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Preplanned Studies

Perspectives

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Cover Image: adapted from the World Health Organization, https://www.who.int/health-topics/violence-against-women#tab=tab_1.

Preplanned Studies

Burdens Attributable to Intimate Partner Violence in Women Aged 15 Years or Older — China, 1990–2019

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Summary

What is already known about this topic?

Intimate partner violence (IPV) represents a significant global public health concern.

What is added by this report?

The burden of HIV/AIDS related to IPV demonstrated an upward trend from 1990 to 2019, exhibiting an annual growth of 4.66% in age-standardized death rates (ASDR) and 4.42% in age-standardized disability-adjusted life years (DALYs) rates. Notably, the age groups 30–34 and 50–54 experienced a higher IPV burden compared to other age groups.

What are the implications for public health practice?

There is a pressing need for public health policymakers to develop efficacious interventions aimed at bolstering the surveillance and prevention of IPV targeted at women in China.

Intimate partner violence (IPV) constitutes a significant public health concern with detrimental implications for women's health (*1*). Globally, more than one in three women aged 15 years or older has experienced IPV in their lifetime (*2*). Recent findings indicate that the prevalence of physical and sexual violence among women in China is 40.2% and 11%, respectively (*3*). While the global burden of IPV has been increasing, China lacks national-level surveillance data on IPV burden. This study assessed the burdens of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), interpersonal violence, and depressive disorders attributable to IPV among women aged 15 years or older in China, utilizing data from the Global Burden of Disease (GBD) 2019 (*4*).

In 2019, China reported an estimated 2,398 IPV-attributable deaths, with an age-standardized death rate (ASDR) of 0.3 per 100,000, reflecting an average annual decrease of 3.63% since 1990. IPV-related disability-adjusted life years (DALYs) in China amounted to 789,926, with an age-standardized rate (ASR) of 93.8 DALYs per 100,000, marking an average annual decrease of 1.34% from 1990 to 2019. Age-standardized DALYs rates for HIV/AIDS, interpersonal violence, and depressive disorders attributable to IPV in China were 4.6, 54.1, and 54.5 (per 100,000), respectively. The burden of HIV/AIDS attributable to IPV exhibited a significant upward trend from 1990 to 2019, with annual increases of 4.66% in ASDR and 4.42% in age-standardized DALYs rate. The age groups 30–34 and 50–54 experienced higher IPV burdens compared to other age groups. Public health policymakers must urgently consider the development and implementation of effective interventions for strengthening IPV surveillance and prevention among women in China.

We acquired data on deaths, DALYs, years of life lost (YLL), and years lived with disability (YLDs) for HIV/AIDS, interpersonal violence, and depressive disorders attributable to IPV among Chinese women aged 15 years or older from the GBD 2019, utilizing the Global Health Data Exchange query tool (http://ghdx.healthdata.org/gbd-results-tool). DALYs were computed as the sum of YLL and YLDs. The GBD 2019 estimates the burden of diseases and injuries in China using data from population registration, national census, mortality registration and reporting systems, disease surveillance systems, systematic review studies, and other sources. The exposure levels of IPV for each age-sex-location-year included in the GBD study were determined based on all available data sources via spatiotemporal Gaussian process regression, DisMod-MR 2.1 (a Bayesian meta-regression method), or alternative methods. Attributable deaths, YLLs, YLDs, and DALYs were computed by multiplying population-attributable fractions (PAFs) by the relevant outcome measure for each age-sex-location-year. Detailed modeling methods can be found in the GBD 2019 supplementary materials (*4*). In this study, the IPV definition used in GBD 2019 refers to individuals who have experienced one or more acts of physical and/or sexual violence by a current or former intimate partner since the age of 15 years. Age data were extracted in five-year increments for a total of 16 GBD age groups.

The ASR per 100,000 individuals were obtained from the GBD database. In the GBD 2019, age standardization was calculated using the Segi world standard population and displayed in 5-year intervals by sex. To assess changing trends over a specified time interval, the estimated average annual percentage change (AAPC) in ASR was calculated, which is commonly used in secondary analyses based on GBD studies (*5*).

Assuming the natural logarithm of ASR fits a linear regression model $y = \alpha + \beta x + \varepsilon$, y is equal to ln(ASR), and x corresponds to the calendar year. Then, the 95% confidence interval (*CI*) of the AAPC was determined using the linear regression model. Then, $EstimatedAAPC = 100 \times (e^{\beta} - 1)$, its 95% *CI* was estimated using the linear regression model. A statistically significant change was identified if the 95% *CI* did not intersect zero. The estimated AAPC value represents the annual percentage change. This study utilized the estimated AAPC to investigate the trends of IPV burden by age (15–49, 50–69, and 70+) and diseases/injuries (HIV/AIDS, interpersonal violence, and depression disorders) in China from 1990 to 2019. All data analyses and mapping were conducted using R software (version 3.6.0; R Core Team, Vienna, Austria).

From 1990 to 2019, the number of deaths attributed to IPV decreased from 3,921 to 2,398, and the ASDR declined from 0.7 per 100,000 to 0.3 per 100,000, representing an annual average decrease of 3.63% (Table 1). During the same period, the number of DALYs associated with IPV in China increased from 763,110 to 789,926, while the age-standardized DALYs rate decreased from 125.5 per 100,000 to 93.8 per 100,000, showing an average annual decrease of 1.34%. In 2019, age-standardized DALYs rates for HIV/AIDS, interpersonal violence, and depressive disorders related to IPV were 4.6 per 100,000, 54.1 per 100,000, and 54.5 per 100,000, respectively. The ASDR for HIV/AIDS and interpersonal violence attributable to IPV were 0.1 per 100,000 and 0.2 per 100,000, respectively.

From 1990 to 2019, there was a downward trend in deaths, DALYs, YLLs, and YLDs attributable to IPV (Figure 1). However, an opposite trend was observed for HIV/AIDS-related deaths and DALYs attributable to IPV, with the average annual ASR increasing by 4.66% and 4.42%, respectively. Furthermore, a decrease in both deaths and DALYs associated with interpersonal violence due to IPV was found, with the average annual ASR decreasing by 4.59% and 1.68%, respectively. Lastly, the age-standardized DALYs rate for depressive disorders exhibited an annual decrease of 1.14% from 1990 to 2019.

The highest number of deaths, YLLs, YLDs, and DALYs due to interpersonal violence resulting from IPV appeared in the 30–34 age group; these measures generally decreased as age increased (Figure 2). Among women aged 50–54 years, the highest DALYs and YLDs were caused by depressive disorders attributable to IPV, with a subsequent decline in value as age progressed. For HIV/AIDS related to IPV, the highest DALYs and YLLs occurred in the 30–34 age group. Meanwhile, the highest number of deaths and YLDs linked to HIV/AIDS attributable to IPV were observed in the 50–54 age group and 45–49 age group, respectively. Notably, DALYs resulting from interpersonal violence exceeded those from depressive disorders before the age of 44, with an inverse trend emerging beyond this age.

DISCUSSION

The present study revealed a decrease in the overall burden of IPV among women aged 15 years or older in China from 1990 to 2019. Nevertheless, an escalating trend was observed in the burden of HIV/AIDS attributable to IPV during the same time frame, with a 4.66% annual increase in ASDR and a 4.42% annual increase in age-standardized DALYs rate. Notably, the age groups of 30–34 and 50–54 experienced a higher IPV burden compared to other age groups.

The observed reduction in IPV prevalence in China may be attributed to advancements in women's rights legislation, educational opportunities, and economic development over the past two decades. Following the adoption of the Beijing Declaration Platform for Action during the United Nations Fourth World Conference on Women in 1995, the Chinese government enacted numerous policies and regulations aimed at eliminating violence against women and promoting gender equality. The Domestic Violence Law of the People’s Republic of China constitutes the nation’s first piece of legislation explicitly prohibiting IPV, extending its application to unmarried cohabiting couples as well (*6*).

Over time, progress toward gender equality has been made in areas such as employment, education, and

TABLE 1. Deaths and DALYs attributable to intimate partner violence in 1990 and 2019, and estimated AAPC in ASRs per 100,000 in females in China from 1990 to 2019.

Diseases/injuries	Death					DALYs				
	Cases (*n*), 1990	ASR per 100,000, 1990	Cases (*n*), 2019	ASR per 100,000, 2019	Estimated AAPC 1990–2019	Cases (*n*), 1990	ASR per 100,000, 1990	Cases (*n*), 2019	ASR per 100,000, 2019	Estimated AAPC 1990–2019
All	3,921 (2,597 to 5,580)	0.7 (0.5 to 1.0)	2,398 (1,679 to 3,211)	0.3 (0.2 to 0.4)	−3.63 (−4.03 to −3.23)	763,110 (392,809 to 1,224,332)	125.5 (63.5 to 199.5)	789,926 (354,381 to 1,304,433)	93.8 (44.6 to 153.4)	−1.34 (−1.56 to −1.12)
HIV/AIDS	70 (8 to 149)	0.0 (0.0 to 0.0)	751 (376 to 1,270)	0.1 (0.1 to 0.2)	4.66 (3.68 to 5.65)	3,764 (502 to 7,825)	0.7 (0.1 to 1.4)	32,318 (15,858 to 56,475)	4.6 (2.3 to 8.1)	4.42 (3.51 to 5.33)
Interpersonal violence	3,851 (5,475 to 2,527)	0.7 (0.4 to 1.0)	1,647 (1,086 to 2,348)	0.2 (0.2 to 0.3)	−4.59 (−5.01 to −4.16)	449,996 (282,928 to 673,978)	78.5 (49.3 to 117.5)	377,516 (238,421 to 561,538)	54.1 (34.2 to 80.5)	−1.68 (−1.87 to −1.50)
Depressive disorders	–	–	–	–	–	309,351 (1,241 to 715,826)	53.9 (0.2 to 124.8)	380,093 (1,480 to 878,531)	54.5 (0.2 to 125.9)	−1.14 (−1.69 to −0.59)
Age group										
15–49 years										
HIV/AIDS	52 (7 to 112)	0.0 (0.0 to 0.0)	388 (177 to 711)	0.1 (0.1 to 0.2)	4.88 (3.83 to 5.95)	3,170 (444 to 6,749)	1.0 (0.1 to 2.1)	20,910 (9,451 to 38,470)	6.0 (2.7 to 11.0)	4.57 (3.58 to 5.57)
Interpersonal violence	3,082 (1,917 to 4,507)	1.0 (0.6 to 1.4)	1,038 (621 to 1,534)	0.3 (0.2 to 0.4)	−4.74 (−5.28 to −4.20)	397,603 (241,127 to 604,037)	123.1 (74.6 to 187.0)	284,510 (169,717 to 447,950)	81.0 (48.3 to 127.6)	−1.86 (−2.07 to −1.64)
Depressive disorders	–	–	–	–	–	248,884 (989 to 577,260)	77.0 (0.3 to 178.7)	190,288 (735 to 431,550)	54.2 (0.2 to 122.9)	−1.47 (−2.12 to −0.83)
50–69 years										
HIV/AIDS	16 (1 to 34)	0.0 (0.0 to 0.0)	298 (148 to 490)	0.2 (0.1 to 0.3)	5.38 (4.34 to 6.42)	551 (47 to 1,158)	0.7 (0.1 to 1.6)	10,123 (4,915 to 16,965)	5.5 (2.7 to 9.2)	5.51 (4.51 to 6.52)
Interpersonal violence	568 (359 to 856)	0.8 (0.5 to 1.2)	417 (258 to 624)	0.2 (0.1 to 0.3)	−4.31 (−4.6 to −4.02)	43,874 (28,706 to 66,137)	59.1 (38.7 to 89.1)	75,992 (46,607 to 117,521)	41.2 (25.3 to 63.7)	−1.43 (−1.58 to −1.29)
Depressive disorders	–	–	–	–	–	51,431 (240 to 129,057)	69.3 (0.3 to 173.8)	157,568 (725 to 395,024)	85.5 (0.4 to 214.2)	0.19 (−0.28 to 0.66)
70+ years										
HIV/AIDS	2 (0 to 4)	0.0 (0.0 to 0.0)	65 (29 to 115)	0.1 (0.1 to 0.2)	6.59 (5.36 to 7.84)	42 (3 to 85)	0.2 (0.0 to 0.4)	1,285 (562 to 2,292)	2.2 (1.0 to 3.9)	6.86 (5.86 to 7.87)
Interpersonal violence	202 (135 to 297)	0.9 (0.6 to 1.4)	192 (126 to 288)	0.3 (0.2 to 0.5)	−3.73 (−4.01 to −3.46)	8,519 (5,595 to 12,773)	39.2 (25.7 to 58.7)	17,013 (10,806 to 26,150)	29.0 (18.4 to 44.5)	−1.13 (−1.19 to −1.07)
Depressive disorders	–	–	–	–	–	9,036 (35 to 22,893)	41.5 (0.2 to 105.3)	32,236 (124 to 82,798)	54.9 (0.2 to 141.0)	0.73 (0.44 to 1.03)

Abbreviation: DALYs=disability-adjusted life years; AAPC=average annual percentage change; ASRs=age-standardized rates; HIV=human immunodeficiency virus; AIDS=acquired immunodeficiency syndrome.

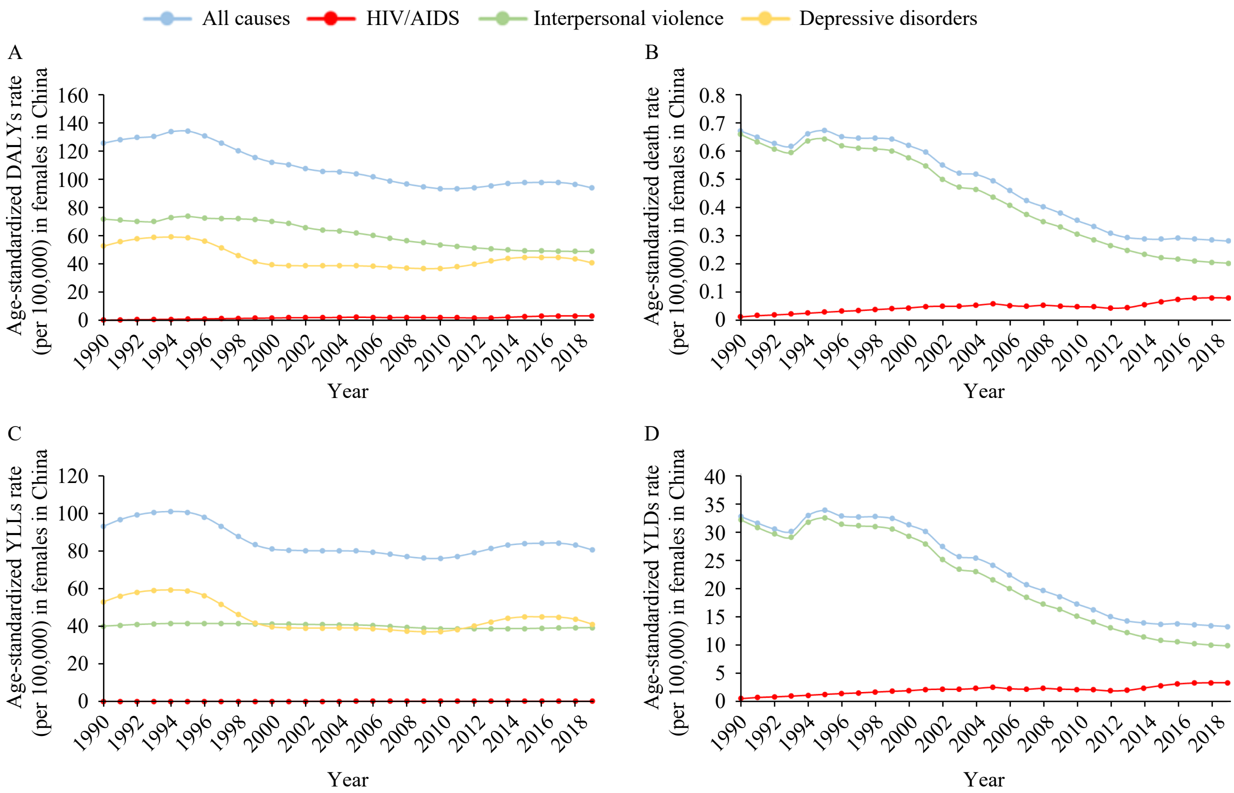

FIGURE 1. Trends of diseases/injuries burden attributable to IPV in China, 1990–2019. (A) Trend in the age-standardized DALYs rate. (B) Trend in the ASDR. (C) Trend in age-standardized YLLs rate. (D) Trend in age-standardized YLDs rate.
Abbreviation: IPV=intimate partner violence; DALYs=disability-adjusted by life years; ASDR=age-standardized death rate; YLLs=years of life lost; YLDs=years lived with disability; HIV=human immunodeficiency virus; AIDS=acquired immunodeficiency syndrome.

entrepreneurial opportunities for women, leading to increased economic independence. This development has been identified as a significant factor in reducing the prevalence of male chauvinism and IPV (*7*).

Although progress has been made in advancing women's status in China, rigid gender norms persist, particularly in rural areas (*3*). Domestic violence, often associated with shame, is regarded as a private issue not to be disclosed to outsiders (*8*). The current study indicates that the prevalence of IPV in China remains high. Consistent with our findings, Yuan et al. reported a high prevalence of physical violence among women in China (40.2%), significantly higher than that in high-income countries such as Japan (15%) (*9*). Importantly, the study demonstrates an increasing burden of HIV/AIDS attributable to IPV, a finding in line with research conducted in South Africa (*7*). This may be attributed to IPV exacerbating HIV prevalence among high-risk women, such as female sex workers (FSWs) and drug users, while also impeding their access to treatment and care. A cross-sectional study in China reported that approximately 58% of FSWs experienced violence from stable partners (*10*). The findings of this study underscore the need for strengthened HIV intervention efforts among key female populations, emphasizing postexposure prophylaxis, HIV testing, and treatment.

The results of this study revealed that the age groups 30–34 and 50–54 experienced a greater burden of IPV compared to other age groups. As women in China tend to postpone marriage and childbearing, those in the 30–34 age range often encounter fatigue, economic pressures associated with raising a child, and disagreements surrounding child-rearing methods (*11*). Moreover, women with children are less likely to leave abusive partners. On the other hand, women aged 50 and older may experience emotional instability due to menopause. The age of 50 also coincides with the typical retirement age for Chinese women, and those who are retired tend to report high-severity IPV as a result of increased activity (*12*).

Our study was subject to several limitations. First, the estimates of the burden attributable to IPV relied on the availability and quality of original data as well as

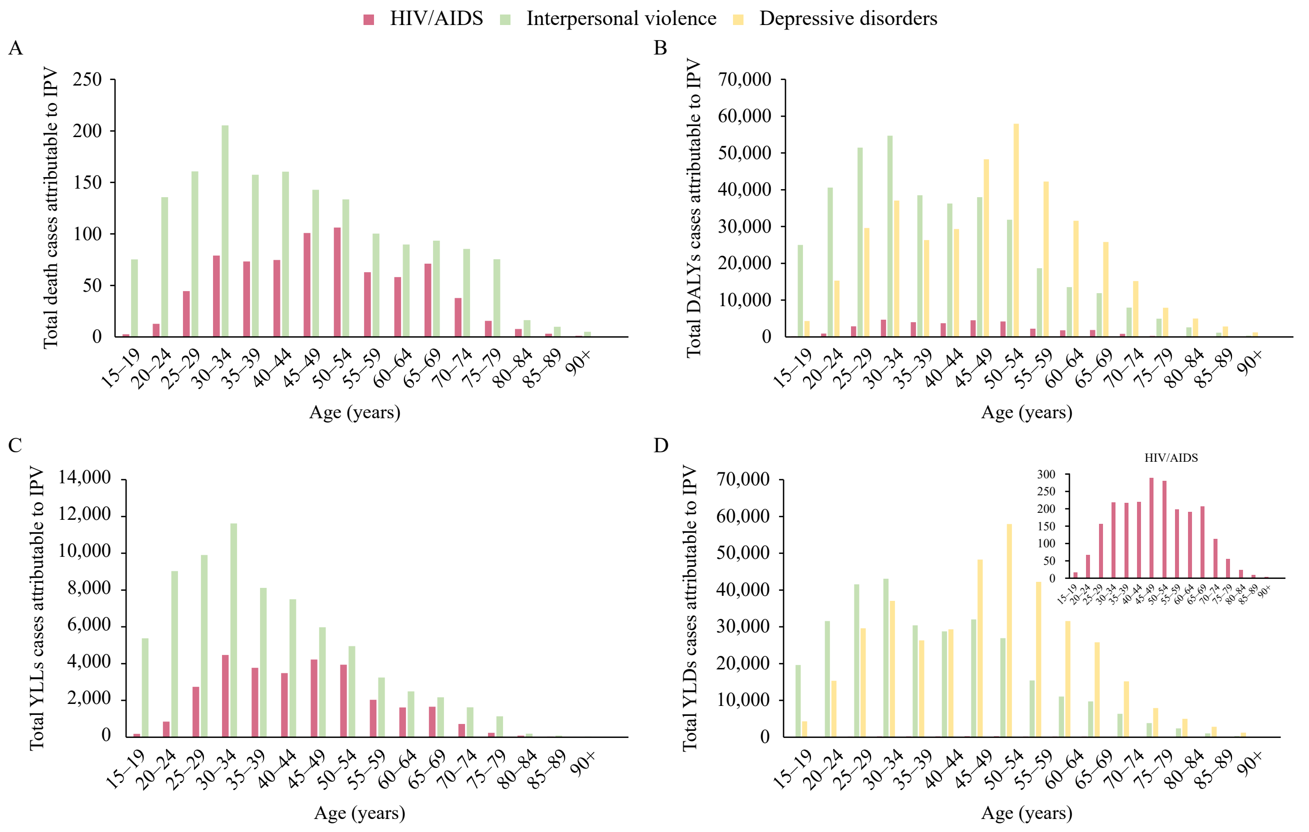

FIGURE 2. Overall death, DALYs, YLLs, and YLDs cases attributable to IPV in China by age, 2019. (A) The number of death cases. (B) The number of DALYs cases. (C) The number of YLLs cases. (D) The number of YLDs cases.
Abbreviation: IPV=intimate partner violence; DALYs=disability-adjusted by life years; YLLs=years of life lost; YLDs=years lived with disability; HIV=human immunodeficiency virus; AIDS=acquired immunodeficiency syndrome.

the efficacy of the models used when original data was absent. Second, the study may underestimate the burdens attributable to IPV, as it only evaluated three diseases/injuries associated with IPV and concentrated solely on women aged 15 years or older. Third, the assessment of the IPV burden by province was not possible due to data unavailability. Finally, the IPV burden could not be evaluated by urban/rural regions as such data was neither collected nor estimated in GBD 2019.

The prevalence of IPV in China remains significant, despite a decreasing trend observed over the past few decades. Alarmingly, the burden of HIV/AIDS attributable to IPV is increasing. Unwavering efforts must be made to develop and implement policies and interventions against IPV, safeguard women's rightful interests, and advocate for gender equality and women's empowerment in order to eliminate all forms of violence against women.

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Preplanned Studies

Parental and Social Factors' Contribution to Adverse Pregnancy Outcomes with Urban-Rural Disparities — Four Provinces, China, 2011–2020

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Summary

What is already known about this topic?

The prevalence of adverse pregnancy outcomes (APOs) exhibits a disparity between urban and rural areas, which is commonly associated with various factors, such as demographic and socio-environmental factors. However, the specific contribution of each factor has not yet been elucidated.

What is added by this report?

This study demonstrates that the primary factors contributing to urban-rural differences in the prevalence of APOs are population structure, parental age, parity, and regional development.

What are the implications for public health practice?

Future prevention and control measures should be directed toward considering population structure and regional differences. Accurate interventions will enhance the efficiency of public health services.

Adverse pregnancy outcomes (APOs), including preterm birth, low birth weight, macrosomia, birth defects, and stillbirths, have significant effects on the health of mothers and newborns. Although the etiology of APOs is multifactorial, their prevalence is typically associated with population characteristics and socioeconomic conditions. Prior research at the individual level has indicated that the risk of APOs increases with reproductive age (*1*–*2*) and may also vary by parity (*3*). Moreover, there is a growing body of evidence demonstrating that social determinants, assessed at individual and/or aggregated levels, have a crucial impact on APOs (*4*).

Owing to China's urban-rural socioeconomic disparities, the prevalence of APOs may differ based on factors such as health service utilization and lifestyle choices. By examining the primary determinants of these urban-rural gaps, policymakers can be provided with valuable insights to develop targeted public health policies, ultimately aiming to reduce urban-rural health inequalities.

We utilized data from the birth registration system within the Huaihe River Basin Birth and Birth Defects Monitoring Project in China, spanning from 2011 to 2020. This study included all birth records (inclusive of birth defect records) registered in four counties across different provinces: Mengcheng County in Anhui Province; Sheyang County in Jiangsu Province; Xiping County in Henan Province; and Wenshang County in Shandong Province. Data were derived from the national survey of population birth quality in these four provinces within the Huaihe River Basin, a project notable for its high-quality monitoring and data.

Employing SAS software (Version 9.4; SAS Institute, Cary, USA), we cleaned the registered records and merged samples from the four counties. Records with missing essential information were excluded to ensure the accuracy of statistical results. Following data cleaning, a total of 379,562 births and 62,328 APOs recorded from 2011 to 2020 were analyzed.

APOs were defined as preterm birth, low birth weight, macrosomia, birth defect, stillbirth, or any combination of these, and were categorized according to maternal residence in either urban or rural areas. Due to socioeconomic and population structure differences between urban and rural settings, along with varying degrees of change and development, crude APO rates may exhibit distinct characteristics. Consequently, it is essential to standardize crude APO rates.

We calculated standardized rates for urban and rural areas, allowing for comparison while controlling for population structure effects (parental age, parity) and regional differences. Subsequently, we decomposed the effects of these factors on APO rates and analyzed the temporal trends of these factors.

The algebraic formula utilized for the standardization and decomposition analysis of the prevalence of APOs is derived from Das Gupta's method of standardization and decomposition (*5*).

$$T_{....} = \sum_{ijkl} \frac{T_{ijkl} N_{ijkl}}{N_{....}} \quad (1)$$

In formula (*1*), $\frac{N_{ijkl}}{N_{....}}$ can be written as

$$\frac{N_{ijkl}}{N_{....}} = A_{ijkl} B_{ijkl} C_{ijkl} D_{ijkl} \quad (2)$$

$$A_{ijkl} = \left(\frac{N_{ijkl}}{N_{.jkl}}\right)^{\frac{1}{4}} \left(\frac{N_{ijk.}}{N_{.jk.}} \cdot \frac{N_{ij.l}}{N_{.j.l}} \cdot \frac{N_{i.kl}}{N_{..kl}}\right)^{\frac{1}{12}} \left(\frac{N_{i..l}}{N_{...l}} \cdot \frac{N_{i.k.}}{N_{..k.}} \cdot \frac{N_{ij..}}{N_{.j..}}\right)^{\frac{1}{12}} \left(\frac{N_{i...}}{N_{....}}\right)^{\frac{1}{4}} \quad (3)$$

The variables i, j, k, and l represent paternal age, maternal age, parity, and region, respectively. The crude rate of APOs is represented by "T" while "N" refers to the number of births in urban areas. In formula (*1*), "T_{ijkl}" and "N_{ijkl}" denote the crude rate of APOs and number of births for the (i, j, k, l) categories in urban settings, respectively. Similarly, the crude rate in rural areas can be expressed using lowercase letters t and n.

The coefficients B_{ijkl}, C_{ijkl}, and D_{ijkl} can be derived from equation (*3*) by interchanging the subscripts i and j,i and k,and i and l, respectively. For instance, $N_{.jkl}$ in (*3*) is transformed into $N_{i.kl}$ in the expression for B_{ijkl}. Similarly, the ratios n_{ijkl}/n can be expressed using the lowercase letters a, b, c, d, and n.

The urban-rural disparities can be represented by the summation of five distinct effects: rate effect, paternal age effect, maternal age effect, parity effect, and regional effect. Each of these effects can be understood as the difference between two standardized rates, which are given by the following:

$$T_{....} - t_{....} = \left[R\left(\bar{T}\right) - R\left(\bar{t}\right)\right] + \left[I\left(\bar{A}\right) - I\left(\bar{a}\right)\right] + \left[J\left(\bar{B}\right) - J\left(\bar{b}\right)\right] + \left[K\left(\bar{C}\right) - K\left(\bar{c}\right)\right] + \left[L\left(\bar{D}\right) - L\left(\bar{d}\right)\right] \quad (4)$$

$$\mathrm{R}\left(\bar{T}\right) = (I, J, K, L) - \text{standardized rate in urban} = \sum_{ijkl} \frac{\frac{N_{ijkl}}{N_{....}} + \frac{n_{ijkl}}{n_{....}}}{2} T_{ijkl} \quad (5)$$

$$\mathrm{I}\left(\bar{A}\right) = (J, K, L, R) - \text{standardized rate in urban} = \sum_{ijkl} \frac{T_{ijkl} + t_{ijkl}}{2} \quad (6)$$

The standardized rates $R(\bar{t})$ and $I(\bar{a})$ for rural areas are obtained, respectively, from equations (*5*) and (*6*) by replacing T_{ijkl} in equation (*5*) with t_{ijkl}. Other standardized rates, such as $J(\bar{b})$, $K(\bar{C})$, $K(\bar{c})$, $L(\bar{D})$, and $L(\bar{d})$ are derived from equation (*6*) by interchanging the respective letters. Standardization and decomposition calculations were performed in the present study using DECOMP(Version 2.0, Wang Jichuan, Wright State University, USA) (*6*).

Figure 1 presents the crude and standardized rates of APO prevalence in urban and rural areas from 2011–2020, revealing three primary patterns throughout the decade. Initially, the crude prevalence of APOs followed comparable trends in both urban and rural settings, with declines noted in both areas between 2012–2017. However, the overall prevalence during that period remained higher in urban areas. Moreover, the prevalence gap between urban and rural

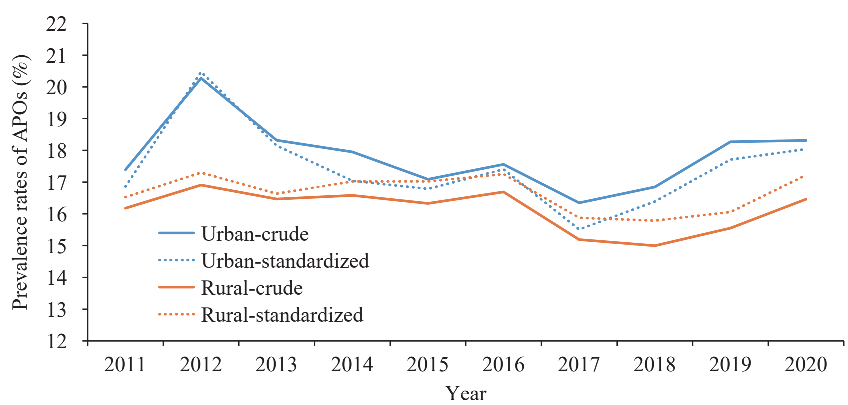

FIGURE 1. Crude and standardized prevalence rates of APOs in urban and rural areas, 2011–2020.
Abbreviation: APOs=adverse pregnancy outcomes.

areas narrowed during 2011–2016 but widened during 2017–2020. Lastly, after standardizing the prevalence rates, the urban-rural discrepancies exhibited different patterns, with a nearly equivalent prevalence between 2014 and 2016 (showing a mere 0.16% difference in 2016). These trends highlight factors such as parental age, parity, and regional characteristics that contribute to the urban-rural disparities in APOs.

Paternal age, maternal age, and parity were considered as demographic factors for the population composition, while the region was included as a factor for decomposition analysis to evaluate their impact on the prevalence of APOs (Table 1). The results indicate that these factors significantly contributed to the gap in APO prevalence between urban and rural areas. Plus and minus signs represent the direction of these factors. For instance, the paternal age effect contribution in 2011 was 38.94, suggesting the paternal age effect contributed to the widening urban-rural gap and accounted for approximately 38.94% of the difference in the crude rate of APOs. Paternal age, maternal age, and region effect tended to increase the urban-rural gap, while parity tended to decrease the gap in APO prevalence between urban and rural areas. Over the past decade, paternal and maternal ages exhibited similar patterns in their contributions to the gap between urban and rural areas, specifically, increasing continuously from 2012 to 2015 and then decreasing after 2015.

Although no measurable variables for regional character were identified, the region itself may serve as an indicator of socioeconomic development status. Furthermore, the region contributed to the observed gap. Between 2011 and 2013, the region's proportion of contribution was lower than that of paternal age. However, after 2013, the proportion of contribution attributed to the region increased, becoming similar to paternal age between 2013 and 2016, and emerging as the primary factor influencing urban-rural differences after 2017. In the case of parity, its proportion of contribution to narrowing the gap declined after 2017. It is noteworthy that since 2013, the proportion of contribution by the region has risen, paralleling paternal age during 2013–2016, and becoming the

TABLE 1. The urban-rural difference of standardized rates (%) and contributions (%) of each factor in rates of APOs by standardization and decomposition, 2011–2020.

Factors	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Paternal age										
Urban-standardized	16.67	18.67	17.28	16.99	16.76	17.26	15.74	16.03	16.81	17.59
Rural-standardized	16.20	18.41	16.97	16.53	16.43	16.88	15.27	15.75	16.58	17.30
Difference	−0.47*	−0.26*	−0.31*	−0.46*	−0.33*	−0.38*	−0.47*	−0.28*	−0.23*	−0.29*
Contributions	38.94	7.75	16.78	33.42	43.48	43.70	40.49	15.10	8.46	15.71
Maternal age										
Urban-standardized	16.59	18.72	17.31	16.94	16.82	17.25	15.72	16.01	16.82	17.55
Rural-standardized	16.28	18.38	16.95	16.57	16.38	16.91	15.30	15.78	16.57	17.34
Difference	−0.31*	−0.34*	−0.36*	−0.37*	−0.44*	−0.34*	−0.42*	−0.23*	−0.25*	−0.21*
Contributions	25.68	10.13	19.49	26.88	57.97	39.10	36.18	12.40	9.20	11.38
Parity										
Urban-standardized	16.32	18.31	16.87	16.70	16.47	16.97	15.55	15.87	16.69	17.35
Rural-standardized	16.59	18.78	17.39	16.84	16.76	17.22	15.53	15.95	16.74	17.56
Difference	−0.06*	−0.07*	−0.06*	−0.05	−0.06*	−0.05*	−0.05	−0.06	−0.05	−0.08*
Contributions	−22.37	−14.01	−28.15	−10.17	−38.21	−28.75	1.72	−4.31	−1.84	−11.38
Region										
Urban-standardized	16.64	18.57	17.22	17.11	16.84	17.21	15.84	16.32	17.03	17.82
Rural-standardized	16.28	18.51	17.04	16.43	16.35	16.96	15.23	15.49	16.39	17.08
Difference	−0.36*	−0.06	−0.18	−0.68*	−0.49*	−0.25	−0.61*	−0.83*	−0.64*	−0.74*
Contributions	29.83	1.79	9.74	49.41	64.56	28.75	52.55	44.76	23.54	40.09

Note: Standard errors were estimated using bootstrapping with 200 resamples.
Abbreviation: APOs=adverse pregnancy outcomes.
* *P*<0.05.

main determinant of urban-rural disparities after 2017.

In examining the general decomposition results, we further compared the age composition of parents, who serve as the primary sources of urban-rural differences in APO prevalence. Due to adjustments in the national family planning policy, there has been a shift in the age structure of parents. We classified the parents into four age groups: under 25 years, 25–29 years, 30–34 years, and 35 years or older. While controlling for region and parity once more, the contributions of each parental age group are illustrated in Figure 2.

The findings reveal distinct temporal trends in the urban-rural gap concerning age. Prior to 2016, the disparity was predominantly linked to parents under 25 years old. The influence of advanced paternal age (over 35 years old) emerged in 2013 and attained a level comparable to that of the younger group by 2016. The impact of various age groups showed a decline after 2017.

DISCUSSION

Consistent with previous research, our findings indicate a disparity in the prevalence of APOs between urban and rural settings, with higher incidence rates observed in urban areas (*7–8*). In the present study, we employed standardization and decomposition analysis (SDA) techniques to assess various factors contributing to the standardized rate and identify the underlying "urban-rural gap" in APO prevalence. Additionally, by utilizing a decade's worth of data, we extended the application of SDA to facilitate the decomposition of these factors and enable a temporal comparison.

We discovered that both parental ages under 25 years old and advanced paternal age (>35 years old) contributed to the disparity in the prevalence of APOs. This finding aligns with previous conclusions drawn from individual studies (*1–3*), indicating that low or high parental age constitutes a risk factor for adverse pregnancy outcomes. The impact of parental age on the urban-rural gap rose steadily from 2012 to 2015 and subsequently declined after 2015. This trend might be associated with urban and rural marriage arrangements aligning with Chinese traditions. Additionally, the proportion of parents aged 30 and above increased continuously until 2016 and then decreased.

Following the implementation of the two-child policy, an increase in births at advanced parental age as well as the proportion of second and third children led to higher risks of APOs (*8–9*). However, our study's results reveal a minimal increase in the prevalence of APOs after 2013 and 2015, with parity demonstrating a negative effect on urban-rural differences. This outcome could be attributed to advancements in healthcare service utilization, medical resources, socioeconomic development, and pregnant women's health behavior knowledge. Nonetheless, the parity effect has diminished since 2017, possibly due to a reduced disparity in the proportion of multiparous mothers after 2017.

Region is a significant factor associated with urban-rural differences, which aligns with previous studies' conclusions that APOs are related to socioeconomic levels (*4,10*). This finding implies that the urban-rural gap varies across different regions. For instance, in our study, the urban and rural per capita disposable income

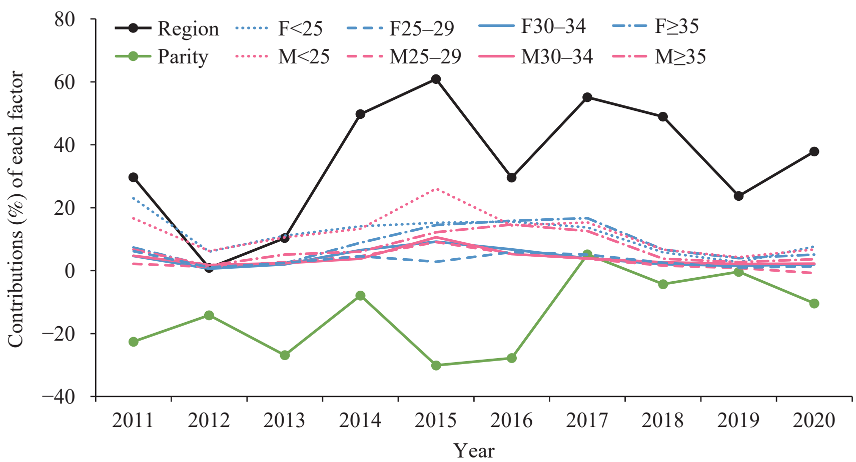

FIGURE 2. Percentage contributions of each factor to the prevalence of adverse pregnancy outcomes, categorized by age group form 2011 to 2020.
Note: M is mother's age, and F is father's age.

within each county were compared over the past decade, revealing that the economic disparities between urban and rural areas fluctuated and varied in different regions.

As a consequence of socioeconomic development and improvements in women's education, the postponement of childbearing has become more prevalent, which is evident in the decreased impact of the four age groups on urban-rural differences since 2017. Moreover, certain national policies have been implemented to reduce health service disparities and promote equity in service accessibility between urban and rural areas. Considering these factors, it is clear that each region requires customized policies to address their distinct needs. As a result, it is recommended that policymakers adopt targeted strategies for different regions to accommodate specific circumstances.

In China, national and provincial governments have implemented various programs targeting rural and impoverished areas to reduce disparities in women's reproductive, maternal, newborn, child, and adolescent health (RMNCAH). However, our findings indicate that for the elimination of inequalities between urban and rural residents, attention should be directed towards demographic composition and fertility characteristics within diverse regions. Consequently, targeted interventions may serve as a more effective approach in promoting equity in healthcare access. Additionally, when comparing the incidence of APOs among different regions and evaluating the effectiveness of interventions and policies, greater consideration should be given to the regional population structures.

In our study, we have analyzed data from 10 years, but in the early stages of this project, the quality of these data is relatively low, with possible omissions, misstatements, and non-standard measurement of body weight, resulting in a certain degree of bias in the results. In addition, numerous factors influence APOs, with distinct risk factors associated with each specific outcome. In the present study, APOs encompass a combination of five outcome measures. However, the demographic characteristics examined in the analysis were limited to parental age and parity, excluding additional factors. This limitation may introduce minor biases in the analysis results, potentially leading to overestimations or underestimations of the impacts of the two demographic factors. Consequently, future research should expand the sample size and conduct further investigation into the disparities between urban and rural populations in relation to various APOs.

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Preplanned Studies

Healthy Lifestyles and Chronic Pain with New-Onset Metabolic-Related Multimorbidity among Older Adults — China, 2011–2018

Ziyang Ren[1,2,&]; Yihao Zhao[3,&]; Guanyu Niu[4]; Xinyao Lian[5]; Xiaoying Zheng[3,#]; Shiyong Wu[6,#]; Jufen Liu[1,2,#]

Summary

What is already known about this topic?

Chronic pain has been identified as a risk factor for cardiovascular diseases. Evidence shows that adopting a healthy lifestyle can help reduce the cardiometabolic risks associated with chronic pain.

What is added by this report?

Results from this cohort study suggest a positive association between chronic pain and the development of new-onset metabolic-related multimorbidity, specifically metabolic multimorbidity and cardiometabolic comorbidity, within middle-aged and older Chinese adults. Furthermore, adopting healthy lifestyles can potentially mitigate or even reverse these associations.

What are the implications for public health practice?

The results of our study emphasize the importance of promoting healthy lifestyles among older Chinese adults as a preventative measure against the medical burdens and cardiometabolic risks associated with chronic pain.

Chronic pain affects over 30% of people worldwide (*1*). It is often considered a precursor to cardiovascular diseases (CVDs) and a consequence of metabolic disorders. However, little is known about whether chronic pain increases the incidence of metabolic-related multimorbidity, including metabolic multimorbidity (MM) and cardiometabolic comorbidity (CMC), or whether adopting healthy lifestyles can mitigate these risks. We addressed these research gaps using the Cox proportional hazards regression and floating absolute risk in R statistical software (version 4.1.2, R Foundation for Statistical Computing, Vienna, Austria). Our results demonstrate that chronic pain is associated with a higher risk of developing new-onset diabetes, dyslipidemia, CVDs, MM, and CMC in middle-aged and older Chinese individuals. Furthermore, adopting healthy lifestyles can lower or even reverse the increased risk of these diseases attributed to chronic pain. Given the substantial burden of chronic pain, our study underscores the importance of adopting healthy lifestyles in preventing metabolic-related multimorbidity among older adults in China.

The present study utilized data from the China Health and Retirement Longitudinal Study (CHARLS) 2011–2018, a nationally representative survey that included participants aged 45 years and older residing in 450 villages and urban communities across China. A total of 17,708 participants were initially recruited at baseline in 2011, with subsequent follow-ups conducted in 2013, 2015, and 2018. To ensure data quality, participants were excluded based on the following criteria: age below 45 years, missing data on sex, residence, education, household income, and marital status at baseline (N=3,089); missing data on chronic pain, hypertension, diabetes, dyslipidemia, and CVDs at baseline (N=336); and missing data on smoking history, alcohol consumption, body mass index (BMI), waist-to-height ratio (WHtR), and sleep at baseline (N=3,175), ultimately resulting in a sample size of 11,108 participants for analysis (Figure 1).

The study involved participants who self-reported pain in various body parts and were then categorized into three groups: 0 (no chronic pain), 1–3 (mild chronic pain), or 4 or more (severe chronic pain) body parts. Five healthy lifestyle factors were identified, namely, never smoking (with no smoking history), low alcohol intake (less than 14 drinks/week for men and 7 drinks/week for women, with a drink containing 13.6 g of ethanol or equivalent to 375 mL of beer or 118 mL of wine) (*2*), normal weight (BMI<24 kg/m^2), absence of central obesity (WHtR<0.5), and optimal sleep (7–8 hours per night) (*3*). The participants were classified as least healthy, relatively healthy, and most healthy based on their 0–2, 3, and 4–5 healthy lifestyles. The study also defined cardiometabolic disorders (CMDs) such as hypertension, diabetes, dyslipidemia, and CVDs (heart disease and stroke) by using self-reported physicians' diagnoses or treatments. For hypertension, a blood pressure of ≥140/90 mmHg

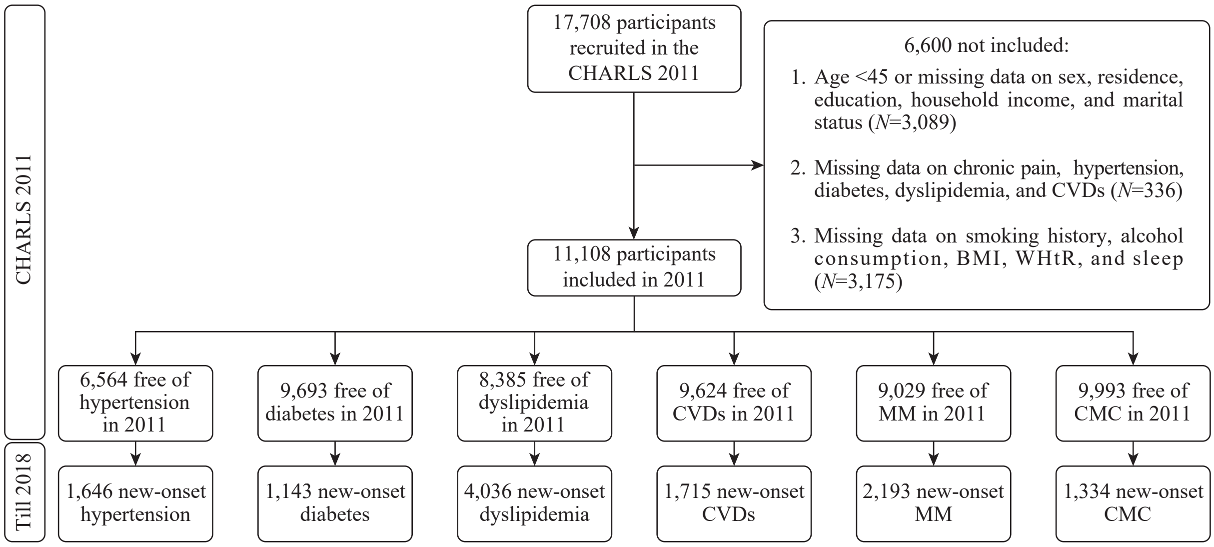


FIGURE 1. Flow chart of participants included.
Abbreviation: CHARLS=China Health and Retirement Longitudinal Study, CVDs=cardiovascular diseases, BMI=body mass index, WHtR=waist-to-height ratio, MM=metabolic multimorbidity, CMC=cardiometabolic comorbidity.

was identified, while diabetes was identified if fasting plasma glucose ≥7.0 mmol/L or random plasma glucose ≥11.1 mmol/L or glycated hemoglobin ≥6.5%. Dyslipidemia was identified if total cholesterol ≥240 mg/dL, low-density lipoprotein cholesterol ≥160 mg/dL, high-density lipoprotein cholesterol ≤40 mg/dL, or if triglycerides ≥200 mg/dL. The presence of two or more of hypertension, diabetes, and dyslipidemia was defined as MM, and the presence of CVDs and one or more of hypertension, diabetes, and dyslipidemia was defined as CMC. Age, sex, residence (rural and urban), education level (primary school or less, middle school, and high school or above), household income (overall income divided into first, second, and third tertiles), and marital status (married/cohabiting and single) were considered as covariates.

This study examined the association between chronic pain severity and the onset of hypertension, diabetes, dyslipidemia, CVDs, MM, and CMC. All models were adjusted for age, sex, residence, education, household income, marital status, and healthy lifestyles. The study evaluated the associations of healthy lifestyles, compared to the least healthy, with these disorders in participants with no, mild, and severe chronic pain, while controlling for relevant confounding variables. We also investigated the effects of healthy lifestyles on the association between chronic pain severity and the above disorders, with "Mild chronic pain and least healthy lifestyles" as the reference category. All analyses were two-tailed and considered statistically significant at a P value of <0.05 and a 95% confidence interval (*CI*) for the hazard ratio (HR) that did not cross 1.00.

Table 1 displays the baseline characteristics of the participants included in our study. The analysis demonstrated that individuals with chronic pain of greater severity exhibit an increased risk for developing diabetes, CVDs, MM, and CMC (all P<0.05). Table 2 illustrates that compared to individuals without chronic pain, those who experienced severe chronic pain were associated with a higher risk of new-onset diabetes, dyslipidemia, CVDs, MM, and CMC. HRs (95% *CI*s) were 1.22 (1.06–1.40), 1.09 (1.01–1.18), 1.70 (1.53–1.90), 1.23 (1.11–1.37), and 1.64 (1.45–1.85), correspondingly.

Figure 2 illustrates a significant association between healthy lifestyles and decreased risks of CMDs, MM, and CMC for participants without chronic pain or with mild to severe chronic pain. The P values for interaction between chronic pain and healthy lifestyles were >0.05. Figure 3 demonstrates how adopting a healthy lifestyle can reverse the associations between chronic pain and diabetes, dyslipidemia, MM, and CMC. The statistical analysis indicates that individuals with severe chronic pain and with the healthiest lifestyles were 30%–50% less likely to develop diabetes, dyslipidemia, MM, and CMC compared to individuals with no chronic pain and with the unhealthiest lifestyles. Moreover, healthy lifestyles had a neutralizing effect on the associations between severe chronic pain and CVDs. Therefore, adopting healthy

TABLE 1. Baseline characteristics of participants by chronic pain severity (*N*=11,108).

Baseline characteristics	Chronic pain severity, *n* (%)			*P* value
	No (*N*=7,368)	Mild (*N*=2,047)	Severe (*N*=1,693)	
Age, years [Median (IQR)]	58.0 (51.0–65.0)	59.0 (53.0–66.0)	59.0 (53.0–65.0)	<0.001
Sex				<0.001
Men	3,866 (52.5)	908 (44.4)	574 (33.9)	
Women	3,502 (47.5)	1,139 (55.6)	1,119 (66.1)	
Residence				<0.001
Rural	4,398 (59.7)	1,418 (69.3)	1,268 (74.9)	
Urban	2,970 (40.3)	629 (30.7)	425 (25.1)	
Education		3,866 (52.5)		<0.001
Primary school or less	4,676 (63.5)	1,537 (75.1)	1,374 (81.2)	
Middle school	1,694 (23.0)	359 (17.5)	230 (13.6)	
High school or above	998 (13.5)	151 (7.4)	89 (5.2)	
Household income				0.041
First tertile	2,435 (33.1)	680 (33.2)	584 (34.5)	
Second tertile	2,403 (32.6)	714 (34.9)	582 (34.4)	
Third tertile	2,530 (34.3)	653 (31.9)	527 (31.1)	
Marital status				0.002
Married/cohabiting	6,537 (88.7)	1,803 (88.1)	1,450 (85.7)	
Single	831 (11.3)	244 (11.9)	243 (14.3)	
Never smoking				<0.001
Yes	4,268 (57.9)	1,248 (61.0)	1,129 (66.7)	
No	3,100 (42.1)	799 (39.0)	564 (33.3)	
No heavy alcohol consumption				<0.001
Yes	6,536 (88.7)	1,834 (89.6)	1,565 (92.4)	
No	832 (11.3)	213 (10.4)	128 (7.6)	
Normal weight				0.315
Yes	3,030 (41.1)	812 (39.7)	670 (39.6)	
No	4,338 (58.9)	1,235 (60.3)	1,023 (60.4)	
No central obesity				0.401
Yes	2,216 (30.1)	624 (30.5)	484 (28.6)	
No	5,152 (69.9)	1,423 (69.5)	1,209 (71.4)	
Reasonable sleep				<0.001
Yes	3,418 (46.4)	693 (33.9)	507 (30.0)	
No	3,950 (53.6)	1,354 (66.1)	1,186 (70.0)	
New-onset hypertension*				0.075
No	3,322 (75.6)	916 (74.8)	680 (72.0)	
Yes	1,074 (24.4)	308 (25.2)	264 (28.0)	
New-onset diabetes*				<0.001
No	5,766 (89.1)	1,542 (86.8)	1,242 (85.9)	
Yes	705 (10.9)	234 (13.2)	204 (14.1)	
New-onset dyslipidemia*				0.197
No	2,959 (52.4)	780 (51.5)	610 (49.6)	
Yes	2,684 (47.6)	733 (48.5)	619 (50.4)	
New-onset CVDs*				<0.001
No	5,554 (84.3)	1,383 (79.7)	972 (74.5)	
Yes	1,031 (15.7)	352 (20.3)	332 (25.5)	

TABLE 1. (Continued)

Baseline characteristics	Chronic pain severity, *n* (%)			*P* value
	No (*N*=7,368)	Mild (*N*=2,047)	Severe (*N*=1,693)	
New-onset MM*				<0.001
No	4,656 (76.8)	1,238 (75.2)	942 (71.4)	
Yes	1,407 (23.2)	409 (24.8)	377 (28.6)	
New-onset CMC*				<0.001
No	5,968 (88.2)	1,549 (85.2)	1,142 (81.1)	
Yes	798 (11.8)	270 (14.8)	266 (18.9)	

Abbreviation: CVDs=cardiovascular diseases; MM=metabolic multimorbidity; CMC=cardiometabolic comorbidity; IQR=interquartile range.
* means the sample size used was less than 11,108.

TABLE 2. Association of chronic pain severity with new-onset CMDs, MM, and CMC.

Outcomes	HR (95% *CI*)		
	No	Mild	Severe
Hypertension	1.00 (0.94–1.07)	0.99 (0.88–1.10)	1.09 (0.97–1.23)
Diabetes	1.00 (0.92–1.08)	1.15 (1.02–1.31)	1.22 (1.06–1.40)
Dyslipidemia	1.00 (0.96–1.04)	1.02 (0.95–1.10)	1.09 (1.01–1.18)
CVDs	1.00 (0.94–1.07)	1.31 (1.18–1.46)	1.70 (1.53–1.90)
MM	1.00 (0.95–1.06)	1.04 (0.95–1.15)	1.23 (1.11–1.37)
CMC	1.00 (0.93–1.08)	1.26 (1.12–1.41)	1.64 (1.45–1.85)

Note: All models were adjusted for age, sex, residence, education, household income, marital status, and healthy lifestyles. Bolded indicates statistical significance.
Abbreviation: HR=hazard ratio; *CI*=confidence interval; CMDs=cardiometabolic disorders; MM=metabolic multimorbidity; CMC=cardiometabolic comorbidity; CVDs=cardiovascular diseases.

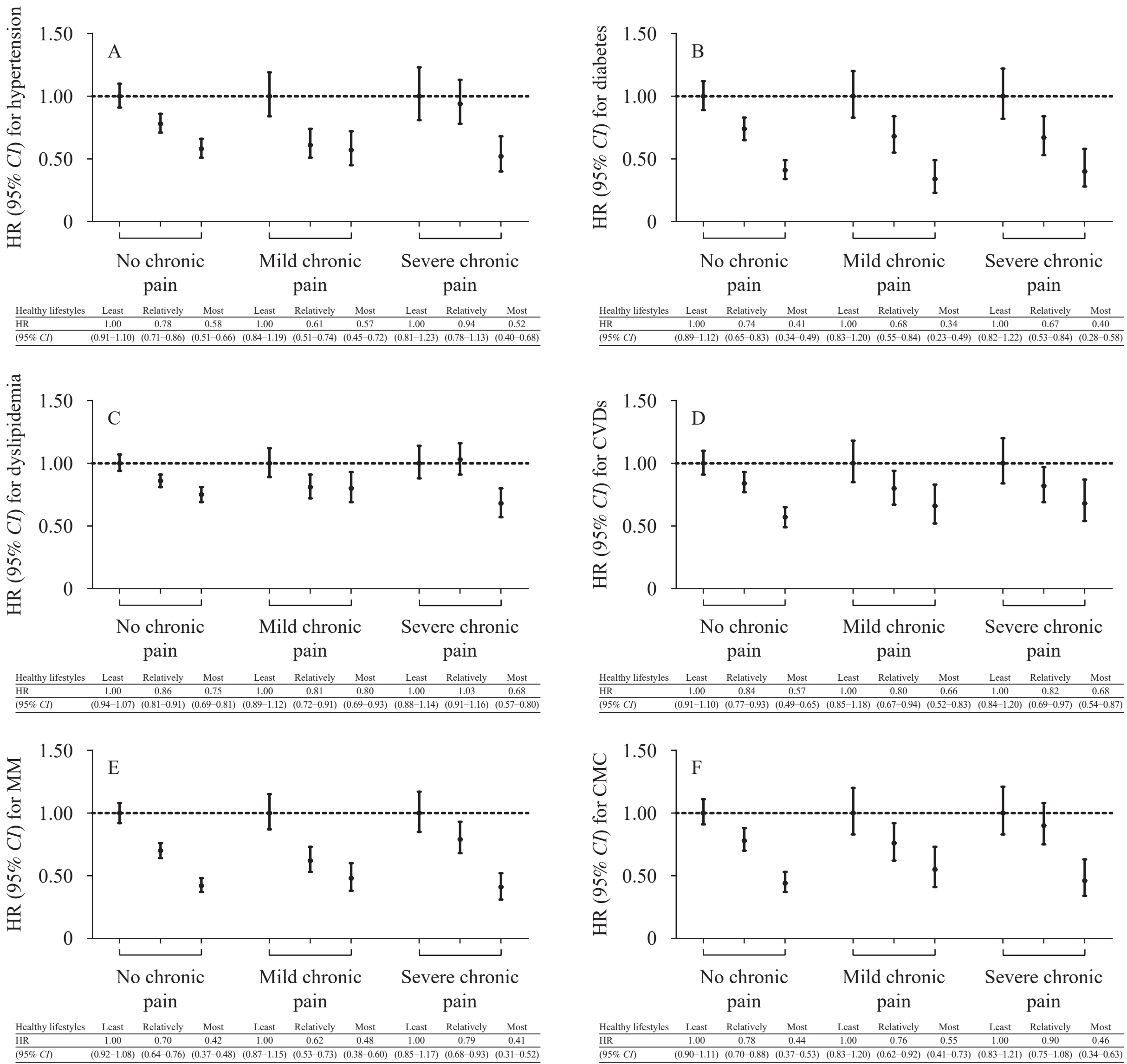
lifestyles can weaken the positive correlations between chronic pain and CVDs.

DISCUSSION

This cohort study revealed a significant association between chronic pain and heightened risks of diabetes, dyslipidemia, CVDs, MM, and CMC. Our research further found that adopting healthy lifestyle can successfully mitigate the risks of chronic pain-induced diabetes, dyslipidemia, MM, and CMC, and partially alleviate certain CVD risks.

Prior research has shown that chronic pain is linked to CVDs (*4*). The occurrence of chronic inflammation which often coexists with chronic pain, can elucidate the significant associations of chronic pain with CMDs. Even minor degrees of chronic inflammation can heighten the chances of insulin resistance and atherosclerosis, both of which play a role in the etiology of CVDs (*5*). Oxidative stress, another potential factor behind chronic pain, can give rise to insulin resistance and hyperlipidemia, which increase the risk of CVDs (*6*). Additionally, individuals with chronic pain are more prone to developing mental health disorders, such as depression, which is highly correlated with cardiometabolic risk (*7*). Nevertheless, the association between chronic pain and hypertension in our study is weak. The impact of analgesic medications used to alleviate chronic pain on blood pressure varies, which may account for the absence of significant associations. However, data related to this point were limited in the CHARLS.

Previous research has shown that adopting healthy lifestyles can effectively lower the risk of CMDs (*8*). This study presents a significant finding that healthy lifestyle choices can mitigate or even reverse risks of CMDs, MM, and CMC associated with chronic pain. Healthcare providers often recommend healthy lifestyle changes to chronic pain patients to alleviate their symptoms, decrease the likelihood of developing depression, nervous system disorders, and subsequently, cardiometabolic risks (*9*). Adopting a healthy lifestyle approach can also reduce inflammation, which has a significant association with chronic pain and CMDs. Conversely, unhealthy lifestyle choices, such as smoking, can quicken the progression of inflammation and lower the pain threshold, exacerbating chronic pain symptoms (*10*). Furthermore, through lifestyle changes, the interconnected relationship between uric acid-based



(A)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.78	0.58	1.00	0.61	0.57	1.00	0.94	0.52
(95% *CI*)	(0.91–1.10)	(0.71–0.86)	(0.51–0.66)	(0.84–1.19)	(0.51–0.74)	(0.45–0.72)	(0.81–1.23)	(0.78–1.13)	(0.40–0.68)

(B)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.74	0.41	1.00	0.68	0.34	1.00	0.67	0.40
(95% *CI*)	(0.89–1.12)	(0.65–0.83)	(0.34–0.49)	(0.83–1.20)	(0.55–0.84)	(0.23–0.49)	(0.82–1.22)	(0.53–0.84)	(0.28–0.58)

(C)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.86	0.75	1.00	0.81	0.80	1.00	1.03	0.68
(95% *CI*)	(0.94–1.07)	(0.81–0.91)	(0.69–0.81)	(0.89–1.12)	(0.72–0.91)	(0.69–0.93)	(0.88–1.14)	(0.91–1.16)	(0.57–0.80)

(D)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.84	0.57	1.00	0.80	0.66	1.00	0.82	0.68
(95% *CI*)	(0.91–1.10)	(0.77–0.93)	(0.49–0.65)	(0.85–1.18)	(0.67–0.94)	(0.52–0.83)	(0.84–1.20)	(0.69–0.97)	(0.54–0.87)

(E)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.70	0.42	1.00	0.62	0.48	1.00	0.79	0.41
(95% *CI*)	(0.92–1.08)	(0.64–0.76)	(0.37–0.48)	(0.87–1.15)	(0.53–0.73)	(0.38–0.60)	(0.85–1.17)	(0.68–0.93)	(0.31–0.52)

(F)

Healthy lifestyles	Least	Relatively	Most	Least	Relatively	Most	Least	Relatively	Most
HR	1.00	0.78	0.44	1.00	0.76	0.55	1.00	0.90	0.46
(95% *CI*)	(0.90–1.11)	(0.70–0.88)	(0.37–0.53)	(0.83–1.20)	(0.62–0.92)	(0.41–0.73)	(0.83–1.21)	(0.75–1.08)	(0.34–0.63)

FIGURE 2. Association of healthy lifestyles with new-onset CMDs, MM, and CMC in participants with no, mild, and severe chronic pain. (A) Healthy lifestyles with new-onset hypertension; (B) Healthy lifestyles with new-onset diabetes; (C) Healthy lifestyles with new-onset dyslipidemia; (D) Healthy lifestyles with new-onset CVDs; (E) Healthy lifestyles with new-onset MM; (F) Healthy lifestyles with new-onset CMC.

Note: The reference was assigned as the "Least healthy lifestyles" to explore whether the associations between adopting healthy lifestyles and outcomes differ in participants with different pain severity. All models were adjusted for age, sex, residence, education, household income, and marital status.

Abbreviation: HR=hazard ratio; *CI*=confidence interval; CMDs=cardiometabolic disorders; MM=metabolic multimorbidity; CMC=cardiometabolic comorbidity; CVDs=cardiovascular diseases.

diseases and metabolic-based diseases can be moderated, which is a matter of concern for future research.

The present study has certain limitations that should be acknowledged. First, due to data limitations, we were unable to include information on exercise and dietary intake. Nonetheless, we utilized BMI and WHtR as proxies, which may partially compensate for the absence of exercise and dietary intake data. Second, we did not consider medical therapies for chronic pain due to data limitations, which may have an impact on the conclusions reached in this study. Moreover, we identified CVDs based on self-reported physician diagnoses and/or ongoing treatments, which may introduce bias. Lastly, our approach to amalgamating various healthy lifestyles may attenuate the influence of individual health practices. To investigate the associations between various healthy lifestyles and

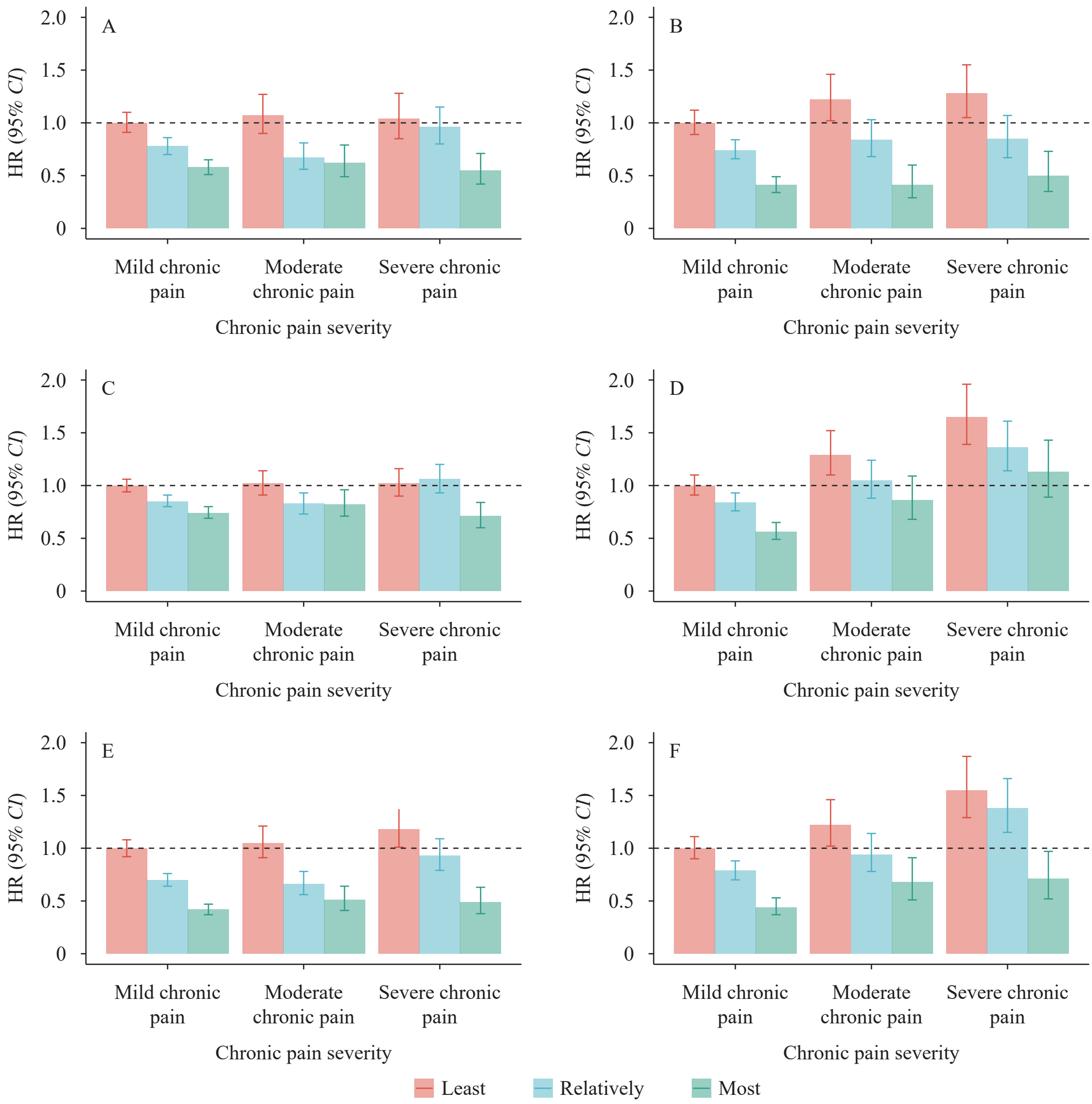


FIGURE 3. The dilution effect of healthy lifestyles on the associations of chronic pain severity with new-onset CMDs, MM, and CMC. (A) Dilution effect of healthy lifestyles on hypertension; (B) Dilution effect of healthy lifestyles on diabetes; (C) Dilution effect of healthy lifestyles on dyslipidemia; (D) Dilution effect of healthy lifestyles on CVDs; (E) Dilution effect of healthy lifestyles on MM; (F) Dilution effect of healthy lifestyles on CMC.

Note: The reference was assigned as "Mild chronic pain and least healthy lifestyles" to explore whether adopting healthy lifestyles can dilute or even mask the risks attributed to chronic pain. All models were adjusted for age, sex, residence, education, household income, and marital status.

Abbreviation: HR=hazard ratio; *CI*=confidence interval; CMDs=cardiometabolic disorders; MM=metabolic multimorbidity; CMC=cardiometabolic comorbidity; CVDs=cardiovascular diseases.

chronic pain as well as comorbidities related to metabolism, it will be necessary to conduct future research that is specific to individual health practices.

In this study, we discovered that chronic pain is a risk factor for CMDs, MM, and CMC. It was observed that practicing healthy lifestyles can help to mitigate or even reverse the risks associated with chronic pain regarding these health conditions. Through our findings, we have demonstrated the need for lifestyle interventions in chronic pain patients to alleviate their pain severity as well as lessen their later cardiometabolic risks. Ultimately, this can promote the development of healthy aging in China, making it an important avenue to explore for future research.

Conflicts of interest: No conflicts of interest.

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Perspectives

Expectations of Improvement of Socioeconomic Status Throughout the Life Course as a Component for Promoting Fertility Intentions

Chao Guo[1,2,#]; Peisen Yang[1]; Yuhan Mu[1]

The 33rd World Population Day focuses on the theme, "A World of 8 Billion: Toward a Resilient Future for All — Harnessing Opportunities and Ensuring Rights and Choices for All." As the global population approaches 8 billion, the United Nations urges individuals to consider the implications for the future. The life course paradigm emphasizes that past, present, and future experiences are interconnected and mutually reinforcing, with individuals' expectations and confidence in the future being influenced by previous and current behaviors and serving as important determinants of current decision-making (*1*).

Within the context of an aging global population, childbearing represents the starting point and significant driver of a nation's demographic development and structure. It is one of the most critical decisions in an individual's life and involves long-term family planning. Fertility intentions, one of the key determinants of birth rates and demand for reproductive health services, are typically measured by the desired number of children (*2*). These intentions reflect sociocultural norms surrounding fertility and individuals' perceptions of childbearing, often employed to summarize group differences in fertility conceptions and measure overall fertility levels.

Fertility intentions are influenced not only by individuals' current situation and family circumstances but also by their life course experiences and expectations for the future life course (*3*). Socioeconomic status (SES) serves as a multifaceted index encompassing factors such as income, occupation, and education. Research has identified SES as one of the main factors affecting fertility (*4*). An individual's family SES during childhood, their current SES, and expectations for future SES can all impact their fertility intentions.

THE IMPACT OF SES THROUGHOUT THE LIFE COURSE ON FERTILITY INTENTIONS

SES influences fertility intentions at various stages of an individual's life course. During childhood, an individual's family status can shape fertility intentions through factors such as marriage conceptions, childbearing practices, and other aspects (*5–6*). In adulthood, SES can directly affect an individual's fertility intentions by determining their ability to raise children based on their education level, income, and occupation (*7–8*). Additionally, a stronger sense of gender equality within the family can promote fertility intentions (*9*). Concurrently, individuals' expectations regarding their future status reflect the dependability of the socioeconomic "safety net" and influence their willingness to expand their family size (*3*). The following sections will further discuss these perspectives, and relevant conclusions are summarized in Figure 1.

Childhood SES

Childhood SES, or the SES of one's family of origin, significantly influences fertility intentions as it serves as the initial environment in which an individual's childbearing motivations are formed (*10*). On one hand, the childhood family's SES directly affects an individual's growth process, potentially impacting their development into adulthood. Fertility intentions are promoted through the accumulation of economic advantages (*6,11*); in other words, families with higher SES provide a favorable environment for growth and education, thereby enhancing individuals' human and social capital. As a result, these individuals gain socioeconomic advantages in adulthood, allowing them to acquire more resources and demonstrate greater resilience when faced with reproductive tasks (*12*).

On the other hand, the SES of one's family of origin

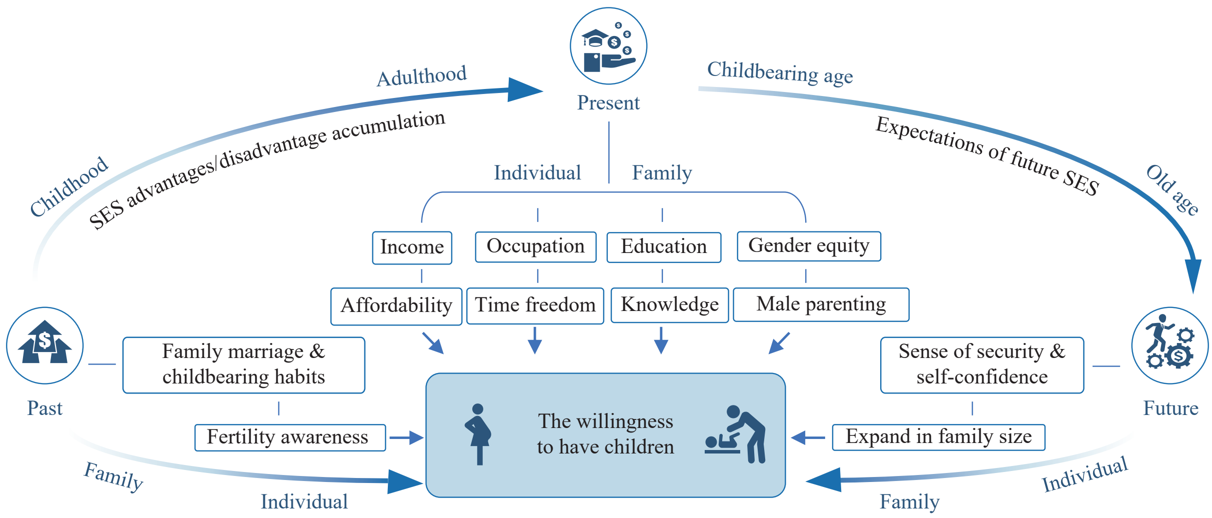

FIGURE 1. The conceptual framework of the association between socioeconomic status (SES) throughout the life course and fertility intentions.

is closely related to the family's conceptual environment, encompassing aspects such as marriage and childbearing attitudes, gender preferences, and consumption patterns. Such factors may influence individuals' fertility conceptions in adulthood through social learning and intergenerational transmission (*13*). Families with high SES convey their values to the next generation, thereby fostering higher-quality development for future generations (*1*).

Current SES

Current SES is a significant factor influencing an individual's intent to have children. A person's current SES directly and realistically impacts their willingness to engage in childbearing. Individuals with higher SES benefit from increased social welfare and economic security, both of which positively affect fertility decisions.

First, higher incomes contribute to greater economic stability and fertility affordability, providing sufficient resources to support childbearing (*9,14–16*). Furthermore, higher occupational positions offer increased flexibility in work schedules, facilitating the reconciliation of employment and fertility (*17*). Additionally, higher education levels promote a more scientific approach to child-rearing and parenting, directly enhancing the growth and educational environment for the subsequent generation (*18–20*). Moreover, families with higher SES typically exhibit a stronger sense of gender equality. As a result, men's increased participation in housework and childcare reduces the burden on women, thereby increasing the family's inclination to have children (*1*).

Although some researchers argue that improved SES may potentially suppress fertility intentions (*2*), the overall perspective of social development suggests that better socioeconomic status remains the most direct contributor to individual fertility.

Future SES

The expectation of future SES serves as a long-term motivator for fertility. As a part of a long-term family plan, childbirth is inherently connected to the expectation of an improved quality of life in the future. Both childhood and current SES influence expectations of future SES, and those expectations also impact present fertility intentions and decisions. The anticipation of a higher SES in the future cultivates a heightened sense of security and self-confidence, encouraging families to grow in size, have more children, and nurture a larger and higher quality succeeding generation. This subjective dimension provides long-term motivation for fertility (*21*).

Individual expectations of the future not only influence current fertility decisions but also shape future family structures and old age. A family with an increasing SES undoubtedly contributes to the creation of a "resilient future."

DISCUSSION

As one of the most populous nations, China has experienced rapid socioeconomic development over the past few decades. The role of SES in promoting fertility intentions demonstrates that during a period when China is actively addressing low fertility rates, national strategies such as economic growth and common prosperity align with population development goals to encourage higher fertility. Enhancing an individual's SES necessitates a life course perspective, acknowledging that past, present, and future experiences are interconnected and inseparable, as well as the relationship between parents and offspring (*22*). While it is impossible to alter one's childhood SES retrospectively, enhancing one's current SES establishes a foundation for the living conditions of future generations (*1*), promotes better health at birth, and contributes to a more resilient future (*12–13*).

Hence, a crucial aspect of public policies is enhancing social security and well-being, and facilitating smooth social mobility channels, enabling more individuals to attain higher living standards and socioeconomic status while fostering confidence in the future. This approach stimulates aspirations for an improved family life and comprehensive planning, subsequently leading to heightened fertility intentions and a more pervasive sense of happiness within society. This mutual reinforcement can assist China and other comparable settings in gradually elevating fertility levels while simultaneously advancing their socioeconomic development to address the challenges posed by an aging population.

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