Chinese trends in adolescent marriage and fertility between 1990 and 2015: a systematic synthesis of national and subnational population data

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Summary

Background Early marriage and fertility are major social determinants of health and wellbeing. Rapid shifts in the past three decades, including a rise in sexual activity in unmarried adolescents, a large population of young migrant workers, and a high proportion of males relative to females, have the potential to alter patterns of reproductive health in Chinese adolescents and young women. We aimed to establish long-term trends of marriage and fertility for girls and women aged 15–24 years in China.

Methods We did a longitudinal study in which we extracted aggregated data for marriage and childbearing status for Chinese girls and women aged 15–24 years from the Chinese National Population Census (in 1990, 2000, and 2010) and the Chinese 1% National Population Sample Survey (in 1995, 2005, and 2015). The census included all individuals with Chinese nationality who resided in China when the survey was done. For the 1% sample survey, communities or villages were randomly selected and all residents with Chinese nationality in the selected communities or villages were included. In all censuses and sample surveys, forms that included information on basic demographic characteristics, education, marriage, and fertility were completed and verified by the census enumerators at the household residence, based on responses provided by the householder or another adult in the household. We calculated the ever-married rate and age-specific fertility rate (ASFR) for all included individuals. We built multivariate random-effects generalised least squares regression models on panel data to test whether marriage or fertility rate was associated with education level, sex ratio, and the proportion of the population who are an ethnic minority in a province.

Findings The ever-married rate for those aged 15–19 years decreased from 4·7% in 1990 to 1·2% (95% CI 1·2–1·3) in 2000, but rebounded to 2·4% (2·4–2·5) in 2015. The ASFR for this age group decreased from 22·0 births per 1000 individuals in 1990 to 6·0 (5·9–6·0) births per 1000 in 2000, and rebounded to 9·2 (8·9–9·4) births per 1000 in 2015. The rebound was found in most provinces. In women aged 20–24 years, the ever-married rate generally declined from 58·6% in 1990 to 25·5% (95% CI 25·4–25·6) in 2015, and the ASFR decreased from 198·8 births per 1000 in 1990 to 55·0 (54·5–55·5) births per 1000 in 2015. In 2015, the ever-married rate and ASFR for girls and women in rural areas aged 15–19 years were three-times higher than those of their urban counterparts (3·8% [95% CI 3·7–3·9] vs 1·1% [1·1–1·1] for the ever-married rate and 15·4 [14·9–15·9] vs 4·1 [3·9–4·3] births per 1000 for the ASFR). There were large disparities in ever-married rate across individuals of different education levels, with increases in the ever-married rate of 15–19-year-olds not attending senior high school between 2000 and 2010. Those aged 15–19 years were more likely to be married or give birth in the western provinces. Education held a protective association against adolescent childbearing, whereas a high ratio of males to females and a high proportion of ethnic minorities were associated with greater risk.

Interpretation Although China's total fertility rate remains far less than replacement, after a period of steady decline, there has been a rebound in adolescent marriage and childbearing in the past decade. A range of adolescent-targeted strategies will be needed across provinces, including scaling up comprehensive sex education, ensuring that girls continue in school, and providing adequate reproductive health services, which specifically meet the needs for modern contraception in sexually active unmarried girls.

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Introduction

The timing of marriage and childbearing carries major implications for the health of women and girls and that of their children.[1,2] Early marriage and childbearing have been linked to greater intimate partner violence, pregnancy complications, and rising risks of maternal death, as well as limiting a girl's education opportunities and employment prospects.[2,3] Globally, child marriage

Research in context

Evidence before this study

China has undergone rapid demographic, social, and economic change in the past three decades, with major implications for marriage and reproductive transitions in young people.

We searched PubMed with the terms ("China"[Mesh]) AND (("adolescent"[Mesh]) OR ("young adult"[Mesh])) AND (("marriage"[Mesh]) OR ("birth rate"[Mesh]) OR ("fertility"[Mesh])) and searched Wanfang (a Chinese database) with terms "*zhongguo*" (China) AND ("*qingshaonian*" (adolescent) OR "*qingnian*" (young adult)) AND ("*jiehun*" (marriage) OR "*zaohun*" (early marriage) OR "*shengyulv*" (birth rate) OR "*zaoyu*" (early parenthood)) for articles published from Jan 1, 1990, up until Oct 9, 2019, without language restrictions. We found one relevant study describing the long-term trend in age-specific fertility rates in urban China, which reported that the fertility rate for urban girls and women aged 15–19 and 20–24 years had generally declined between 1955 and 2013. We also found several studies relevant to early marriage among rural young people or rural-to-urban migrant workers published in Chinese journals. However, to our knowledge, there has been no comprehensive report of marriage and fertility patterns in adolescent girls and young women in China.

Added value of this study

The nationally representative Chinese National Population Census and Chinese 1% National Population Sample Survey provided an opportunity to analyse the long-term trends and subnational disparities of marriage and fertility among adolescent girls and young women over the past 25 years. Over this period, the size of the 15–24-year-old population has decreased, and has been accompanied by a gradually increasing

sex ratio of adolescents that is biased towards males. Our data revealed that there was a consistent decline in both marriage and fertility in women aged 20–24 years between 1990 and 2015, but that these two indicators had rebounded since 2000 in girls and women aged 15–19 years. The 15–19-year-olds with rural residency and in the western provinces were more likely to marry and have children as adolescents. Economic growth and longer participation in education was associated with delayed marriage and fertility in girls and women, while an inflated male-biased sex ratio, a large population of young migrant workers, and unmet contraception needs among unmarried adolescents were associated with a rebound in marriage and fertility in girls and women aged 15–19 years.

Implications of all the available evidence

After a period of steady decline, there has been a rebound in adolescent marriage and fertility since 2000 across most Chinese provinces. A range of adolescent-targeted strategies will be needed to reduce adolescent marriage and fertility, as the presumptive drivers of this rebound—a male-biased sex ratio, a large population of migrant workers, and more sexually active unmarried adolescents—will persist across the coming decades. These strategies should include scaling up comprehensive sex education, support for girls to continue their education, and provision of reproductive health services that specifically includes meeting the demand for modern contraception in sexually active unmarried adolescents and young women. Greater investment in education in those areas where school retention rates are lowest is also needed to reduce current inequalities around adolescent marriage and fertility.

(younger than 18 years) and fertility rates for 15–19-year-olds have declined with socioeconomic progress, but with major geographical variation.[4]

China has seen unprecedented demographic change during the past few decades, which has implications for marriage and reproductive norms in its young population. These changes are starkly reflected in the reduced size of the adolescent cohort. In 2015, the number of Chinese individuals aged 15–24 years was 186 million, a 27% decrease from 1990 (256 million).[5] Chinese preference for sons and the once rigorous one-child policy, introduced in 1980, has also resulted in a disproportionate number of boys and men aged 15–24 years, with a sex ratio at birth of 1·12–1·17 males per 1·00 female in the 1990s.[6] Internal labour migration is a further feature of this period. From the 1980s, driven by changes in economic and market policies and rapid economic development, a large number of rural residents flowed into larger cities to engage in non-agricultural work, resulting in a new cohort of young rural-urban migrant workers and of rural left-behind children and adolescents whose parents have migrated to cities for

employment. China's marked economic growth has also brought better access to education for children and adolescents; today's young cohort is more educated than their peers from even a few decades ago.[7] However, large educational inequality still exists with respect to sex, urban-rural location, and geography.[7]

China introduced a minimum age of marriage law in 1980, being 20 years for women and 22 years for men. In the past several decades, Chinese women have typically postponed the timing of marriage and have also had fewer children.[8–11] The median age at first marriage in Chinese women increased from 22·0 years in the 1960–69 birth cohort to 24·7 years in the 1980–89 birth cohort.[8] Yang and colleagues reported that the rate of early marriage (assessed by the yearly proportion of people marrying before the legal age) of Chinese women decreased between 1990 and 2010 from 23·5% to 10·9%.[9]

In the early-1990s, the total fertility rate declined to a level far less than replacement and has continued to decline, resulting in a fertility rate of 1·5 (95% CI 1·4–1·6) per 1000 women in 2017.[10,11] Zhao and colleagues reported declines in the fertility rate of Chinese urban adolescents

aged 15–19 and 20–24 years from the 1950s up until 2013.[12] However, the determinants of early marriage and childbearing are continuing to change. In addition to demographic and socioeconomic transitions, Chinese children now enter puberty earlier and unmarried adolescents have engaged in more sexual activity over the past three decades.[13–15] However, to our knowledge, no study has yet systematically analysed the patterns, trends, and subnational disparities in adolescent marriage and fertility across China. Given the rapid demographic changes in the past three decades, it is important that policy makers understand the health, education, and reproductive service needs of adolescent girls. That several sociological studies have revealed a high prevalence of early marriage in some rural areas and among rural-to-urban migrant workers makes a systematic report on this issue even more urgent.[16,17]

In this study, using nationally representative data from the Chinese National Population Census and the Chinese 1% National Population Sample Survey from 1990 to 2015, we aimed to describe the long-term trends of marriage and fertility for girls and women aged 15–24 years in China. We analysed disparities with respect to urban-rural location, education level, and geographical locations, and additionally aimed to explore the socioeconomic factors associated with changes in adolescent marriage and fertility. We hypothesised that the declines in adolescent marriage and fertility over the past three decades will have occurred less in rural areas, western provinces, and in adolescents with lower levels of education.

Methods

Study design and participants

Data were extracted from the Chinese National Population Census in 1990, 2000, and 2010, and the Chinese 1% National Population Sample Survey in 1995, 2005, and 2015 (the most recent survey) in China (appendix 2 p 2).[18–23] Survey forms were completed and verified by trained enumerators at the household residence based on responses provided by the resident or others in the household who were familiar with the family. The survey was answered by one adult per household, providing information on all members. The long form of the survey included information on basic characteristics (eg, age, sex, ethnic group), education level, marriage status (unmarried, married, divorced, or widowed), whether a child had been born during the past year (date of birth and sex of the child), and occupation, among others. The censuses included all individuals of Chinese nationality who resided in China when the survey was done. In the 1990 census, all individuals completed the long form. In the census of 2000 and 2010, a 10% sample of randomly selected houses completed the same long form. The post-enumeration survey estimated that the under-reporting rates for the three censuses were 0·07% in 1990, 1·81% in 2000, and 0·12% in 2010.[18–20] For the 1% sample surveys, communities or villages were randomly selected using a

probability-proportion-to-size method; all residents of Chinese nationality were included in the survey and also completed the long form of the survey. The under-reporting rate for the sample surveys was 1·72% in 2005 and 0·54% in 2015, while no rate was reported in 1995.[21–23] The sample surveys finally included 1·03% of the whole population in 1995, 1·33% in 2005, and 1·55% in 2015.[21–23] As we used published aggregated data for analysis, no ethical approval was required and no consent was necessary.

Procedures

We used secondary data for analysis. The data for marriage, childbirth, and education in our analyses were obtained from the aggregated tabulations published by the National Bureau of Statistics of China, based on these population censuses and sample surveys, including national or provincial tabulation on the 1990/2000/2010 Population Census of the People's Republic of China, and tabulation on the 1995/2005/2015 Population Sample Survey of the People's Republic of China.[18–23] The population of people living in ethnic minority autonomous areas in a province was obtained from *China's Ethnic Statistical Yearbooks*, also based on the censuses and sample surveys.[24] We obtained the nominal gross domestic product (GDP) per capita for provinces from 1990 to 2015 from the *Chinese Statistical Yearbook*.[25] Chongqing has been considered as a munici-pality since 1997. The data for marital and childbirth status were missing for Tibet in 2015. The data for education for Shanxi, Jilin, Anhui, Shandong, and Tibet were missing in 2015. The sample size for each age group (15–19 or 20–24 years) in our analyses on marriage and fertility ranged from 442 898 to 767 236 girls and women for the population sample survey. For the population census in 2000 and 2010, the sample size ranged from 4 135 677 to 5 832 745 girls and women for each age group.

Data for the total fertility rate from 1950 to 2017 in China came from the Global Burden of Diseases, Injuries, and Risk Factors Study 2017.[10] The sex ratio at birth was extracted from estimates by Chao and colleagues.[6] The number of 15–24-year-olds by sex from 1950 to 2020 was extracted from the 2019 World Population Prospects released by the UN.[5] The proportion of girls and women aged 15–24 years living in urban areas and having ever attended senior high school was obtained from the Chinese National Population Census and the Chinese 1% National Population Sample Survey.[18–23] Rural left-behind children refers to rurally based 0–17-year-olds residing in the family household with at least one parent working outside their hometown.[26] The number of rural left-behind children was extracted from research by Duan and colleagues and calculated on the basis of the Chinese National Population Census and the Chinese 1% National Population Sample Survey.[26] Migrant workers refers to people aged 16 years or older who had rural household registration and had left their hometown to engage in non-agricultural work. Data for migrant workers were
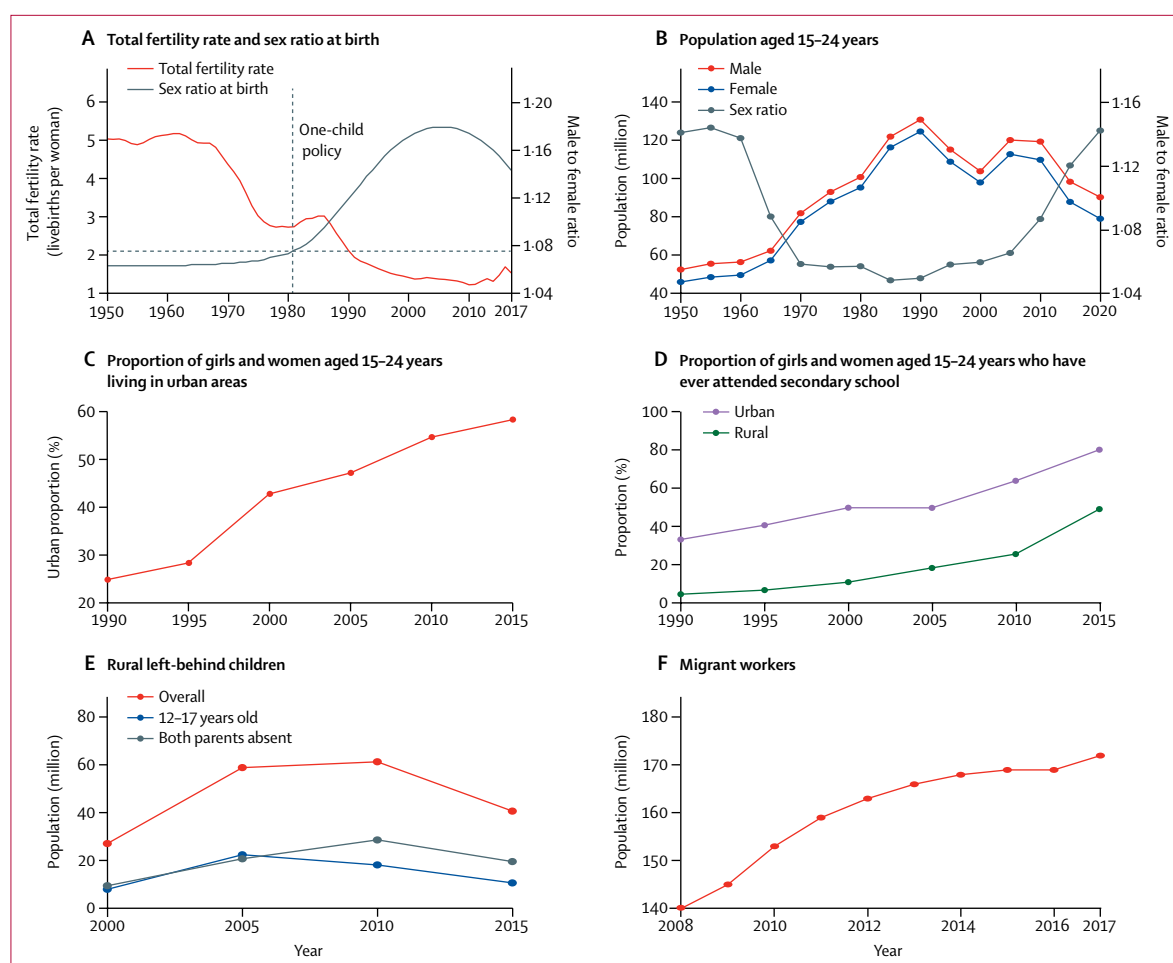
Figure 1: Demographic changes in China
The number of 15-24-year-olds by sex from 1950–2020 was estimated and projected by the UN. The horizontal dashed line shows replacement level (2·1 livebirths per woman) total fertility rate.

obtained from the National Report on Migrant Worker Monitoring and Survey.[27]

Statistical analysis

The ever-married rate and fertility rates for girls and women were calculated by age group (15–19 and 20–24 years). The ever-married rate (%) was defined as: 1–the number never married divided by the total number for the age group multiplied by 100%. We directly extracted the age-specific fertility rate (ASFR, births per 1000 girls and women in the past year) from the published fertility tabulation, which was defined as the number of births in the past year divided by the total number for the age group multiplied by 1000. We displayed the ever-married rate and ASFR by urban-rural location (communities or villages located in urban or rural areas), education level (grouping of education level is in the appendix 2 p 1), and province. The ever-married rates by urban-rural location in 2000 were unavailable. We used ArcMap 10.3 to display the subnational patterns of

adolescent marriage and fertility rate and their change across time. We reported the 95% CIs for the ever-married rate and the fertility rate, by age group, educational level, and location (national, urban, and rural areas, and 31 provinces) in 1995, 2000, 2005, 2010, and 2015. In 1990, all the residents of the corresponding age in China were included for analyses, so no 95% CIs were reported. The 95% CIs were calculated using the normal approximation method to the binomial distribution.

We used scatter plots and Spearman's rank correlation coefficient to assess the association of provincial GDP per capita (in 2015 US$) or educational level (presented as the proportion of people with an education level of senior high school or beyond in girls and women aged 15–19 or 20–24 years) with female ever-married rate or ASFR. We adjusted the nominal GDP for consumer price index to get the real GDP in a constant price referenced to 2015. To make our analyses internationally comparable, we transformed the currency unit into US$ according to the mean exchange rate for 2015 (¥1·00 to $0·16) to get

provincial GDP per capita in 2015 US$. We built multivariate random-effects generalised least squares regression models on panel data to test whether adolescent marriage or fertility rate was associated with education level, sex ratio, and the proportion of the population who were from an ethnic minority in a province. In those models, the group variable was province and the time variable was year. The SE was adjusted for the clustering on province. The dependent variables were provincial ever-married rate or ASFR. The three independent variables were defined as follows: percentage of individuals who attended senior secondary school, which was the proportion of people with an education level of senior secondary school or beyond in girls and women aged 15–19 or 20–24 years; sex ratio (males per female), which was the population of males to the population of females in the age group of 15–19 or 20–24 years; percentage of individuals who were part of an ethnic minority, which was the proportion of people living in ethnic minority autonomous areas in a province (the ethnic minority autonomous area refers to administrative areas where one or more ethnic minorities live and execute regional autonomy according to law; 11 of 31 provinces have no ethnic minority autonomous areas and were assigned 0 for this variable across all years). The linear models included provincial data for 1990, 2000, 2010, and 2015. Shanxi, Jilin, Anhui, Shandong, and Tibet were excluded from the models for 2015 because of missing data for education. Our statistical significance cutoff threshold was 0·05. We used Stata version 14.0 for the models.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. DL and YS had full access to all the data in the study. YS and JM had final responsibility for the decision to submit for publication.

Results

Figure 1 shows the demographic changes over the past several decades. The total fertility rate in China dropped below replacement level (2·1 livebirths per woman) at the beginning of the 1990s and continued to decline to reach 1·3 per woman in 2014. The number of young people aged 15–24 years was 186 million in 2015, a 27% decrease from 1990 (256 million). The male to female sex ratio for this age group consistently grew between 1990 and 2015, most noticeably from 2005. In 1990, 25·0% of girls and women aged 15–24 years lived in urban areas, a proportion that more than doubled by 2015 (58·4%). In 1990, 4·5% of girls and women aged 15–24 years in rural areas and 33·2% of those in urban areas had ever attended senior high school. This proportion increased greatly over time, notwithstanding a persisting large urban-rural gap (urban 80·4% vs rural 49·2% in 2015). The population of rural left-behind children decreased from a peak of 61·0 million
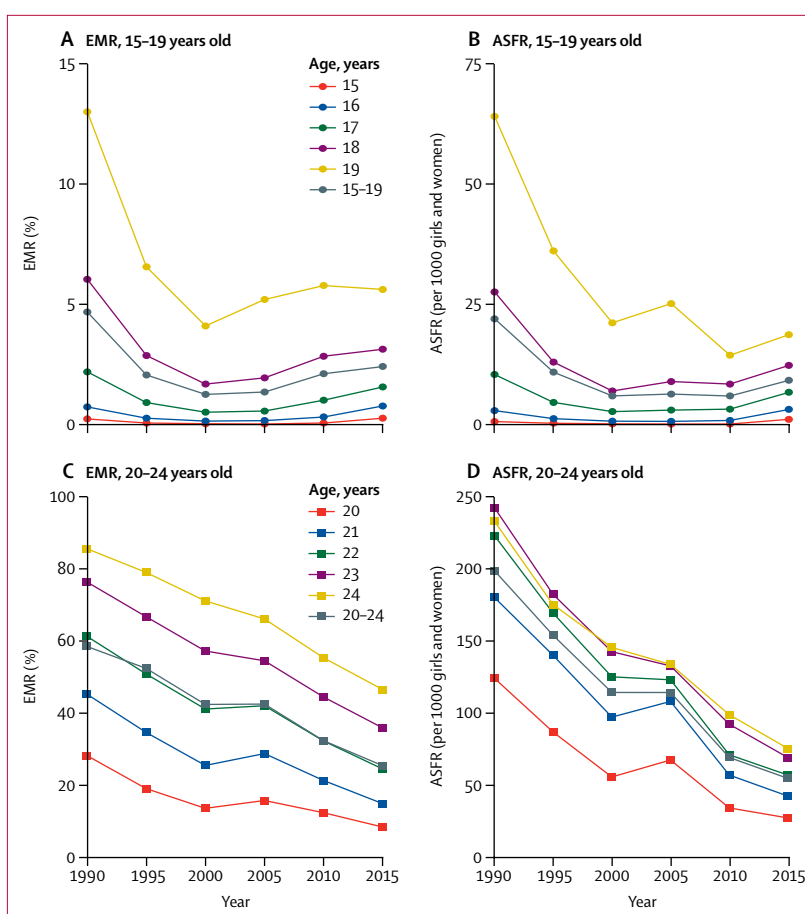

Figure 2: National trends for ever-married rate and ASFR for Chinese girls and women aged 15–24 years, 1990–2015
EMR=ever-married rate. ASFR=age-specific fertility rate.

in 2010 to 40·5 million in 2015, around half (48·1%) of whom had both parents living away from home in 2015. The number of migrant workers from outside a given hometown gradually increased from 140 million in 2008 to 172 million in 2017.

National trends for ever-married rate are shown in figure 2 and appendix 2 (p 7). In 15–19-year-olds, the ever-married rate decreased from 4·7% in 1990 to 1·2% (95% CI 1·2–1·3) in 2000, and rebounded to 2·4% (2·4–2·5) in 2015. In 20–24-year-olds, the ever-married rate declined from 58·6% in 1990 to 25·5% (95% CI 25·4–25·6) in 2015. The total fertility rate generally declined between 1990 and 2015, with different trends in different age groups (figure 2, appendix 2 p 3, 8). Among girls and women aged 15–19 years, the ASFR decreased from 22·0 births per 1000 in 1990 to 6·0 (95% CI 5·9–6·0) per 1000 in 2000, but then increased to 9·2 (95% CI 8·9–9·4) per 1000 in 2015 (a 58% decrease since 1990). Among women aged 20–24 years, the ASFR decreased from 198·8 births per 1000 in 1990 to 114·5 (95% CI 114·2–114·8) per 1000 in 2000, and further declined to 55·0 (95% CI 54·5–55·5) per 1000 in 2015, a 72% decrease since 1990.
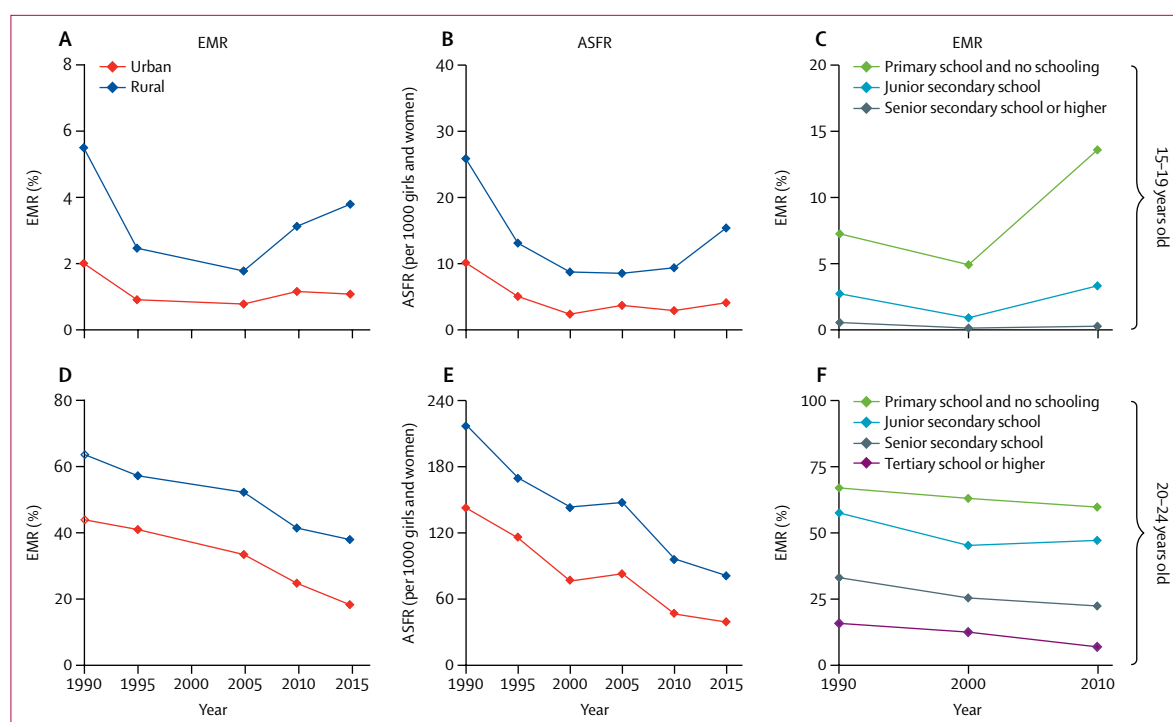
Figure 3: **Ever-married rate and ASFR by urban-rural location and by education level, 1990–2015**
Data were not available for ever-married rate by urban-rural location in 2000 and by education level in 1995, 2005, and 2015. EMR=ever-married rate. ASFR=age-specific fertility rate.

Urban-rural differences in ever-married rates and ASFRs are shown in figure 3. In 2015, the ever-married rate for girls and women aged 15–19 years in rural areas was 3·8% (95% CI 3·7–3·9), compared with 1·1% (1·1–1·1) in urban areas (figure 3, appendix 2 p 9). Between 1990 and 2015, the urban-rural disparity in adolescent marriage increased, with ever-married rates decreasing less in rural areas (31% for 15–19-year-olds) compared with urban areas (46%). After declining between 1990 and 2000, the ever-married rates increased between 2005 and 2015 in 15–19-year-olds, especially in rural areas. In 2000, on average, 8·7 (95% CI 8·6–8·9) and 2·3 (2·3–2·4) of 1000 girls and women aged 15–19 years gave birth in rural and urban areas, a decrease of 66% in rural and 77% in urban areas, since 1990. (figure 3, appendix 2 p 10) However, the ASFRs among 15–19-year-olds increased between 2000 and 2015, resulting in 15·4 (95% CI 14·9–15·9) births in rural areas and 4·1 (3·9–4·3) in urban areas per 1000 girls and women in 2015.

Girls and women with lower levels of education had higher ever-married rates (figure 3, appendix 2 p 11) than those who received more education. Disparities in ever-married rate by education level generally increased between 1990 and 2010. In 2010, for 15–19-year-olds, 0·3% (95% CI 0·3–0·3) of those who had at least attended senior secondary school and 3·3% (3·3–3·3) of those with junior secondary schooling were ever-married, in comparison to 13·6% (13·5–13·8) in those with only primary schooling or

no schooling. The ever-married rates were larger in 2010 than in 1990 for 15–19-year-olds with junior secondary schooling or lower levels of education. The ever-married rates for women aged 20–24 years generally decreased over time. The exception was an increase in the ever-married rate by 4% between 2000 and 2010 in women with junior secondary schooling.

Adolescent girls aged 15–19 years were more likely to marry or give birth in western provinces, such as Xinjiang, Qinghai, Yunnan, Ningxia, Guizhou, and Tibet, compared with other provinces (figure 4, appendix 2 pp 4–5). In Xinjiang, 7·8% (95% CI 7·6–7·9) of 15–19-year-old girls and women had ever married in 2010, the highest among all provinces (figure 4, appendix 2 p 12), and in Yunnan, on average, 21·3 (95% CI 20·6–22·0) children were born per 1000 girls and women, the highest among all provinces (figure 4, appendix 2 p 13). Between 1990 and 2000, the ever-married rate declined in all provinces, with 11 provinces decreasing by more than 80% (figure 4). All provinces except Guizhou also had a decrease in ASFR across the same period, with a decrease of more than 80% in 12 provinces. Most provinces (25 of 31) had an increase in ever-married rate and half of the provinces (15 of 31) had an increase in ASFR between 2000 and 2010. Between 2010 and 2015, in 15–19-year-olds, 17 of the 30 provinces (data were not available for Tibet) had an increase in ever-married rate (appendix 2 p 4) and 26 had an increase in ASFR (appendix 2 p 5). In 2015, seven of 30 provinces

(Guangxi, Hainan, Guizhou, Yunnan, Qinghai, Ningxia, and Xinjiang) had an ASFR of more than 20 births per 1000 girls and women aged 15–19 years (appendix 2 p 5).

For women aged 20–24 years, overall the ever-married rate and ASFR declined over time (appendix 2 pp 4–5, 14–15).

Figure 5 and the table show the associations between ever-married rate or ASFR and education level, sex ratio, and ethnic minority density (proportion of people from an ethnic minority in the population). Provincial-level ever-married rate and ASFR for 15–19-year-olds were negatively associated with GDP per capita and the proportion of people with at least senior high school education (p<0·0001; figure 5). The same was true for 20–24-year-olds (appendix 2 p 6). The multivariate regression (table) shows that education is a protective factor for early marriage and fertility in 15–19-year-olds (both p<0·0001) and 20–24-year-olds (both p<0·0001). The population ratio of boys to girls was positively associated with the ever-married rate (p=0·0005) and ASFR (p=0·0001) in 15–19 year-olds. Provinces with a larger proportion of ethnic minorities in the population also had higher ever-married rate (p=0·010) and ASFR (p=0·0047) in girls and women aged 15–19 years.

Discussion

These nationally representative data from China show large reductions over the past three decades in livebirths to young women. Compared with 2015, in 1990, rates were 1·4 times higher in 15–19-year-olds (22·0 per 1000 vs 9·2 per 1000) and 2·6 times higher in 20–24-year-olds (198·8 per 1000 vs 55·0 per 1000 women). We found consistent declines in both marriage and fertility in women aged 20–24 years but a rebound in the ever-married rate and ASFR for 15–19-year-old girls and women from 2000. The increases in the ever-married rate between 2000 and 2010 in 15–19-year-olds who did not attend senior high school were particularly large, with increasing inequality by education level. We additionally found large urban–rural disparities and major subnational differences in adolescent marriage and fertility.

Compared with high-income countries (16·2 livebirths per 1000)[10] and non-communicable disease predominant countries (14·1 livebirths per 1000),[4] China's ASFR in 2015 was relatively low in 15–19-year-olds. Given a continuous decline in the total fertility rate, the increase in marriage and fertility rate in this age group since 2000 was unexpected. One possible explanation is the so-called marriage market (ie, mate-selection in people of a demographic likely to be planning to or getting married), with an excess of males due to traditional preferences for boys, heightened by the one-child policy from 1981 to 2015. The male to female ratio at birth started to rise in 1981 (1·07), reaching the highest level in 2005 (1·18).[6] In 2000, the cohort born with an inflated male sex ratio began entering the marriage market (approximately at
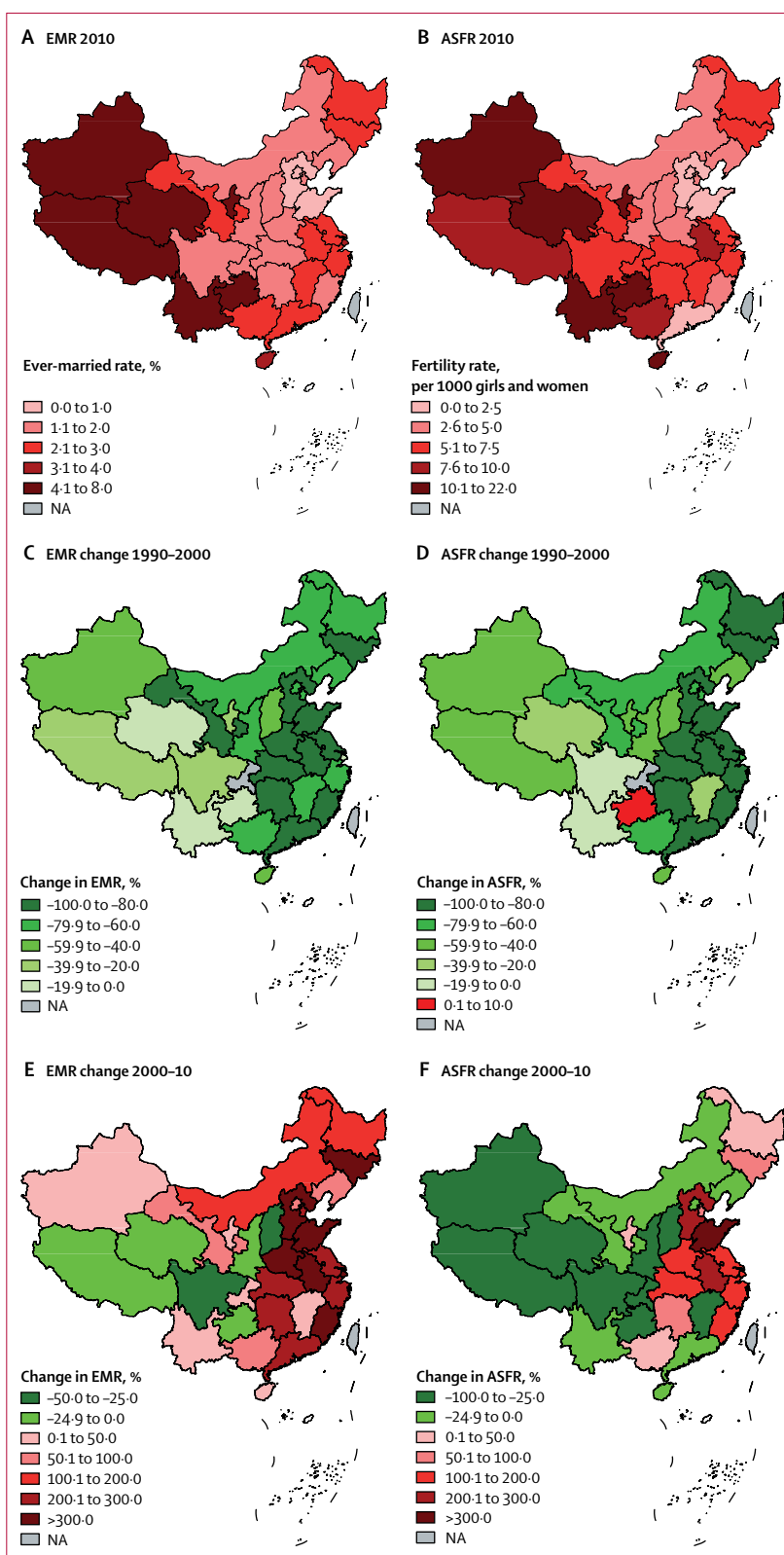

Figure 4: The ever-married rate and ASFR in 31 regions for girls and women aged 15–19 years
EMR=ever-married rate. ASFR=age-specific fertility rate.

the age of 20 years); in 2015, the male to female ratio reached 1·11 for those aged 20–24 years.[5] In the context of a surplus of men, young individuals might develop alternative strategies to find a spouse, such as paying a higher bride price, turning to younger girls and women, or even buying trafficked brides from countries such as Vietnam.[11,28,29]

With a biased sex ratio in the marriage market, rural girls are at higher risk of early marriage and fertility compared with their urban counterparts because of their lower education level and the persistence of traditional gender norms in poor rural areas.[9,16] Educational attainment has substantially improved over the past few decades in China, but the urban-rural education gap has hardly decreased. As shown in our study, there was a consistent urban–rural difference (29–39%) in the proportion of girls and women aged 15–24 years who had attended senior high school. Girls in rural areas face inequality compared with boys in enrolling in senior high school and beyond.[30] Cultural attitudes mean that rural girls who drop out of school are more likely to get married and have children earlier than their school-attending peers.[31] Pregnancy is also a reason to leave school early.[32] A local study in rural Yunnan has documented a high prevalence of early marriage, and argued that the potentially dominant position of girls and women in the marriage market resulted from this biased sex ratio has not been realised in poor rural areas because of persisting gender inequality and the lower education level of girls.[16] Guilmoto predicted that the sex imbalance will severely affect the marriage market in China, at least until the second half of the 21st century, when the risk of early marriage and childbearing, especially for rural girls, are likely to persist without additional protections.[33]

A further explanation for the rebound in adolescent marriage and fertility in China is that unmarried adolescents are becoming more sexually active without using reliable contraception.[34] Over the past 20 years, sexual activity outside marriage and high-risk sexual behaviours have increased among Chinese adolescents, contributing to more unwanted pregnancies.[14,15] A review showed that the number of unmarried young people having sexual intercourse in China has increased significantly since the mid-1990s, with more than 10% of unmarried 10–24-year-olds becoming sexually active over the past two decades.[14] From 2000–09, there was also an upward trend in the number of individuals having unwanted pregnancies in those who were sexually active, which increased from 10·8% to 28·4%.[14] The first
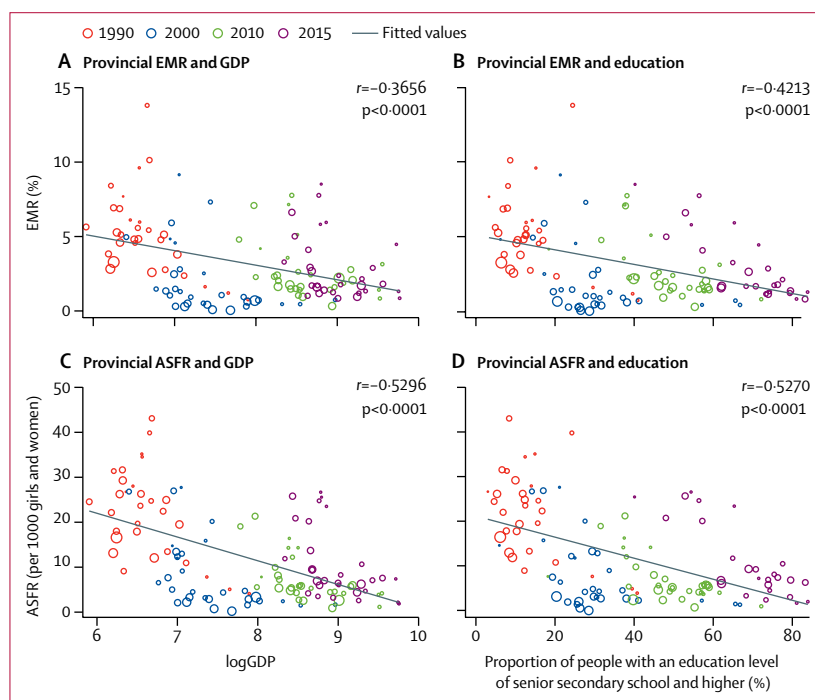

Figure 5: The associations of provincial economic growth and education level with marriage and fertility rate for girls and women aged 15–19 years
The bubble size is weighted by the provincial population size of girls and women aged 15–19 years in each year. The EMR, ASFR, and proportion of people with an education level of senior secondary school and higher are all in 15–19-year-olds. logGDP is the natural logarithm of GDP per capita (US$). EMR=ever-married rate. ASFR=age-specific fertility rate.

	EMR (%)			ASFR (per 1000)		
	β coefficient (95% CI)	SE	p value	β coefficient (95% CI)	SE	p value
Girls and women aged 15–19 years						
Proportion attending senior secondary school	–0·04 (–0·05 to –0·03)	0·01	<0·0001	–0·23 (–0·28 to –0·18)	0·03	<0·0001
Sex ratio (males per female)	4·50 (1·96 to 7·05)	1·30	0·0005	24·55 (12·60 to 36·49)	6·09	0·0001
Proportion of population from an ethnic minority*	0·03 (0·01 to 0·05)	0·01	0·010	0·08 (0·03 to 0·14)	0·03	0·0047
Women aged 20–24 years						
Proportion attending senior secondary school	–0·63 (–0·68 to –0·57)	0·03	<0·0001	–2·51 (–2·72 to –2·30)	0·11	<0·0001
Sex ratio (males per female)	17·21 (–1·88 to 36·29)	9·74	0·077	69·37 (5·35 to 133·39)	32·66	0·034
Proportion of population from an ethnic minority*	0·02 (–0·07 to 0·11)	0·05	0·68	–0·01 (–0·28 to 0·26)	0·14	0·96

Data are % (95% CI) unless specified. Data are the results of the multivariate random-effects generalised least squares regression models on panel data (n=118), including provincial data from 1990, 2000, 2010, and 2015 (Shanxi, Jilin, Anhui, Shandong, and Tibet in 2015 are excluded). In those models, dependent variables are provincial EMR or ASFR. EMR=ever-married rate. ASFR=age-specific fertility rate. *The age range does not apply to ethnic minority as the proportion of the population from an ethnic minority was calculated in people at all ages.

Table: Provincial associations between education level, sex ratio, ethnic minority density and EMR and ASFR

nationwide survey of adolescent sexual and reproductive health in China was done in 2009. This survey showed that among unmarried young people aged 15–24 years who had experience of sexual intercourse, 21·4% did not use any contraception during the most recent episode of intercourse.[15] A local study involving cases of premarital pregnancies (n=2012) showed that most resulted in abortion (83·9%).[35] A study in the USA suggested that promoting access to contraception has been the key intervention in declines in adolescent pregnancy and birth rates from 2007 to 2012.[36] Yet in China, sexual and reproductive health has historically been overlooked in adolescents. In addition to an absence of comprehensive sexuality education in schools, health-care providers commonly fail to provide unmarried adolescents with supportive, non-judgmental services.[15] The 2009 nation-wide survey on adolescent sexual and reproductive health revealed that most unmarried adolescents aged 15–24 years sought sexual and reproductive knowledge from books or from the internet, and more than 50% of their counselling and treatment needs related to sexual and reproductive health were unmet.[15] Although China's modern contraceptive use among married women was the highest in the world from 1980 to 2010 (89% in 2010), reliable contraceptive needs among sexually active unmarried women remain largely unmet.[34,37]

China's large number of internal migrant workers might be another explanation for the rebound in adolescent marriage and fertility. Studies in Guangzhou and Shanghai revealed that unmarried young migrants generally chose to cohabit, with risk of unprotected sex and unintended pregnancy due to a scarcity of health information and poor accessibility to sexual and reproductive health services.[38,39] A study of nationally representative data from the Migrant Worker Monitoring Survey in 2014 reported that the early marriage (cohabitation as husband and wife without marital registration before the legal age) rate for female migrant workers was 14·7%.[17] In the absence of parents, unmet emotional needs and absence of supervision might also affect the sexual behaviour of left-behind adolescents, an area warranting further research.[40] The presumptive factors outlined above (sex ratio, sexual behaviour, and internal migrant workers) might also affect marriage and fertility for women aged 20–24 years. However, the influence might not be strong enough to reverse the declining trend that is being driven by continued engagement in education, as the baseline ever-married rate and ASFR for this age group was much higher than those for 15–19-year-olds.

In China, minority autonomous regions are allowed, at least to some extent, to formulate their own marriage laws and family planning policies in the context of local customs. Generally, ethnic minorities have been allowed to give birth to two children and marry 2 years earlier (18 years for women and 20 years for men) compared with their Han counterparts. In this study, regions with a high percentage of ethnic minorities in the population (including Ningxia, Tibet, Xinjiang, Guangxi, Qinghai, Yunnan, and Guizhou) also have high ever-married rates and ASFRs, with differences in culture and norms influencing attitudes towards early marriage, abortion, and childbearing.[41]

The protective effect of education on marriage and childbearing in 15–19-year-olds is obvious in our study, and previously shown.[31] Although a policy of 9 years of compulsory education in China has led to nearly 100% completion of lower secondary education, the proportion of boys and girls with 12 years of education is still low. For women aged 20–24 years in China, the rate of completion of secondary education in 2010 was 44·9%, much lower than in Japan (90·8%) or South Korea (99·2%).[4] Although gender and regional gaps in education have substantially lessened in the past two decades in China due to policies promoting education, educational engagement in economically disadvantaged areas is still concerning, particularly for poor, rurally based girls and women.[7] Greater investment from the Chinese Government might be needed to facilitate greater participation in schooling for disadvantaged girls.

The Sustainable Development Goals call for universal access to sexual and reproductive health services.[42] High participation rates in junior secondary education in China would provide a platform to deliver comprehensive sexuality education in schools.[43] Delivery of reliable contraception is also required, including to unmarried adolescents, which would require an effective primary health-care system and investment in educating providers around providing more adolescent-friendly health services.

To our knowledge, this is the first study to systematically describe the long-term trends and subnational disparities of adolescent marriage and fertility in China. There are some limitations to note. Data are lacking on girls aged 10–14 years, although we might assume that marriage and fertility are minimal in this age group given that the rates for 15–year-olds are very low. A further limitation is that ever-married rates and ASFRs are highly likely to be underestimated, especially for 15–19-year-olds due to under-reporting of early marriage and unplanned births.[41] The high abortion rate in unmarried young women in China suggests that the actual pregnancy rate will be far higher than what is indicated by the fertility rate.[15,35] Relying on provincial measures in the association analyses could raise a possibility of an ecological fallacy. We assume that it would not be a problem for the analysis on education, as our data already showed that people with a lower education level had higher ever-married rates or ASFRs. Lastly, we cannot provide stronger examinations on the effects of internal migrant workers and the absence of contraception because of data limitations. China announced the universal two-child policy in October, 2015.[44] However, according to a recent nationwide study from 2019, the number of nulliparous

births (the typical age of nulliparous mothers ranges from 20–29 years) has continued to drop in 2016 and 2017.[44] Although it might be assumed that young Chinese women will further delay the timing of marriage and childbirth as their education levels improve with further socioeconomic development, China's unbalanced sex ratio is anticipated to persist for at least several decades and increasing sexual activity in unmarried adolescents can be similarly anticipated.

It appears that economic growth will not of itself address the challenge of early marriage and fertility if its benefits are not equally enjoyed by the most disadvantaged girls and without additional efforts to provide sexual and reproductive services for sexually active adolescents. Further investments in secondary education are required, especially to keep economically disadvantaged girls at school. Additional actions are also needed from China's education and health sectors to improve the access, use, and quality of sexual and reproductive education and health services for unmarried adolescents.

References
1 Patton GC, Sawyer SM, Santelli JS, et al. Our future: a *Lancet* commission on adolescent health and wellbeing. *Lancet* 2016; **387**: 2423–78.
2 Marphatia AA, Ambale GS, Reid AM. Women's marriage age matters for public health: A review of the broader health and social implications in South Asia. *Front Public Health* 2017; **5**: 269.
3 Grønvik T, Fossgard Sandøy I. Complications associated with adolescent childbearing in Sub-Saharan Africa: a systematic literature review and meta-analysis. *PLoS One* 2018; **13**: e0204327.
4 Azzopardi PS, Hearps SJC, Francis KL, et al. Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990–2016. *Lancet* 2019; **393**: 1101–18.
5 UN, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2019 Revision. 2019. https://population.un.org/wpp/Download/Standard/Population/ (accessed Nov 14, 2019).
6 Chao F, Gerland P, Cook AR, Alkema L. Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. *Proc Natl Acad Sci USA* 2019; **116**: 9303–11.
7 Yang J, Huang X, Liu X. An analysis of education inequality in China. *Int J Educ Dev* 2014; **37**: 2–10.
8 Yu J, Xie Y. The second demographic transition in China. *Popul Res* 2019; **43**: 3–16 (in Chinese).
9 Yang J, Liang HY. Analysis of early marriage: 1980–2010. *South China Popul* 2016; **31**: 57–68 (in Chinese).
10 Murray CJL, Callender CSKH, Kulikoff XR, et al. Population and fertility by age and sex for 195 countries and territories, 1950–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; **392**: 1995–2051.
11 Jiang Q, Feldman MW, Li S. Marriage squeeze, never-married proportion, and mean age at first marriage in China. *Popul Res Policy Rev* 2014; **33**: 189–204.
12 Zhao Z, Xu Q, Yuan X. Far below replacement fertility in urban China. *J Biosoc Sci* 2017; **49**: S4–19.
13 Song Y, Ma J, Wang HJ, et al. Trends of age at menarche and association with body mass index in Chinese school-aged girls, 1985–2010. *J Pediatr* 2014; **165**: 1172–1177.
14 Yu XM, Guo SJ, Sun YY. Sexual behaviours and associated risks in Chinese young people: a meta-analysis. *Sex Health* 2013; **10**: 424–33.
15 Zheng XY, Chen G, Han YL, et al. Survey of youth access to reproductive health in China. *Popul Dev* 2010; **16**: 2–16 (in Chinese).
16 Jiang T, Liu JL, Fu J. An investigation on early marriage of rural population in the Yao Township of Mengtong in Yunan Malipo County . *J Wenshan Teach Coll* 2009; **22**: 23–26 (in Chinese).
17 Liu CB, Tong FY. Accompanying, love and family: study on the early marriage of the internal migrant youth. *China Youth Study* 2016; **6**: 54–60 (in Chinese).
18 Population Census Office under the State Council, Department of Population Statistics, National Bureau of Statistics. Tabulation on the 1990 Population Census of the People's Republic of China. Beijing: China Statistics Press, 1993 (in Chinese).
19 Population Census Office under the State Council, Department of Population and Social Science and Technology Statistics, National Bureau of Statistics. Tabulation on the 2000 Population Census of the People's Republic of China. Beijing: China Statistics Press, 2002 (in Chinese).
20 Population Census Office under the State Council, Department of Population and Employment Statistics, National Bureau of Statistics. Tabulation on the 2010 Population Census of the People's Republic of China. Beijing: China Statistics Press, 2012 (in Chinese).
21 National Population Sample Survey Office. Tabulation on the 1995 Population Sample Survey of the People's Republic of China. Beijing: China Statistics Press, 1996 (in Chinese).
22 Leading Group Office of the National 1% Population Sample Survey under the State Council, Department of Population and Employment Statistics, National Bureau of Statistics. Tabulation on the 2005 Population Sample Survey of the People's Republic of China. Beijing: China Statistics Press, 2007 (in Chinese).
23 Department of Population and Employment Statistics, National Bureau of Statistics. Tabulation on the 2015 Population Sample Survey of the People's Republic of China. Beijing: China Statistics Press, 2016 (in Chinese).
24 Department of Economic Development of the State Commission on Ethnic Affairs, Department of Comprehensive Statistics of the National Economy, National Bureau of Statistics. China's Ethnic Statistical Yearbook. Beijing: China Statistics Press, 2016 (in Chinese).
25 National Bureau of Statistics of the People's Republic of China. Statistical Yearbook of China. http://www.stats.gov.cn/tjsj/ndsj/ (accessed Sept 2, 2019; in Chinese).
26 Duan CR, Lai MH, Qin M. Trends of left-behind children in rural China since the 21st century. *China Youth Study* 2017; **6**: 52–60.
27 National Bureau of Statistics of the People's Republic of China. National Report on Migrant Worker Monitoring and Survey. http://www.stats.gov.cn/tjsj/zxfb/201904/t20190429_1662268.html (accessed Nov 1, 2019; in Chinese).
28 Jiang Q, Sánchez-Barricarte JJ. Bride price in China: the obstacle to 'bare branches' seeking marriage. *Hist Fam* 2012; **17**: 2–15.

29 Stöckl H, Kiss L, Koehler J, Dong DT, Zimmerman C. Trafficking of Vietnamese women and girls for marriage in China. *Glob Health Res Policy* 2017; **2:** 28.

30 Zeng J, Pang X, Zhang L, Medina A, Rozelle S. Gender inequality in education in china: a meta-regression analysis. *Contemp Econ Policy* 2014; **32:** 474–91.

31 Marphatia AA, Saville NM, Amable GS, et al. How much education is needed to delay women's age at marriage and first pregnancy? *Front Public Health* 2020; **7:** 396.

32 Stoner MCD, Rucinski KB, Edwards JK, et al. The relationship between school dropout and pregnancy among adolescent girls and young women in South Africa: A HPTN 068 analysis. *Health Educ Behav* 2019; **46:** 559–68.

33 Guilmoto CZ. Skewed sex ratios at birth and future marriage squeeze in China and India, 2005–2100. *Demography* 2012; **49:** 77–100.

34 Li J, Temmerman M, Chen Q, Xu J, Hu L, Zhang WH. A review of contraceptive practices among married and unmarried women in China from 1982 to 2010. *Eur J Contracept Reprod Health Care* 2013; **18:** 148–58.

35 Wu YH, Chen JG. Analysis on the outcomes of 2012 cases of pre-marital pregnancies (in Chinese). *Shenzhen J Integr Tradit Chin West Med* 2014; **24:** 59–60.

36 Lindberg L, Santelli J, Desai S. Understanding the decline in adolescent fertility in the United States, 2007–2012. *J Adolesc Health* 2016; **59:** 577–83.

37 Wang C. Trends in contraceptive use and determinants of choice in China: 1980–2010. *Contraception* 2012; **85:** 570–79.

38 Yu C, Lou C, Cheng Y, et al. Young internal migrants' major health issues and health seeking barriers in Shanghai, China: a qualitative study. *BMC Public Health* 2019; **19:** 336.

39 Zong Z, Yang W, Sun X, Mao J, Shu X, Hearst N. Migration experiences and reported sexual behavior among young, unmarried female migrants in Changzhou, China. *Glob Health Sci Pract* 2017; **5:** 516–24.

40 Fellmeth G, Rose-Clarke K, Zhao C, et al. Health impacts of parental migration on left-behind children and adolescents: a systematic review and meta-analysis. *Lancet* 2018; **392:** 2567–82.

41 Wang D, Chi G. Different places, different stories: a study of spatial heterogeneity of county-level fertility in China. *Demogr Res* 2017; **37:** 493–526.

42 UN. Sustainable Development Goals. 2015. https://www.un.org/sustainabledevelopment/ (accessed April 9, 2019).

43 UNESCO. International technical guidance on sexuality education (revised edition). 2018. https://unesdoc.unesco.org/ark:/48223/pf0000260770 (accessed Nov 11, 2019).

44 Li HT, Xue M, Hellerstein S, et al. Association of China's universal two child policy with changes in births and birth related health factors: national, descriptive comparative study. *BMJ* 2019; **366:** l4680.