the marital status of our 1931–1950 study cohorts. In 1990, they were at least 40 years old.

In Figure 9, both OLS and 2SLS estimates show that high sex ratios in men's 30s increased the likely that they would remain single. On the contrary, women were much less likely to remain single, although the OLS estimates are not estimated precisely.

Widowhood Effect

The positive sex-ratio effect on women's mortality seems puzzling. Women who experienced the removal of the marriage ban were more likely to marry. They supposedly had greater bargaining power within the household considering that there were a significant number of bachelors in the marriage market. In principle, the skewed sex ratio in the 30s in favour of women should be good for their health and longevity, yet we have observed a negative effect on women's mortality rate. We suspect one possible channel is the widowhood effect; that is, women's probability of dying increases with the death of their spouses. To test this, we added the mortality rate of older men into the regressions related to

[3] According to the Ministry of Health and Welfare in Taiwan, malignant neoplasms and hypertensive diseases have been leading causes of death in Taiwan since the 1980s (see data available at https://dep.mohw.gov.tw/DOS/lp-1819-113-xCat-1.html).

mortality in women. For instance, for women's mortality rate at ages 50–54 (55–59), we controlled for men's mortality at ages 55–59 (60–64) on the right. For men's regressions, we added women's mortality in younger age categories. We used different age categories to reflect the fact that men tend to marry younger women in this context.

The mortality rate added on the right is clearly endogenous and thus requires another instrumental variable. We used the gender difference in mortality in both Taiwan and the world and separately interacted them with the log of Mainland Chinese men to form two instrumental variables. The OLS and 2SLS results are illustrated in Figure 10. Please note the change in the symbols used to denote point estimates: in panels A and B, we use circles and crosses to denote women's sex-ratio effect on mortality at ages 50–54 and 55–59 respectively; in panels C and D, we use squares and triangles to denote men's sex-ratio effect on mortality at ages 55–59 and 60–64 respectively.

As shown in panel B, the 2SLS estimates of the sex-ratio effect for women turn negative, suggesting that sex ratios actually lower women's mortality once we control for men's mortality at the adjacent older age category. In stark contrast, controlling for younger women's mortality does not dilute the sex-ratio effect for men.

6. Conclusion

This paper examines the long-term effect of the male-biased sex ratio on mortality using the removal of the marriage ban on soldiers in Taiwan in 1959 as a natural experiment. We have found that men who were exposed to the sudden elevation in mating competition in early adulthood experienced a rise in mortality a few decades later. Interestingly, higher sex ratios also take a toll on women's mortality, likely because of the widowhood effect.

High sex ratios have persisted in some Asian countries, including China and India, for a few decades (Das Gupta, 2005). However, the long-term hidden health costs of sex-ratio imbalance have not been well recognized. For the generations born to skewed sex ratios in the past several decades, the future mortality costs loom large.

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Figure 1. National age-specific sex ratios by birth cohort. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively.

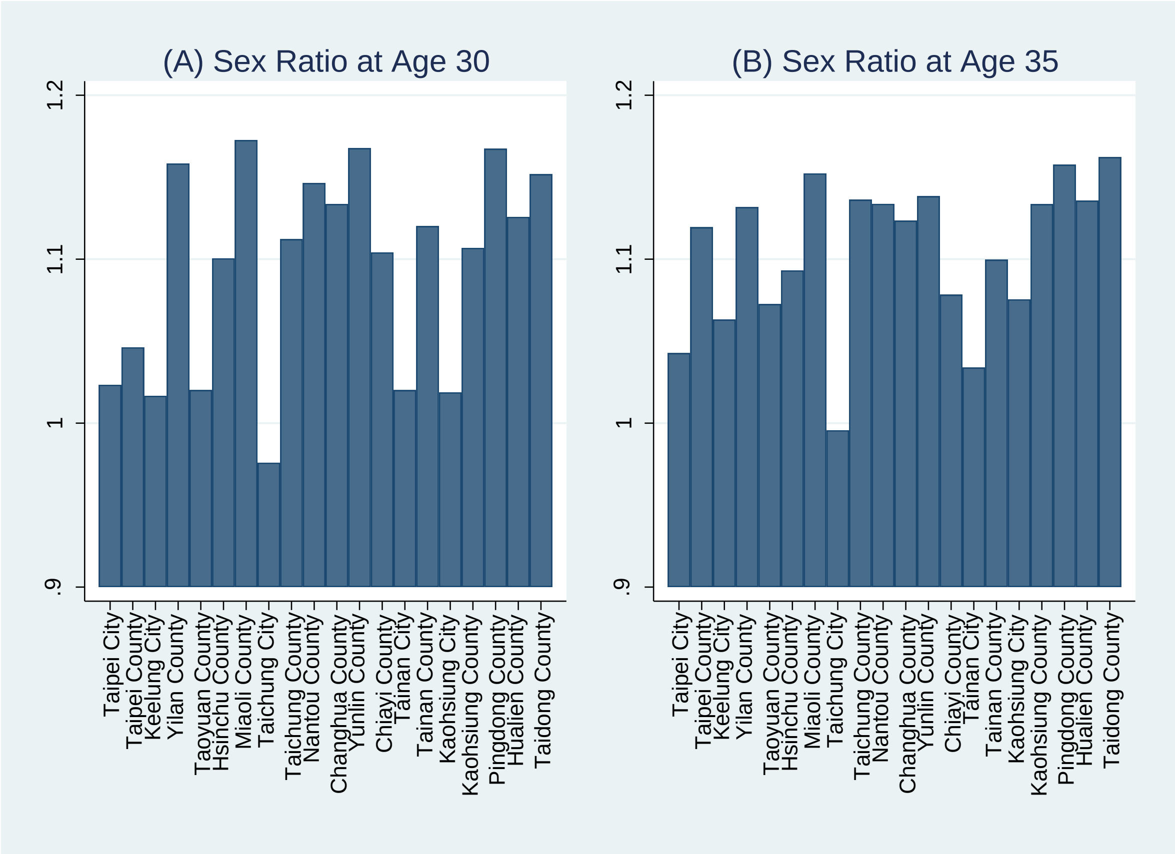

Figure 2. Age-specific sex ratios by county. County age-specific sex ratios averaged across birth cohorts 1931–1950 are shown. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively.

Figure 3. Ordinary least squares estimates of sex-ratio effect on age-specific mortality rates. Dependent variables are mortality rates at ages 50–54, 55–59, 60–64, and 50–64 in panels (A), (B), (C), and (D) respectively. Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

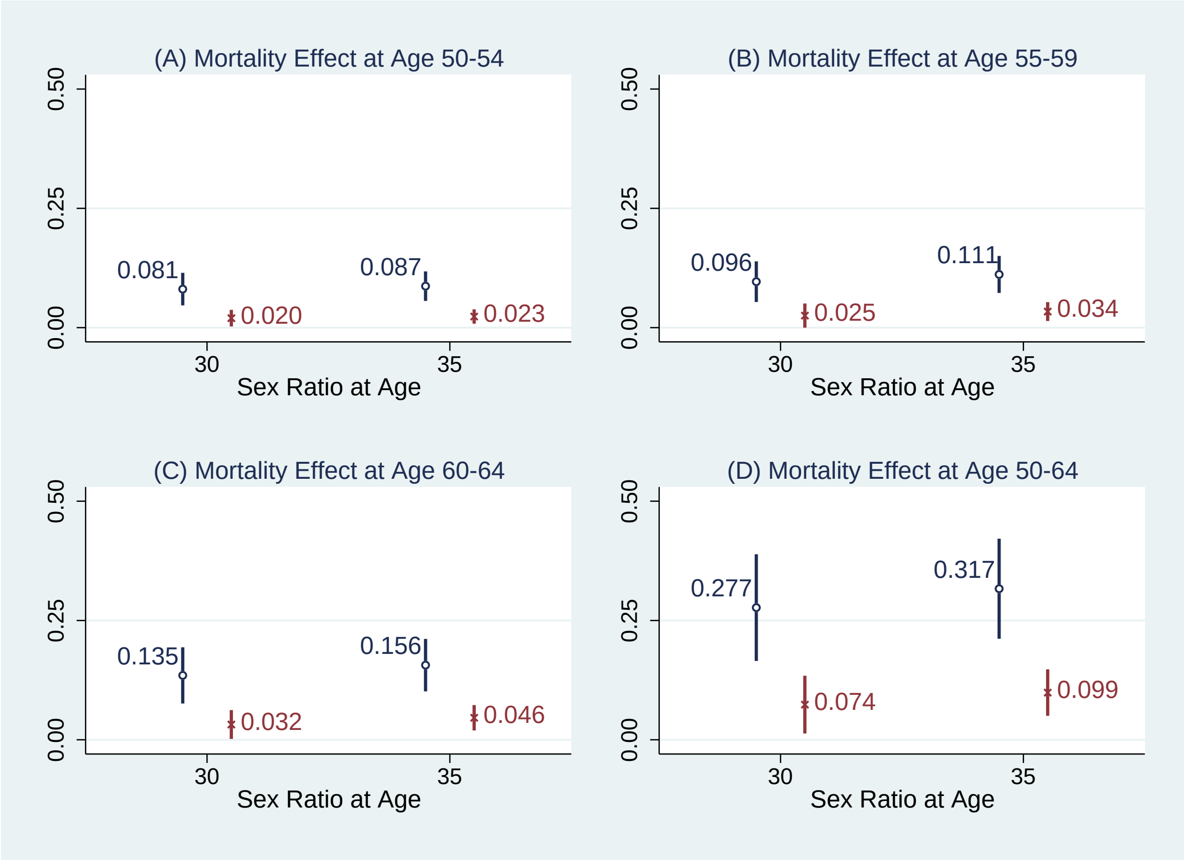

Figure 4. Two-stage least squares estimates of sex-ratio effect on age-specific mortality rates. Dependent variables are mortality rates at ages 50–54, 55–59, 60–64, and 50–64 in panels (A), (B), (C), and (D) respectively. Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. The instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

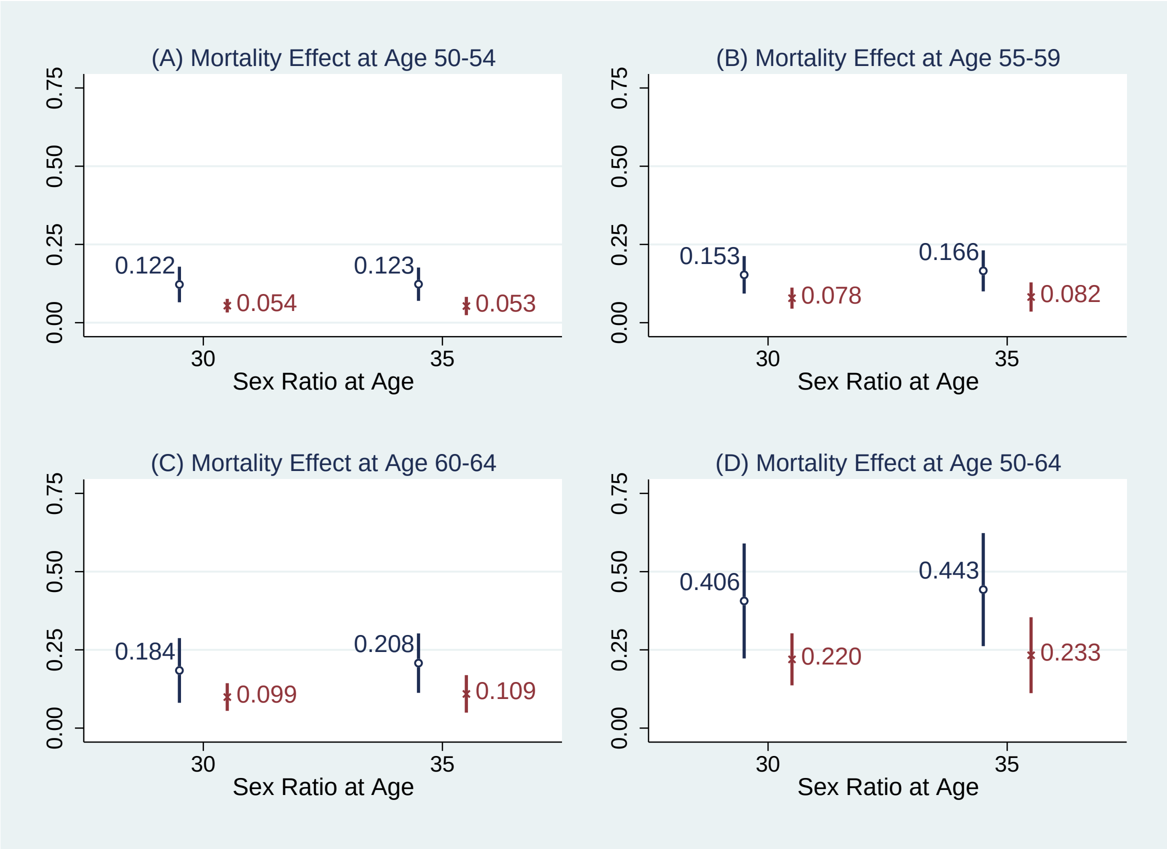

Figure 5. Two-stage least squares estimates using alternative instrumental variable. Dependent variables are mortality rates at ages 50–54, 55–59, 60–64, and 50–64 in panels (A), (B), (C), and (D) respectively.
Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. The instrumental variable is the log of Mainland Chinese men interacted with gender differential in estimated global mortality rate at age 20 when each cohort reached age 20. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated mortality rate at age 20 for males and females were drawn from the Abridged Life Table for Male and Female, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Figure 6. Estimates of mortality effect using sex ratios with wide age range (15–49). Dependent variables are mortality rates at ages 50–54, 55–59, 60–64, and 50–64.

Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 15–49 when each cohort reached age 30 and 35 respectively. In panels (E), (F), (G), and (H), the instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

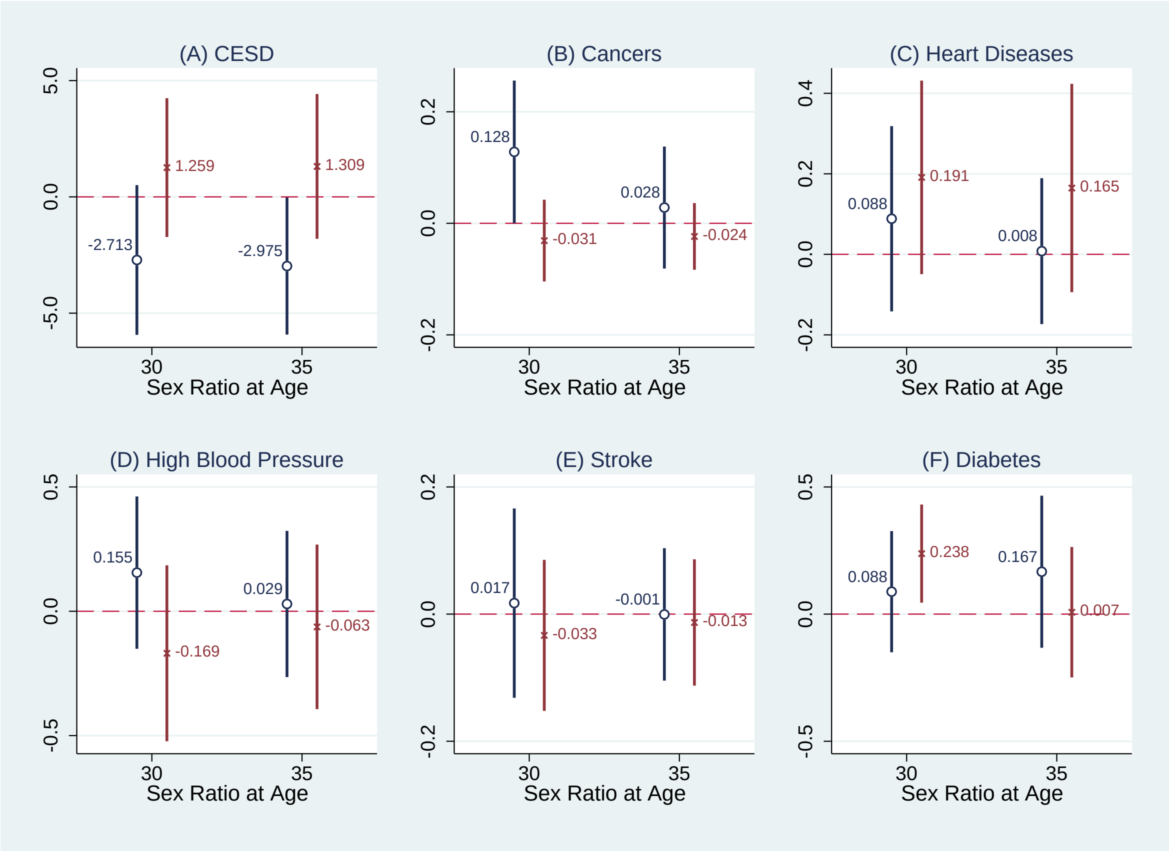

Figure 7. Ordinary least squares estimates of sex-ratio effect on other health outcomes. The Center for Epidemiologic Studies Depression Scale (CES-D) measures depression with a score ranging from 0 (low depression) to 30 (high depression). All other dependent variables are dummy variables indicating if a person has the respective medical condition.

Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for age, age squared, log of prime-age (20–64) male at county at corresponding age, a full set of county and birth cohort dummy variables, and a dummy variable indicating the sample drawn in 2003. The sample includes birth cohorts born from 1929 to 1953 across 20 counties.

Health outcomes data were drawn from the Health and Living Status of the Middle-Aged and Elderly Survey in Taiwan 1996 and 2003. Sex ratios are the authors' own imputations. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

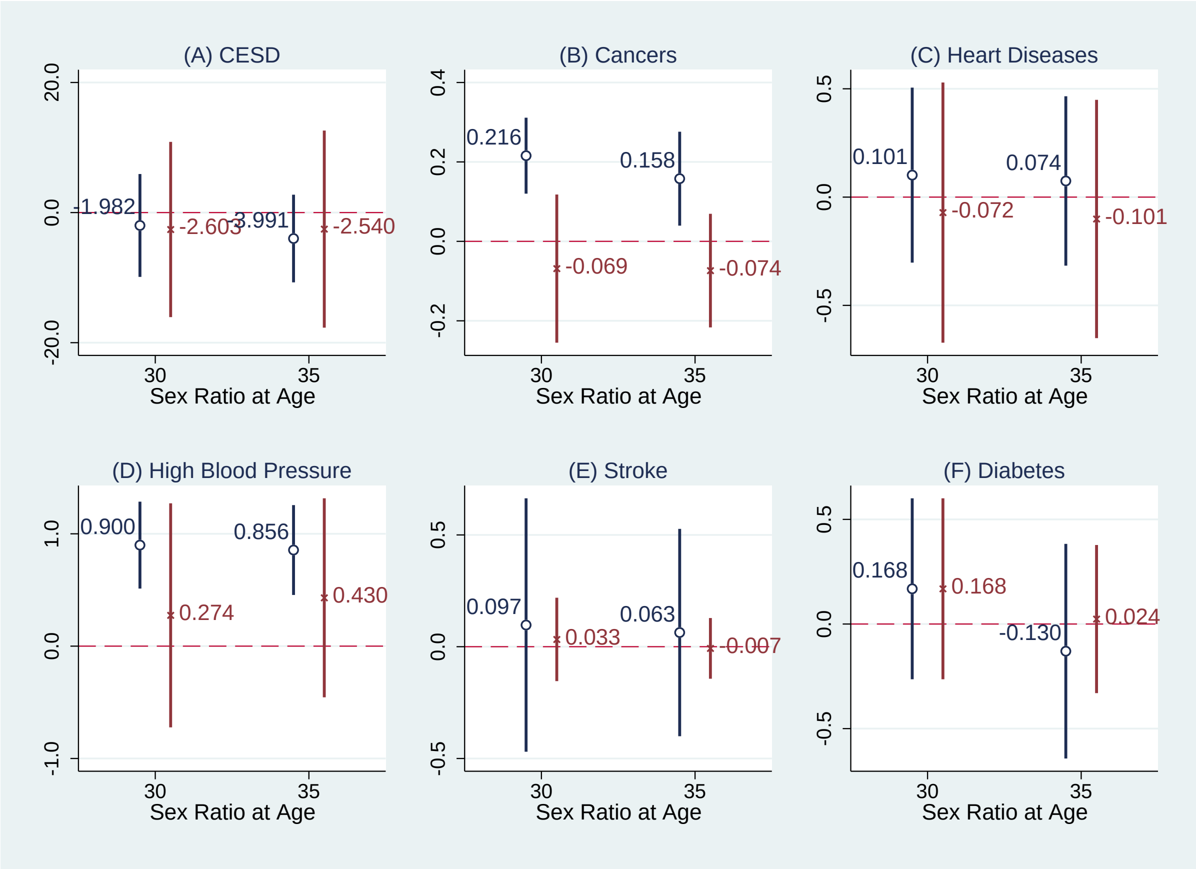

Figure 8. Two-stage least squares estimates of sex-ratio effect on other health outcomes. CES-D measures depression with a score ranging from 0 (low depression) to 30 (high depression). All other dependent variables are dummy variables indicating if a person has the respective medical condition. Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. The instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for age, age squared, log of prime-age (20–64) male at county at corresponding age, a full set of county and birth cohort dummy variables, and a dummy variable indicating the sample drawn in 2003. The sample includes birth cohorts born from 1929 to 1953 across 20 counties.

Health outcomes data were derived from the Health and Living Status of the Middle-Aged and Elderly Survey in Taiwan 1996 and 2003. Sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

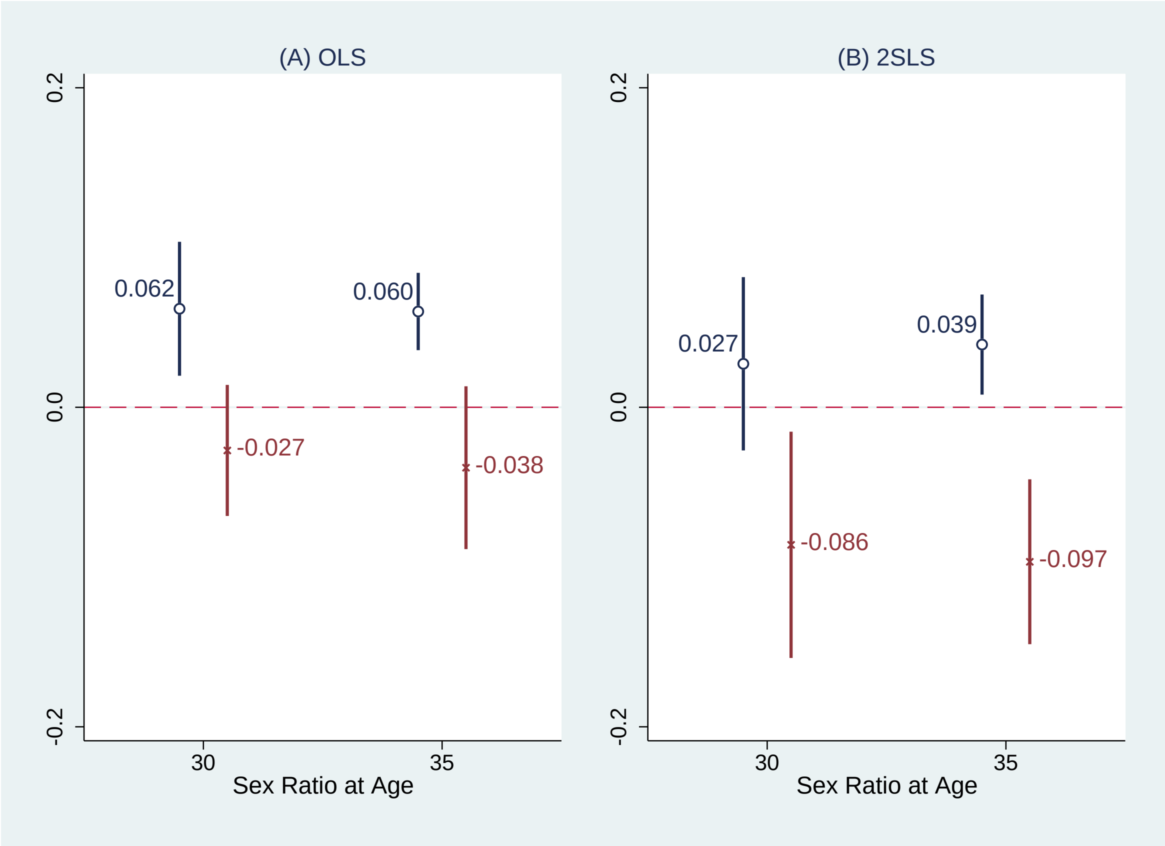

Figure 9. Sex-ratio effect on bachelorhood. Dependent variables are a dummy variable indicating if an individual is single. Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. Circles and crosses indicate point estimates for men and women respectively. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. In panel (B), the instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

Marital status data were obtained from the 1990 Population and Housing Census in Taiwan. Sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

Figure 10. Widowhood-effect test. The dependent variables in panels (A) and (B) are women's mortality rates at ages 50–54 (circle) and 55–59 (cross). The dependent variables in panels (C) and (D) are men's mortality rates at ages 55–59 (square) and 60–64 (triangle). In the regressions of women's mortality at age 50–54 (50–59), men's mortality at age 55–59 (60–64) has been further controlled to test the widowhood effect. In the regressions of men's mortality at age 55–59 (60–64), women's mortality at age 50–54 (55–59) has been further controlled to test the widowerhood effect. Point estimates with 95% confidence interval are shown. Robust standard errors clustered at county have been used to construct confidence interval. All estimates have been obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. In panels (B) and (D), the instrumental variables are the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20, and the log of Mainland Chinese men interacted with gender differential in estimated global mortality rate at age 20 when each cohort reached age 20. The sample includes birth cohorts born from 1931 to 1950 across 20 counties.

Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan. Global estimated mortality rates at age 20 for male and female were obtained from the Abridged Life Table for Male and Female, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Appendix

Table A1. Estimates of Sex-Ratio Effect on Mortality Rates

	Ordinary Least Squares (OLS)				Two-Stage Least Squares (2SLS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Men	Women	Men	Women	Men	Women	Men	Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35	Age 30	Age 30	Age 35	Age 35
	Panel A: Mortality Rate at Age 50–54							
Sex ratio	0.044***	0.013**	0.037***	0.013**	0.081***	0.020**	0.087***	0.023***
	(0.012)	(0.005)	(0.012)	(0.005)	(0.017)	(0.009)	(0.016)	(0.008)
	Panel B: Mortality Rate at Age 55–59							
Sex ratio	0.060***	0.018*	0.055***	0.017*	0.096***	0.025*	0.111***	0.034***
	(0.017)	(0.009)	(0.019)	(0.008)	(0.022)	(0.013)	(0.020)	(0.010)
	Panel C: Mortality Rate at Age 60–64							
Sex ratio	0.084***	0.022**	0.079***	0.025**	0.135***	0.032**	0.156***	0.046***
	(0.024)	(0.010)	(0.026)	(0.011)	(0.030)	(0.015)	(0.028)	(0.014)
	Panel D: Mortality Rate at Age 50–64							
Sex ratio	0.164***	0.050**	0.150***	0.052**	0.277***	0.074**	0.317***	0.099***
	(0.044)	(0.021)	(0.049)	(0.021)	(0.057)	(0.031)	(0.053)	(0.025)
Kleibergen–Paap F					41.85	41.91	56.66	56.35
Observations	400	400	400	400	400	400	400	400

Notes: Dependent variables are mortality rates at county-cohort level at ages 50–54, 55–59, 60–64, and 50–64 in panels A, B, C, and D respectively. The instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. The sample includes birth cohorts born from 1931 to 1950 across 20 counties. All estimates obtained from separate regressions. Sex ratio at age 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions control for log of working-age (20–64) males at county level at each age and a full set of county and birth cohort dummy variables. Robust standard errors clustered at county in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%. Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

Table A2. First-Stage Estimates

Sex Ratio at Age	(1) Age 30	(2) Age 35
	Panel A	
Log of MCM × gender diff in mortality (0–14) *in Taiwan*	–8.262*** (1.495)	–8.058*** (1.548)
	Panel B	
Log of MCM × gender diff in global mortality (20)	47.494*** (14.076)	48.559*** (11.956)

Notes: The dependent variables are sex ratio at ages 30 and 35, in columns (1) and (2) respectively. They are measured as the ratio of men to women who are 25–34, 30–39, and 35–44 at the county level respectively. In panel A, the key explanatory variable is the log of Mainland Chinese men (MCM) at county level in 1956 interacted with the national gender differential in mortality at age 0–14 in Taiwan when each birth cohort reached age 20. In panel B, the key explanatory variable is the log of MCM interacted with the gender differential in estimated global mortality rate at age 20 when each cohort reached age 20. All regressions control for log of prime-age (20–64) male at county level at each age and a full set of county and birth cohort dummy variables. Robust standard errors clustered at county in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%.
Sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan. Estimated global mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Male and Female, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Table A3. Two-Stage Least Squares Estimates Using World Gender Difference in Estimated Mortality Rate as Instrument

Sex Ratio at Age	(1) Men Age 30	(2) Women Age 30	(3) Men Age 35	(4) Women Age 35
	Panel A: Mortality Rate at Age 50–54			
Sex ratio	0.122***	0.054***	0.123***	0.053***
	(0.029)	(0.011)	(0.027)	(0.015)
	Panel B: Mortality Rate at Age 55–59			
Sex ratio	0.153***	0.078***	0.166***	0.082***
	(0.031)	(0.017)	(0.033)	(0.024)
	Panel C: Mortality Rate at Age 60–64			
Sex ratio	0.184***	0.099***	0.208***	0.109***
	(0.053)	(0.023)	(0.048)	(0.031)
	Panel D: Mortality Rate at Age 50–64			
Sex ratio	0.406***	0.220***	0.443***	0.233***
	(0.094)	(0.042)	(0.092)	(0.062)
Observations	400	400	400	400
Kleibergen–Paap F	37.05	37.62	45.94	46.37

Notes: The dependent variables are mortality rates at county-cohort level at ages 50–54, 55–59, 60–64, and 50-64 in panels A, B, C, and D respectively. The sample includes birth cohorts born from 1931 to 1950 across 20 counties. All estimates obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions control for log of working-age (20–64) male at county level at each age and a full set of county and birth cohort dummy variables. The instrumental variable is the log of Mainland Chinese men interacted with the gender differential in estimated mortality rate at age 20 in the world when each cohort reached age 20. Robust standard errors clustered at county in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%. *Kleibergen-Paap F* statistics for weak instrument test at bottom.

Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Male and Female, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Table A4. Estimates of Mortality Effect Using Sex Ratios with Wide Age Range (15–49)

	Ordinary Least Squares				**Two-Stage Least Squares**			
	(1) Men	(2) Women	(3) Men	(4) Women	(5) Men	(6) Women	(7) Men	(8) Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35	Age 30	Age 30	Age 35	Age 35
	Panel A: Mortality Rate at Age 50–54							
Sex ratio	0.071***	0.026***	0.085***	0.031***	0.088***	0.022**	0.126***	0.034***
	(0.016)	(0.007)	(0.015)	(0.007)	(0.023)	(0.010)	(0.029)	(0.012)
	Panel B: Mortality Rate at Age 55–59							
Sex ratio	0.093***	0.041***	0.122***	0.046***	0.105***	0.028*	0.161***	0.049***
	(0.021)	(0.011)	(0.022)	(0.011)	(0.028)	(0.015)	(0.035)	(0.018)
	Panel C: Mortality Rate at Age 60–64							
Sex ratio	0.124***	0.048***	0.162***	0.062***	0.147***	0.035*	0.226***	0.067***
	(0.036)	(0.013)	(0.038)	(0.013)	(0.039)	(0.018)	(0.051)	(0.023)
	Panel D: Mortality Rate at Age 50–64							
Sex ratio	0.253***	0.108***	0.323***	0.131***	0.302***	0.080**	0.458***	0.143***
	(0.061)	(0.027)	(0.062)	(0.026)	(0.076)	(0.037)	(0.097)	(0.044)
Kleibergen–Paap F					103.2	104.4	118.8	119.2
Observations	400	400	400	400	400	400	400	400

Notes: The dependent variables are mortality rates at county-cohort level at age 50–54, 55–59, 60–64, and 50–64 in panels A, B, C, and D respectively. The instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. The sample includes birth cohorts born from 1931 to 1950 across 20 counties. All estimates obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 15–49 when each cohort reached age 30 and 35 respectively. All regressions control for log of working-age (20–64) male at county level at each age and a full set of county and birth cohort dummy variables. Robust standard errors clustered at county in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%. Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

Table A5. Ordinary Least Squares Estimates of Sex-Ratio Effect on Other Health Outcomes

Sex Ratio at Age	(1) Men Age 30	(2) Women Age 30	(3) Men Age 35	(4) Women Age 35
	Panel A: CES-D			
Sex ratio	–2.713*	1.259	–2.975**	1.309
	(1.538)	(1.426)	(1.408)	(1.487)
Observations	1,855	1,796	1,855	1,796
	Panel B: Cancers			
Sex ratio	0.128**	–0.031	0.028	–0.024
	(0.061)	(0.035)	(0.052)	(0.029)
Observations	1,939	1,869	1,939	1,869
	Panel C: Heart Diseases			
Sex ratio	0.088	0.191	0.008	0.165
	(0.110)	(0.115)	(0.087)	(0.124)
Observations	1,939	1,869	1,939	1,869
	Panel D: High Blood Pressure			
Sex ratio	0.155	–0.169	0.029	–0.063
	(0.146)	(0.169)	(0.141)	(0.158)
Observations	1,939	1,869	1,939	1,869
	Panel E: Stroke			
Sex ratio	0.017	–0.033	–0.001	–0.013
	(0.071)	(0.057)	(0.050)	(0.047)
Observations	1,939	1,865	1,939	1,865
	Panel F: Diabetes			
Sex ratio	0.088	0.238**	0.167	0.007
	(0.114)	(0.092)	(0.143)	(0.123)
Observations	1,939	1,869	1,939	1,869

Notes: CES-D measures depression with a score ranging from 0 (low depression) to 30 (high depression). All other dependent variables are dummy variables indicating if a person has the respective medical condition. All estimates obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for age, age squared, log of prime-age (20–64) male at county at corresponding age, a full set of county and birth cohort dummy variables, and a dummy variable indicating the sample drawn in 2003. The sample includes birth cohorts born from 1929 to 1953 across 20 counties. Robust standard errors clustered at county have been used to construct confidence interval. ***, **, and * indicate significance at 1%, 5%, and 10%.

Health outcomes data were drawn from the Health and Living Status of the Middle-Aged and Elderly Survey in Taiwan 1996 and 2003. Sex ratios are authors’ own imputations.

Table A6. Two-Stage Least Squares Estimates of Sex-Ratio Effect on Other Health Outcomes

Sex Ratio at Age	(1) Men Age 30	(2) Women Age 30	(3) Men Age 35	(4) Women Age 35
	Panel A: CES-D			
Sex ratio	–1.982	–2.603	–3.991	–2.540
	(4.035)	(6.873)	(3.438)	(7.730)
Observations	1,855	1,796	1,855	1,796
	Panel B: Cancers			
Sex ratio	0.216***	–0.069	0.158***	–0.074
	(0.049)	(0.095)	(0.060)	(0.073)
Observations	1,939	1,869	1,939	1,869
	Panel C: Heart Diseases			
Sex ratio	0.101	–0.072	0.074	–0.101
	(0.206)	(0.306)	(0.200)	(0.281)
Observations	1,939	1,869	1,939	1,869
	Panel D: High Blood Pressure			
Sex ratio	0.900***	0.274	0.856***	0.430
	(0.197)	(0.509)	(0.204)	(0.452)
Observations	1,939	1,869	1,939	1,869
	Panel E: Stroke			
Sex ratio	0.097	0.033	0.063	–0.007
	(0.289)	(0.095)	(0.237)	(0.069)
Observations	1,939	1,865	1,939	1,865
	Panel F: Diabetes			
Sex ratio	–0.175	0.168	–0.130	0.024
	(0.272)	(0.221)	(0.262)	(0.181)
Observations	1,939	1,869	1,939	1,869
Kleibergen–Paap F	28.92	24.89	32.49	33.13

Notes: CES-D measures depression with a score ranging from 0 (low depression) to 30 (high depression). All other dependent variables are dummy variables indicating if a person has the respective medical condition. All estimates have been obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. The instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. All regressions additionally control for age, age squared, log of prime-age (20–64) male at county at corresponding age, a full set of county and birth cohort dummy variables, and a dummy variable indicating the sample drawn in 2003. The sample includes birth cohorts born from 1929 to 1953 across 20 counties. Robust standard errors clustered at county have been used to construct confidence interval. ***, **, and * indicate significance at 1%, 5%, and 10%.

Health outcomes data were drawn from the Health and Living Status of the Middle-Aged and Elderly Survey in Taiwan 1996 and 2003. Sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

Table A7. Sex-Ratio Effect on Bachelorhood

Sex Ratio at Age	(1) Men Age 30	(2) Women Age 30	(3) Men Age 35	(4) Women Age 35
		Panel A: OLS		
Sex ratio	0.062***	–0.027	0.060***	–0.038
	(0.020)	(0.020)	(0.012)	(0.024)
		Panel B: 2SLS		
Sex ratio	0.027	–0.086**	0.039**	–0.097***
	(0.028)	(0.036)	(0.016)	(0.026)
Observations	1,809,775	1,737,723	1,809,775	1,737,723
Kleibergen–Paap F	34.94	39.94	36.63	50.24

Notes: The dependent variable is a dummy variable indicating that a person is single. All estimates have been obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. In panel (B), the instrumental variable is the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county dummy variables. The sample includes birth cohorts born from 1931 to 1950 across 20 counties. Robust standard errors clustered at county have been used to construct confidence interval. ***, **, and * indicate significance at 1%, 5%, and 10%.

Marital status derived from the 1990 Population Census in Taiwan. Sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan.

Table A8. Widowhood Effect Test				
	(1)	(2)	(3)	(4)
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35
	Panel A: Women's Mortality: OLS			
Sex ratio	0.005	0.003	0.005	0.003
	(0.005)	(0.006)	(0.004)	(0.006)
	Panel B: Women's Mortality: 2SLS			
Sex ratio	–0.039**	–0.120*	–0.038**	–0.114**
	(0.017)	(0.066)	(0.017)	(0.050)
Outcome: Women's Mortality	Age 50–54	Age 55–59	Age 50–54	Age 55–59
Control: Men's Mortality	Age 55–59	Age 60–64	Age 55–59	Age 60–64
Observations	400	400	400	400
Kleibergen–Paap F	6.335	2.091	8.446	3.341
	Panel C: Men's Mortality: OLS			
Sex ratio	0.053**	0.072***	0.048**	0.065***
	(0.015)	(0.019)	(0.017)	(0.020)
	Panel D: Men's Mortality: 2SLS			
Sex ratio	0.064***	0.111***	0.069***	0.121***
	(0.019)	(0.018)	(0.021)	(0.021)
Outcome: Men's Mortality	Age 55–59	Age 60–64	Age 55–59	Age 60–64
Control: Women's Mortality	Age 50–54	Age 55–59	Age 50–54	Age 55–59
Observations	400	400	400	400
Kleibergen–Paap F	10.68	14.09	11.68	16.09

Notes: The dependent variables in panels (A) and (B) are women's mortality rates at ages 50–54 and 55–59. The dependent variables in panels (C) and (D) are men's mortality rates at ages 55–59 and 60–64. In regressions of women's mortality at age 50–54 (50–59), men's mortality at age 55–59 (60–64) is further controlled to test the widowhood effect. In regressions of men's mortality at age 55–59 (60–64), women's mortality at age 50–54 (55–59) is further controlled to test the widowerhood effect. All estimates have been obtained from separate regressions. Sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions additionally control for log of prime-age (20–64) male at county at corresponding age and a full set of county and birth cohort dummy variables. In panels (B) and (D), the instrumental variables are the log of Mainland Chinese men interacted with the national gender differential in mortality at age 0–14 in Taiwan when each cohort reached age 20, and the log of Mainland Chinese men interacted with gender differential in estimated global mortality rate at age 20 when each cohort reached age 20. Robust standard errors clustered at county have been used to construct confidence interval. The sample includes birth cohorts born from 1931 to 1950 across 20 counties. ***, **, and * indicates significance at 1%, 5%, and 10%. Mortality rates and sex ratios are authors' own imputations. The data relating to Mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of Interior in Taiwan. World estimated mortality rates at age 20 for male and female were obtained from the Abridged Life Table for Male and Female, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.