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Unveiling the direct and indirect effects of sibling size on happiness: evidence from adults in early and mid-adulthood in China

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As China grapples with the dual policy challenges of declining birth rates and the pursuit of individual happiness, understanding the relationship between these two factors is important. This study empirically examined the influence of sibling size on happiness in China, distinguishing between direct and indirect channels of impact. Using data from the 2008 Chinese General Social Survey, this analysis focused on how sibling size shapes individual income and education levels, which are both key determinants of happiness. It addressed the endogeneity issue inherent in sibling size by employing variations in the implementation of family planning policies across provinces in the 1970s as instrumental variables. The findings revealed an indirect relationship between sibling size and happiness; an increase in sibling size negatively affected both income and education levels, subsequently reducing happiness. This study contributes to the ongoing dialogue on the relationship between family size and individual happiness in China by offering nuanced insights into the channels through which these effects occur. This study also highlights the policy implications, suggesting that initiatives to raise the birth rate should be accompanied by efforts to enhance income and educational opportunities to foster individual happiness.

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Introduction

China's demographic landscape has experienced a significant flux over the last few decades, prompting radical shifts in population policy. The nation has transitioned from stringent birth controls under the one-child policy to policies designed to encourage larger families in response to the challenges of an aging population and declining birth rates. The relaxation of the one-child policy in 2013 to permit two children for families with a single-child parent, and its subsequent extension to all families in 2015, culminated in a 2021 allowance for families to have three children (State Council of PRC, 2015, 2021). Despite these legislative changes, China faces an unyielding decline in birth rates, reaching a historical nadir of 0.752% in 2021 (National Bureau of Statistics of the People's Republic of China, 2021). The undercurrent of this demographic strategy reflects a broader concern: the impact of a shrinking and aging population on the healthcare and pension systems and the labour force. An aging society carries socioeconomic burdens, raising questions about its effects on the economic obligations of the working-age population, and inextricably, their subjective well-being. In a departure from traditional economy-centric development goals, the recent National Congress of the Communist Party of China shifted its focus to prioritising the well-being and happiness of the population (CCP, 2022).

Amidst these demographic shifts, the dynamics of sibling size and their influence on personal happiness have garnered attention. The World Happiness Report indicated that Chinese residents' happiness levels showed remarkable resilience from 2015 to 2019, with an uptick post-2020, contradicting assumptions of a happiness decline parallel to the falling birth rate (Blazyte, 2023; Helliwell et al., 2023). This paradox could be partially explained by the "quality-quantity" trade-off hypothesis, suggesting that having fewer siblings enables parents to allocate more resources per child, enhancing their well-being. However, the relationship between sibling size and happiness in China remains unclear.

Research on the relationship between subjective well-being and family size, especially the number of siblings, in the Chinese context, has increased in recent years; however, there is no definitive consensus on these results. Some studies found a positive relationship between subjective well-being and the number of siblings or family size, arguing that only children without sibling support face the burden of parental child-rearing responsibilities and have lower subjective well-being (Lei et al., 2015; Chen and Yan, 2021; Chen and Fang, 2021; Liao et al., 2022). Conversely, other studies found a negative relationship, with individuals without siblings benefiting from greater familial resource investment, which may lead to better educational outcomes, higher social status, and, ultimately, greater well-being (Wang et al., 2013; Lin et al., 2021). Other studies found a nonlinear relationship between the number of siblings and happiness, suggesting that too many children and only children have a negative impact on happiness (Fan, 2016; Zhao, 2022).

However, a critical lacuna exists in the extant literature: a failure to account for the indirect pathways through which sibling numbers might influence happiness. In a closely related area, there is a growing body of research on how the number of siblings affects a person's subsequent level of education and income in China (e.g., Qian, 2009; Liu, 2014; Weng et al., 2019). As education and income are important determinants of happiness, it is important to examine the indirect effects of the number of siblings on happiness through these channels.

Furthermore, the complexity of the sibling number as an endogenously determined variable based on parental choice complicates its causal link to happiness and educational attainment, requiring careful consideration. That is, the number of children depends on various other factors, such as the family

environment and parental preferences, which may be unobservable and affect the educational attainment of individuals and their happiness. In this case, estimating the impact of the number of children on the educational attainment and happiness variables through regression analysis would introduce bias into the estimated coefficients, preventing their interpretation as part of a causal relationship. This endogeneity problem has been widely addressed in empirical analyses of the relationship between the number of children and educational attainment in China but has not been addressed much in Chinese studies of happiness.

This study empirically examines the relationship between the number of siblings and happiness in China, filling the gaps in the existing research from the above perspective. Using data from the 2008 Chinese General Social Survey (CGSS, 2008), this study meticulously dissects both the direct and indirect impacts of sibling size on individual happiness. It addresses the intrinsic value of siblings and their potential role as conduits that influence educational and income levels, which are pivotal determinants of happiness. In addition, it addresses the endogeneity issue by employing instrumental variables to navigate the causality challenge. In particular, this study leverages provincial variations in the implementation of the one-child policy during the 1970s as instrumental variables to unravel the causal pathways at play. This study presents a pioneering econometric analysis that substantiates the multifaceted impact of family size on individual happiness in China's unique demographic context.

The remainder of this paper is organised as follows. Section "Literature review" describes previous studies on the relationship between the number of siblings and individual happiness. Section "Data and setting" describes the data and background. Section "Methodology" presents our methodology for estimating the effect of the number of siblings on educational attainment and income and for dealing with endogeneity bias. Section "Results and discussion" presents the main results of the study. Finally, Section "Conclusion" concludes the paper.

Literature review

This study examined the pathways through which the number of siblings influences subjective well-being. The number of siblings may have a direct impact on individual subjective well-being, but may also have an indirect impact on socioeconomic status, such as income and education. In the following section, we review the existing studies and state our hypotheses within this framework.

The direct effect of sibling size on happiness. The number of siblings may have an intrinsic value and be a direct factor in creating a sense of happiness. However, existing empirical studies have found little association between the number of siblings and individual happiness after controlling for confounding factors such as parental status and one's own income and education (e.g., Miller et al., 2001; Holder and Coleman, 2009). Examining the effect of sibling status on children's happiness is useful for examining direct effects because, unlike adults, it eliminates the possibility of an indirect effect of the number of siblings on an individual's educational background and income. Holder and Coleman (2009) examined the impact of happiness on social relationships among 432 children aged 9–12. They found that the number of siblings had little or no correlation with happiness. However, existing research indicates that birth order is often related to happiness. For example, Fukuya et al. (2021) used data from the Adachi Children's Health Impact of Living Difficulties (A-CHILD) study to investigate the relationship between birth order and mental health problems, self-esteem, resilience, and

happiness in 9–10-year-old children. They found that middle-born children had the lowest happiness scores.

In China, different results have been presented in recent empirical studies on the relationship between happiness and the number of siblings, but the details of the indirect effects and channels remain open to study (Chen and Fang, 2021; Chen and Yan, 2021; Fan, 2016; Lei et al., 2015; Liao et al., 2022; Lin et al., 2021; Wang et al., 2013; Wang and Zhou, 2018; Zhao, 2022). Several studies have found a positive relationship between subjective well-being and the number of siblings or family size, arguing that families facing the one-child policy and children without the support of siblings face various negative effects on their mental health, face the burden of parental child-rearing responsibilities, feel lonely, and have lower subjective well-being (Lei et al., 2015; Chen and Yan, 2021; Chen and Fang, 2021; Liao et al., 2022). Other studies found a negative relationship (Wang et al., 2013; Lin et al., 2021). Wang et al. (2013) used the 2008 CGSS to estimate the generation after 1979, estimating the relationship between the two and finding a negative relationship. The analysis of the post-1980 generation is also meaningful because the number of children in China showed deviations in the 1980s due to the relaxation of the one-child policy, as described later. The negative relationship seen in recent generations suggests that only children feel more secure about their lives, which may be because they have a greater share of their parents' assets and property and have better mental capacity. Moreover, several studies have focused on the complex patterns of relationships. Wang and Zhou (2018) found that happiness increases when there are more male than female siblings, while Wang (2023) found that the relationship depends on economic status. Zhao (2022) and Fan (2016) found a nonlinear relationship in which happiness increased with the number of children but decreased with too many children. However, these studies did not highlight the indirect effects of the number of siblings on subjective well-being through the effects of education and income, and the pathways of these effects are not clear.

Existing studies suggest that the number of family members affects happiness; however, more specifically, the effect is likely to be secondary or indirect, such as the effect of birth order or higher income due to siblings helping each other; it is difficult to state that the number per se has a clear direct effect on happiness. If we controlled for income, education, and other relevant factors, the direct relationship between family size and individual happiness would probably weaken. Based on these arguments, we formulated the first hypothesis:

Hypothesis 1: In China, sibling size has no direct association with individual happiness, after controlling for income and educational attainment.

The indirect effect of sibling size on happiness through the income channel. Numerous happiness studies have suggested a positive correlation between income and happiness, and this channel is essential when considering the indirect effects of the number of siblings on happiness. In happiness research, it has long been known that income is a major factor in happiness, but the relationship has been regarded as nonlinear and is not observed above a certain income level (e.g., Howell and Howell, 2008; Kahneman and Deaton, 2010). Recently, in China, this relationship applies in the same way and empirical studies have shown that income and happiness are positively correlated (Xing, 2011; Zhu and Yang, 2009; Zhang, 2021; Wang, 2011; Hunag, 2013). Furthermore, income inequality and happiness are strongly correlated, but the relationship is nonlinear (Zhang and Cai, 2011). Thus, if the number of siblings affects income, it should be considered as indirectly affecting happiness.

Regarding the relationship between sibling size and income, several empirical studies point to a negative association, including in China (Keister, 2003; Parr, 2006; Lampi and Nordblom, 2010; Lersch, 2019; Skog, 2019; Wang et al., 2020). The mechanism is explained by the dilution hypothesis; that is, siblings dilute their parents' finite economic resources and nonmaterial resources, such as time (e.g., Keister, 2003; Lersch, 2019). This reduction in resources can negatively affect not only children's educational attainment, as discussed below, but also their economic attainment by reducing their inter-vivo transfer and inheritance. In the case of China, existing studies point out that the one-child policy limited the number of children and promoted the accumulation of human capital per child, resulting in the personal income of an only child greatly exceeding that of a non-only child (Wang et al., 2020; Liao, 2013). Wang et al. (2020) found that the number of siblings has a negative effect on income based on individual data from the 2006 and 2008 CGSS for those aged 18 years and older, dealing with the endogeneity of the number of siblings using the sex of the first-born child as an instrumental variable. However, in the case of China, different results have also been produced; some studies suggest that the two are nonlinear (Liu et al., 2020), whereas others suggest a positive correlation when a policy variable related to the number of children is used as a proxy variable for the number of siblings (Liu and Wei, 2016; Liang, 2017). However, further studies are needed for confirmation.

Based on the above considerations, we propose the following hypothesis regarding the impact of family size on happiness through income in China:

Hypothesis 2: Sibling size affects individual happiness through its effect on income. In China, when the number of siblings increases, a person's income decreases, which leads to a decrease in individual happiness.

The indirect effect of sibling size on happiness through the education channel. The existing literature suggests that higher individual educational attainment increases individual happiness, which should be considered as another indirect pathway by which family size affects happiness. Education can change a person's knowledge and cognitive abilities, leading to the acquisition of vision and skills that lead to happiness. In China, Hunag (2013) and Qiu and Zhang (2021), using the CGSS 2005 and CGSS 2017, respectively, showed that high educational attainment and high subjective well-being are positively correlated. Their studies suggested that a higher education level (before graduate school) had the greatest effect on happiness. Given that education has an indirect effect on employment, income, and other social interactions, its impact on happiness may be more significant than income alone. Florida et al. (2011) demonstrated this for urban residents in the United States, arguing that education is more important for happiness than income.

The next point to consider is how sibling size affects educational attainment, which, in turn, can affect happiness. Previous studies have presented conflicting views on this topic. On the one hand, several studies have suggested that there is a trade-off between quantity and quality (Becker, 1964; Blake, 1981; Karwath et al., 2014; Kugler and Kumar, 2017; Klemp and Weisdorf, 2011). Parents must choose between quantity, family size, quality, and the amount of economic resources provided to each child. Households with fewer children can provide more care and resources to each child. Consequently, an increase in the number of siblings reduces the probability of college admission, completion of higher education, and the attainment of an additional year of schooling. However, several empirical studies have suggested that family size has no effect or positive effects on

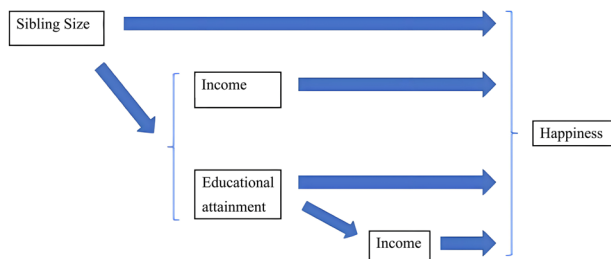


Fig. 1 Direct and indirect pathways of sibling size on happiness.

educational achievement (Black et al., 2005; Angrist et al., 2010; Schultz, 2007; Qian, 2009). This positive relationship can be attributed to the effects of economies of scale on childcare and education. An increase in the number of siblings in a family can improve the quality of siblings' experiences by granting them opportunities to learn from one another. In addition, there may be economies of scale in the costs of childcare or items such as clothing and textbooks such that one additional sibling reduces the marginal cost of care for all children.

Several empirical studies have tested this relationship in China, and recent results seem to support the quantity–quality trade-off hypothesis (Weng et al., 2019, 2020; Zhong and Dong, 2018; Liu and Wei, 2016; Liang, 2017). For example, Weng et al. (2019) examined this relationship in detail using datasets from the 2013 China Household Income Project survey. They utilised regional differences in China's family planning policy as instrumental variables, and the results supported the negative impact of family size on educational attainment; that is, a trade-off between quantity and quality. Using multiple microdatasets (CGSS and CFPS), Zhong and Dong (2018) showed that an increase in the number of siblings in Chinese households decreases individual educational outcomes and that this effect is more severe for women.

Based on the above discussion, we propose the following hypothesis regarding the impact of family size on happiness through education in China:

Hypothesis 3: Sibling size affects individual happiness through its effect on education. In China, when the number of siblings increases, a person's educational attainment decreases, which leads to a decrease in individual happiness.

Endogeneity issues in the direct and indirect pathways from the number of siblings to happiness. In light of the foregoing discussion, the causal pathway of the number of siblings on happiness is summarised in Fig. 1. Hypothesis 1 predicts that the direct effect of sibling size on happiness (top arrow) is only apparent, whereas the indirect effect through income and educational attainment is what is actually important. Hypotheses 2 and 3 predict that the effect of the number of siblings on income and educational attainment will be negative; consequently, the indirect effect on happiness will be negative.

One methodological challenge in testing causal relationships in an empirical analysis is the endogeneity of the number of siblings. This endogeneity issue has been a major challenge in examining the effect of the number of siblings on education in the literature (e.g., Qian, 2009; Liu, 2014; Chen and Fang, 2021; Weng et al., 2019), which could also be applied to examining the effect on income and happiness. The number of children depends on the parents' environment and preferences. However, if these are unobservable factors that also affect the child's educational investment, earning capacity, or happiness, an endogeneity bias in the sibling size variable arises, and ordinary least squares (OLS) cannot correctly estimate the effect of sibling size on these

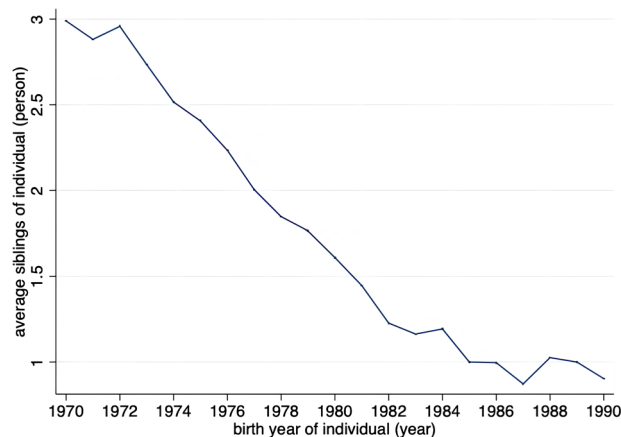


Fig. 2 Birth year and average number of siblings. Sources: Author's calculation based on the 2008 Chinese General Social Survey (CGSS).

outcomes. Families with more liberal values may tend to prefer having fewer children with higher levels of education (e.g., Lesthaeghe and Surkyn, 1988). It is also possible that the unobserved economic environment and human connections possessed by parents have an impact on children's access to jobs, income, as well as their subjective well-being (e.g., Tuominen and Haanpää, 2022).

To address this issue, we utilised information on provincial-level heterogeneity in the implementation of family planning policies in the 1970s. While previous studies have tended to utilise the differences in the number of siblings caused by the one-child policy and the revisions to it in the 1980s (e.g., Qian, 2009; Liu, 2014), actual changes in fertility in China began in the early 1970s when provincial governments established Family Planning Leading Groups (FPLs) at different times. Figure 2 presents the average number of siblings in the sample by birth year. The findings confirmed that the decline in fertility began around the beginning of the 1970s, far ahead of the implementation of the one-child policy. This is consistent with recent studies on the impact of the one-child policy (McElroy and Yang, 2000; Zhang, 2017; Chen and Huang, 2020). Previous studies confirmed that the establishment of these organisations caused differences in provincial fertility levels and used differences in the timing of the establishment of the FPLs to estimate the impact of the number of children on parents' well-being in old age in China (Chen and Huang, 2020; Chen and Fang, 2021); we followed this strategy.

Data and setting

This study conducted empirical analyses using datasets from the 2008 Chinese General Social Survey (CGSS). The CGSS data were collected by the China National Survey Data Archive (CNSDA), which is supported by the International Social Survey Programme (ISSP) and East Asian Social Survey (EASS). The data cover both urban and rural areas and include information on individual-level educational attainment and family backgrounds. The survey used four-stage stratified (district/county, township/street, neighbourhood/village, and household) unequal probability-sampling methods. The sample included 29 of 34 provinces.

The 2008 CGSS has advantages over the same and other surveys from other years in terms of the uniqueness of the data. First, the data include information on the economic and social status of individuals and households as well as answers to subjective questions about happiness. Information on siblings, including those who live apart from the household, is recorded; in particular, the ages of siblings are available, which provides information on birth order. In addition, information on the parents'

Table 1 Descriptive statistics.

Variables	(1)	(2)	(3)	(4)	(5)
	Obs	Mean	SD	Min	Max
Income(log)	4227	9.368	0.998	4.605	14.982
Years of education	5913	10.397	3.607	1	24
Number of siblings	6102	2.078	1.676	0	12
Gender (female)	6102	0.549	0.498	0	1
Communist party membership	6102	0.186	0.389	0	1
Health status	6102	3.981	0.906	1	5
Marital status	6102	2.359	127.995	0	1
Rural	6096	0.477	0.5	0	1
Birth order	6102	2.306	1.534	1	12
Birth year	6102	1977.02	5.519	1969	1987
Birth year of mother (1939-1941)	4030	0.076	0.266	0	1
Birth year of mother (1942-1944)	4030	0.093	0.29	0	1
Birth year of mother (1945-1947)	4030	0.121	0.326	0	1
Birth year of mother (1948-1950)	4030	0.16	0.367	0	1
Father's years of education	6102	3.352	3.747	0	16
Mother's years of education	6102	2.358	3.2	0	16
Father's job: Civil servant	6102	0.025	0.157	0	1
Father's job: State firm	6102	0.223	0.416	0	1
Father's job: Other	6102	0.127	0.333	0	1
Mother's job: Civil servant	6102	0.007	0.084	0	1
Mother's job: State firm	6102	0.136	0.343	0	1
Mother's job: Other	6102	0.086	0.28	0	1

Sources: Authors' calculations based on the 2008 Chinese General Social Survey (CGSS). The sample is restricted to individuals who were born after 1968 and before 1988.

occupation when the individual was 14 years old was recorded. This is particularly important when examining the determinants of educational attainment, which is a key concern of this study. This is because the age of 14 is near the end of compulsory education in China, a time when decisions are made about whether to pursue additional educational attainment. In addition, information on the respondent's place of birth and the current place of residence was recorded.

Table 1 presents the summary statistics of the basic variables from the datasets. The sample is limited to those born between 1968 and 1988. The reason for limiting the sample to those born after 1968 is that, as discussed below, this study takes advantage of the exogenous variation due to China's family planning policies that began in the late 1960s to address endogeneity bias in the sibling size variable. We also exclude those born after 1988 because they may still be enrolled in higher education institutions at the time of the survey and their educational attainment (or years of education) and income cannot be properly assessed. Removing observations from other generations resulted in a sample of 6102 individuals. The main variable, individual happiness, used in this study comes from a question in the 2008 CGSS questionnaire: "Overall, do you think you are happy now?" The answers ranged from 'very unhappy' to 'very happy'. Each level of happiness is assigned a number from 1 to 5, that is, 1 indicates very unhappy, 5 indicates very happy, and so on. For the Health Status variable, we used responses to a question that asked about health on a 5-point scale. Rural variable is a dummy variable made from the residential registration (Hukou note) where it is 1 for individuals registered in rural areas and 0

otherwise. Parental occupation types were included as dummy variables and reflected the parents' job type when the respondent was 14 years of age. Stable jobs such as civil servants and employees in a state-owned enterprise have specific dummy variables, and the category "other" includes other private, unstable, or minor jobs, while unemployment status is used as the reference category.

Figure 3 shows how the variables of our primary interest—happiness, income, and education—change on average as the number of siblings increases, based on our dataset. These three figures clearly confirm that the number of siblings is negatively correlated with happiness, income level, and education level in China. The effects of the number of siblings beyond one or two are considered meaningful, even in the context of the one-child policy in China; in fact, our data show that more than 20% of individuals born in rural areas in the first half of the 1980s had two or more siblings. Figure 3 confirms that the level of happiness decreases with the number of siblings in China; however, this cannot be immediately interpreted as representing a causal relationship. Furthermore, we do not know how the number of siblings affects income and education levels, and thus, indirectly, how it affects happiness. This study examines this point in detail through an econometric analysis.

Methodology

Relationship between family size and individual happiness. For the baseline model with happiness as the dependent variable, we estimated the following latent regression with an ordered probit model, given that the happiness indicator is a discrete variable.

$$H_i = \alpha + \beta_1 S_i + \beta_2 I_i + \beta_3 E_i + X_i' \beta_4 + \varepsilon_i, \tag{1}$$

where H_i represents the latent variable of the happiness level of individual i , I_i is the log of the income of individual i , E_i is the educational attainment (the year of education) of individual i , S_i is the number of individual i 's siblings, X_i' is a vector of individual characteristics, and ε_i is the error term. X_i' represents the factors that affect happiness and includes the following variables: gender, birth year, health status (from 1 to 5, the healthier it is, the higher the number), marital status, educational attainment (number of years), income, communist party membership, and residential registration (Hukou Note)¹. Furthermore, provincial fixed effects based on residential registration were included.

Note that the interpretation of β_1 , the coefficient of the number of siblings, differs depending on whether I and E are added or dropped in this estimation equation. β_1 in the case of the estimation equation in which I and E are dropped, shows the association between the number of siblings and individual happiness, which includes the effect of the number of siblings on happiness indirectly through income and education effects. In this sense, β_1 can be considered to represent the total effect, including indirect and direct effects. On the other hand, β_1 in the estimation equation including I and E shows the correlation between the number of siblings and happiness, which remains after the indirect effects of the number of siblings on happiness through income and education effects are excluded. In this case, β_1 can be regarded as representing a direct effect. In our estimation, we have carefully checked this point.

Relationship between income/education and individual happiness. Based on the above results and to further examine the effect of the number of siblings on an individual's income and education (which are predicted to be important determinants of happiness) in more detail, we also attempt to estimate the

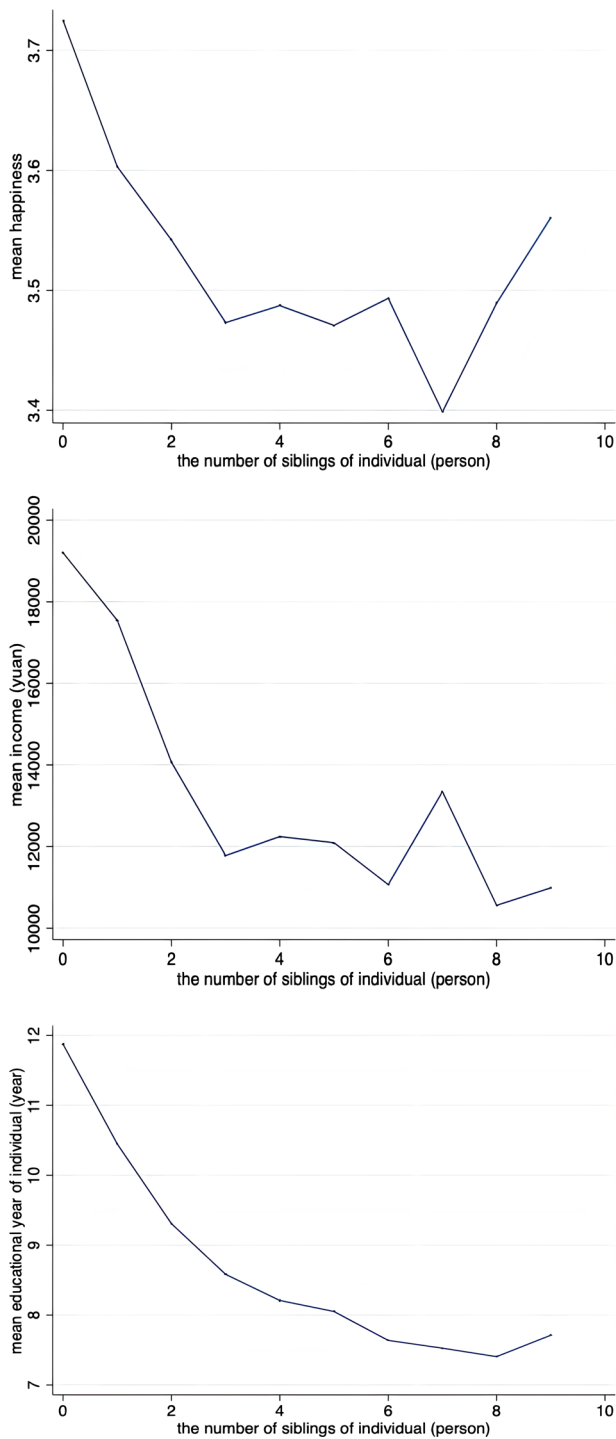


Fig. 3 The relationship between number of siblings and happiness/income/educational attainment. Sources: Author’s calculations based on the 2008 Chinese General Social Survey (CGSS).

following:

$$Y_i = \gamma + \delta_1 S_i + Z_i' \delta_2 + \mu_i, \tag{2}$$

where Y_i represents the (logarithm of the) income or years of education of individual i , S_i is the number of individual i ’s siblings, Z_i' is a vector of individual and household characteristics, and μ_i is the error term.

The vectors Z_i' include the factors that affect income/educational attainment and include the following variables:

gender, residential registration (Hukou Note), (individual or parental) birth years, parental years of education, and parental occupational status when the individual was 14 years old. Furthermore, provincial fixed effects were included based on information from residential registration. In models in which individual income was the dependent variable, we also compared the results with and without years of education as an independent variable. This is to consider the pathway through which the number of siblings affects education, which in turn affects income.

IV approach. As mentioned earlier, in the estimation Eqs. (1) and (2), we need to address the problem that the sibling number variable S_i can be an endogenous variable. Therefore, we utilised information on provincial-level heterogeneity in the establishment of FPLs during the 1970s. Specifically, we created a policy exposure variable as an instrumental variable by taking the difference between the birth year of the individual and the year in which the local FPL was established in the province where the individual was born. It takes the value of zero if the group has not yet been established. It is assumed that the more time that passes since the establishment of the FPL, the more widespread the policy will be and the greater its impact on childbirth decisions. Furthermore, as explained below, we differentiated the timing of the establishment of the FPL within the same province.

There are rational reasons to assume that this instrumental variable satisfies the exclusion restriction, i.e., it does not directly affect the outcomes of interest to us, i.e., current income and education levels. First, the aim of establishing the FPL was solely to manage the birth rate, and not to improve education or income. Second, unobserved provincial-specific factors may affect both fertility and outcomes, which can be controlled by including provincial fixed effects. Since this instrumental variable takes the difference from one’s birth year, it is possible to include provincial fixed effects since individuals within a province can take different variables. In addition, to account for the diversity within the province, we differentiate within the same province the founding year of the FPLs, as explained below. Third, the assumption that this instrumental variable has no direct impact on the outcomes of our interest, happiness, education, and income, is suggested, in part, by the result that when this instrumental variable was included as an independent variable in the second stage estimation, it did not have significant results (see Table A3 in Supplementary Tables).

We collected data on the year of the establishment of the FPLs from provincial population chronicles and the Encyclopaedia of Chinese Family Planning (Peng, 1997). The first provincial FPL was established in 1969 in Guangdong. After 1969, three committee levels—provincial, prefectural, and county—were gradually established throughout the country. In 1971, the State Council issued Document [71] No. 51, “Report on the Better Implementation of Family Planning Policies,” and FPLs were gradually established everywhere, from provincial capitals to provincial cities and from urban areas to rural areas (Peng, 1997). Thus, we introduce variation within the same province during the year of FPL establishment, given that the effect of the diffusion of policies was not uniform even within a province. Specifically, the year in which the FPL was established in a provincial capital is identified as the year of establishment for the provincial capital, while for other locations in the province, the year of establishment is the year recorded in the policy document for the province as the year when “FPLs have been disseminated to all locations in the province, such as cities, counties and villages” or “The entire province has started work on FPLs across the board.”

Table A2 in Supplementary Tables presents the first-stage estimation results, in which the dependent variable is the number

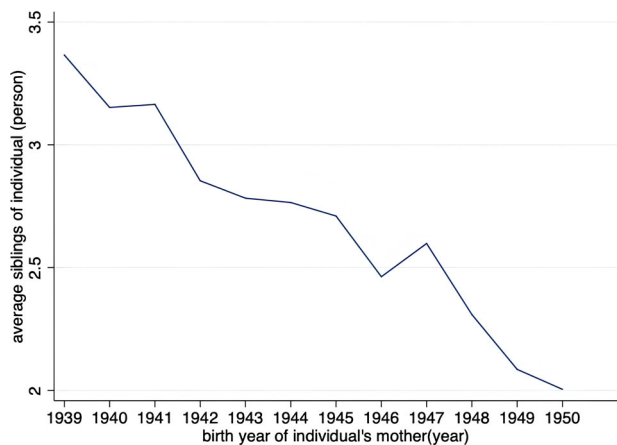


Fig. 4 Mother's birth year and average number of siblings. Sources: Authors' calculations based on the 2008 Chinese General Social Survey (CGSS).

of siblings. The results of model (1) were used to estimate the effect on education in the second step, those of model (2) were used to estimate the effect on income, and those of model (3) were used to estimate the effect on income (including education variables as independent variables). For the effect of year of birth, the mother's age at birth was added as a variable instead because of concerns about the correlation of the individual birth year with the instrumental variable. As shown in Fig. 4, the age of the mothers illustrates the relationship whereby the number of children declines as one moves down generations. We confirm that the instrumental variables are negative and significant at the 1% level in all models, implying that the FPL strongly affected the number of siblings, as predicted. Furthermore, we obtain intuitive results for several independent variables. The coefficients of the female dummy variable and the rural residence variable are positive and significant in all models, while parental education has a negative effect.

Results and discussion

The direct association between sibling size and happiness.

Table 2, which presents the estimation results of Eq. (1), suggests that the strong correlation observed between the number of siblings and happiness in China is generally due to indirect effects and not a direct relationship. As shown in model (1), a negative association between the number of siblings and happiness was observed when explanatory variables other than provincial fixed effects were not controlled. However, when we added other control variables including the years of education variable in (2) or the income level variable in (3), this relationship became completely insignificant. This suggests that the number of siblings does not have a direct effect on happiness, but only an indirect effect through other variables such as education and income. In fact, the education and income variables seemed to be very strong explanatory factors, and the positive correlation remained significant at the 1% level when both variables were simultaneously input in (4). Further, we performed 2SLS estimations using the instrumental variables and methods described in Section 4.3. The results are shown in (5). Although the null hypothesis that the number of siblings is an exogenous variable was not rejected in this estimation (bottom panel of (5)), the number of siblings was still non-significant in this estimation. These results support Hypothesis 1.

We will now offer additional remarks on the interpretation of Table 2: First, we examined the explanatory variables that would make the number of siblings insignificant. As shown in Table A1

in the Supplementary Tables, the negative significance of the number of siblings variable was maintained when including birth order, birth year, gender, Communist Party membership, health status, and marital status, as well as provincial fixed effects ((2) in Table A1). However, when the rural variable was added ((3) in Table A1), or when the income or education variables were added, the number of siblings became insignificant. However, the rural variable was highly correlated with the income and education variables and became non-significant when all three variables were included simultaneously (see (4) in Table 2). This suggests that the variables including indirect effects could be income and education variables. Second, when the sample was restricted to the younger generation, the negative significance, albeit at the 10% level, tended to hold, as shown in Model (4) of Table A1. This result is consistent with some existing studies in China (e.g., Wang et al., 2013), indicating that the number of siblings may affect happiness more directly among younger generations. However, the significance level was low, and there appears to be insufficient evidence to support this point.

The association between sibling size and income. Table 3 shows the results of estimating the effect of the number of siblings on personal income using OLS and 2SLS with instrumental variables. First, the coefficients of the number of siblings were negative and significant at the 1% level for OLS, whereas they were non-significant for 2SLS. However, for the 2SLS results, we should consider the fact that the exogeneity test (Hausman's test) did not reject the exogeneity of the number of siblings (bottom of the table) in this estimation. Thus, the 2SLS estimators should be considered less efficient. In other words, the results strongly suggest that the number of siblings negatively affects income. Furthermore, a comparison of models (2) and (3) confirms that the number of siblings had both an indirect effect on income through the education variable and a direct effect on income without going through the education effect. Specifically, the coefficient of -0.058 in the model (2) indicates the total effect of both effects combined, while the coefficient of -0.028 in model (3) indicates the direct effect, and the difference of -0.030 indicates the indirect effect (Karlson and Holm, 2011). In China, a larger number of children is suggested to reduce income by decreasing family resources per child (e.g., land, inheritance, and human connections), which are useful in obtaining income-earning capacity and means. This, together with the results in Table 2, suggests that the number of siblings reduces income and indirectly lowers happiness, supporting Hypothesis 2.

The results for the coefficients of the other independent variables were largely as predicted. The negative coefficient of the gender dummy implied that females have a lower income than males. The coefficient of Communist Party membership was positive and significant at the 1% level, meaning that the wider one's social network, the higher one's income. The positive coefficient of health status implied that healthy individuals earn more. Marital status was also positive, indicating that married people earn higher incomes. The coefficients of the parental years of education were positive and significant at the 1% level, suggesting that people raised by educated parents have a higher income. The negative coefficient of the rural variable indicated that individuals in rural areas face income disadvantages (poor employment environment, fewer jobs, and low incomes).

The association between sibling size and educational attainment.

Table 4 shows the results of the OLS and 2SLS estimates of the effect of the number of siblings on an individual's educational level. The results revealed a negative effect at the 1% level in all models. In this estimation, the exogeneity of the number of

Table 2 Ordered probit estimates of the effects of the number of siblings on happiness.

Variables	(1) Model 1 Ordered probit	(2) Model 2 Ordered probit	(3) Model 3 Ordered probit	(4) Model 4 Ordered probit	(5) Model 5 2SLS
Number of siblings	-0.057*** (0.008)	0.002 (0.019)	-0.010 (0.019)	0.008 (0.020)	-0.071 (0.083)
Birth order		-0.010 (0.017)	-0.004 (0.017)	-0.012 (0.018)	0.074 (0.064)
Birth year ^a		0.006* (0.003)	0.008** (0.004)	0.008* (0.004)	0.009*** (0.003)
Gender		0.189*** (0.034)	0.240*** (0.039)	0.228*** (0.039)	0.196*** (0.035)
Communist party membership		0.103** (0.041)	0.109** (0.047)	0.050 (0.048)	0.082* (0.044)
Health status		0.249*** (0.019)	0.245*** (0.026)	0.248*** (0.026)	0.188*** (0.017)
Marital status		-0.0001*** (0.000)	-0.0001*** (0.000)	-0.0001*** (0.000)	-0.001 (0.000)
Rural		-0.062 (0.038)	-0.090* (0.049)	-0.018 (0.050)	0.053 (0.043)
Years of education		0.039*** (0.005)		0.030*** (0.005)	0.024*** (0.007)
Income (log)			0.185*** (0.023)	0.150*** (0.023)	0.102*** (0.019)
Obs.	6102	5907	4223	4151	2750
R-squared	0.021	0.049	0.052	0.051	0.133
Province dummies	Yes	Yes	Yes	Yes	Yes
F-scores					138.991
Exogeneity test (p-value)					0.426

Sources: Authors' calculations based on the 2008 Chinese General Social Survey (CGSS). Clustered standard errors are shown in parentheses. ****p* < 0.01, ***p* < 0.05, **p* < 0.1. ^aThe birth year in column (5) is replaced by the mother's birth year.

siblings variable was strongly rejected (see the bottom part of the table); therefore, the 2SLS results should be considered more efficient. Our results are consistent with existing studies, such as Weng et al. (2019), and support the quantity-quality trade-off hypothesis for the relationship between the number of children and education. Taken together with the results in Table 2, the number of siblings in China should be viewed as reducing family resources directed towards education per child and educational attainment, which in turn indirectly lowers happiness. In other words, the results support Hypothesis 3.

While the results for most of the other variables were consistent with those reported in the literature, this study also found that the parental occupation type when the individual was 14 years old was an important determinant. The negative coefficient of the gender dummy implies that females have fewer educational opportunities than males. The coefficients of parents' years of education were positive and significant at the 1% level, suggesting that educated parents tend to invest more in their children's education. The negative coefficient of the rural variable indicates that residents in rural regions are educationally disadvantaged. Moreover, the occupational dummies for mothers working as civil servants, employees of state-owned firms, and in other jobs when the individual was 14 years old were positive and significant in some of the models. It has been suggested that a stable occupation and economic status are important childhood factors that strongly affect children's educational attainment.

Discussion. The analysis in this study produced three main findings with unique policy implications. First, although we observed an apparent negative correlation between the number of siblings and happiness, the relationship was indirect rather than direct through the effect of the number of siblings on income and

educational levels (Table 2). While these findings are consistent with existing research that found a negative relationship between the number of siblings and subjective well-being or other mental health measures (e.g., Wang et al., 2013; Lin et al., 2021; Wang, 2023), they are also novel in that we articulated the importance of the indirect pathways, which has practical implications for population policy. In other words, an increase or decrease in the number of siblings due to population policies or a fertility trend does not directly affect the subjective well-being of these children. In this sense, it is not irrational for the government to take the approach of increasing both fertility and subjective well-being. However, a change in the number of siblings may have indirect effects on the population through education and income, suggesting the need to carefully monitor the effects of population policies on education and income.

Second, the number of siblings negatively affects an individual's income (see Table 3), which can result in lower happiness. The novelty here is that we explicitly showed that the number of siblings affects income not only via an indirect path in which the effect is generated through the education effect but also via a more direct path in which the effect is not generated through the education effect. When the number of children is large, inter-vivo transfers and inheritances passed from parents to children, such as houses, land, and human connections, are diluted, thus limiting the resources available to children. This is suggested to reduce economic opportunities for children. Thus, any increase in fertility must be accompanied by policies such as increasing the capacity of credit markets to prevent constraints on children's resources, which is important to avoid reducing the subjective welfare of future generations.

Third, the number of siblings had a negative effect on an individual's level of education (Table 4), which, in turn, could lead to

Table 3 OLS and 2SLS estimates of the effects of the number of siblings on income.

Variables	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS	(4) Model 4 2SLS	(5) Model 5 2SLS
Number of siblings	-0.155*** (0.013)	-0.058*** (0.015)	-0.028** (0.013)	0.059 (0.086)	0.133 (0.085)
Birth order	0.058*** (0.014)	0.013 (0.014)	0.009 (0.013)	-0.060 (0.068)	-0.104 (0.067)
Years of education			0.087*** (0.006)		0.090*** (0.007)
Birth year		0.001 (0.004)	-0.003 (0.004)		
Gender		-0.371*** (0.042)	-0.347*** (0.039)	-0.412*** (0.037)	-0.392*** (0.035)
Communist party membership		0.155*** (0.034)	-0.020 (0.033)	0.183*** (0.046)	-0.008 (0.045)
Health status		0.064*** (0.021)	0.044** (0.018)	0.085*** (0.018)	0.064*** (0.018)
Marital status		0.00004*** (0.000)	0.0001*** (0.000)	0.0001 (0.0001)	0.0001 (0.0001)
Rural		-0.396*** (0.055)	-0.148*** (0.053)	-0.471*** (0.045)	-0.246*** (0.043)
Birth year of mother (1939-1941)				-0.083 (0.065)	-0.075 (0.062)
Birth year of mother (1942-1944)				-0.013 (0.058)	0.007 (0.056)
Birth year of mother (1945-1947)				-0.086 (0.053)	-0.099* (0.052)
Birth year of mother (1948-1950)				0.020 (0.047)	0.013 (0.045)
Father's years of education		0.015** (0.006)	0.009 (0.005)	0.028*** (0.006)	0.015*** (0.006)
Mother's years of education		0.015** (0.006)	0.010* (0.006)	0.020*** (0.007)	0.011* (0.006)
Father's job: Civil servant		0.035 (0.070)	-0.009 (0.067)	-0.007 (0.103)	-0.033 (0.099)
Father's job: State firm		0.036 (0.036)	0.039 (0.037)	0.075 (0.047)	0.078* (0.045)
Father's job: Other		-0.011 (0.054)	0.019 (0.054)	-0.041 (0.064)	-0.027 (0.061)
Mother's job: Civil servant		0.059 (0.087)	-0.010 (0.088)	0.018 (0.202)	-0.003 (0.193)
Mother's job: State firm		0.052 (0.040)	0.027 (0.037)	0.042 (0.063)	0.053 (0.061)
Mother's job: Other		0.095* (0.052)	0.073 (0.053)	0.142* (0.078)	0.138* (0.075)
Constant	10.188*** (0.021)	7.166 (7.359)	15.299** (7.257)	9.706*** (0.135)	8.708*** (0.155)
Obs.	4227	4223	4151	2812	2750
R-squared	0.225	0.326	0.369	0.377	0.401
Province dummies	Yes	Yes	Yes	Yes	Yes
F-scores				142.228	139.294
Exogeneity test (p-value)				0.278	0.109

Sources: Authors' calculations based on the 2008 Chinese General Social Survey (CGSS). Clustered standard errors are shown in parentheses. ****p* < 0.01, ***p* < 0.05, **p* < 0.1.

lower happiness. The trade-off between the number of children and educational attainment in China, both methodologically and in terms of the findings, confirms the analysis of recent studies (e.g., Weng et al., 2019; Zhong and Dong, 2018). However, we emphasise something that has not been well addressed in the research thus far: it is important in the pathways that in turn affect people's subjective welfare as well as their economic achievement, as shown in Table 2. Education is not only directly related to happiness but also has a pathway to happiness through income, as shown in Table 3. Therefore, it is crucial to monitor the impact of fertility policies on

education. More specifically, policy interventions such as equalising educational and employment opportunities for vulnerable groups, including women and rural residents; improving rural schools; and improving other infrastructures should be considered.

Conclusion

This study examined and presented the effect of sibling size on happiness in contemporary China from an integrated perspective, considering indirect pathways. The following three main results

Table 4 OLS and 2SLS estimates of the effects of number of siblings on educational attainment.

Variables	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 2SLS
Number of siblings	-0.906*** (0.075)	-0.325*** (0.059)	-1.981*** (0.248)
Birth order	0.201*** (0.060)	0.049 (0.042)	1.367*** (0.196)
Gender		-0.480*** (0.107)	-0.224** (0.114)
Rural		-3.042*** (0.185)	-2.403*** (0.132)
Birth year		0.100*** (0.008)	
Birth year of mother (1939-1941)			-0.074 (0.197)
Birth year of mother (1942-1944)			-0.165 (0.180)
Birth year of mother (1945-1947)			0.081 (0.165)
Birth year of mother (1948-1950)			0.014 (0.144)
Father's years of education		0.074*** (0.013)	0.148*** (0.018)
Mother's years of education		0.064*** (0.017)	0.079*** (0.022)
Father's job: Civil servant		0.903*** (0.265)	0.710** (0.325)
Father's job: State firm		0.096 (0.110)	-0.059 (0.151)
Father's job: Other		-0.155 (0.190)	0.043 (0.196)
Mother's job: Civil servant		0.595 (0.497)	0.033 (0.647)
Mother's job: State firm		0.322** (0.121)	-0.317 (0.196)
Mother's job: Other		0.461** (0.202)	0.154 (0.238)
Constant	14.272*** (0.050)	-184.087*** (16.318)	12.659*** (0.364)
Observations	5913	5907	3694
R-squared	0.244	0.457	0.343
Province dummies	Yes	Yes	Yes
F-scores			204.119
Exogeneity test (p-value)			0.000

Sources: Authors' calculations based on the 2008 Chinese General Social Survey (CGSS). Clustered standard errors are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$.

were obtained: First, although we observed an apparent negative correlation between the number of siblings and happiness (subjective welfare), the relationship was indirect rather than direct, through the effect of the number of siblings on income and educational levels. Second, the number of siblings negatively affects an individual's income, resulting in lower happiness levels. Third, the number of siblings had a negative effect on an individual's level of education, which in turn led to lower happiness. Thus, we conclude that the number of siblings indirectly leads to lower happiness, mainly through its effects on income and education.

The number of children has been a major policy concern in China since the 1970s. In recent years, China has been facing a decline in the number of children and the government has begun to prioritise raising birth rates. Our results provide important insights into the impact of population policies on individual and subjective happiness. An increase in the fertility rate does not have a direct impact on happiness. However, if it has a negative effect on income or education, it is likely to result in lower happiness levels. Therefore, any attempt to increase fertility should always be paired with policies aimed at increasing income and educational opportunities. Once these policies are implemented, it is possible to simultaneously seek to increase fertility and happiness.

Finally, we would like to remark on the remaining issues. First, we were unable to examine the differences in effects across generations in detail, partly because of sample size limitations. Whether the results of this study can be applied to younger couples in the future is debatable, and this point should be examined using other census data or long-term time series data. Second, related to the above point, it would be desirable to test the impact of recent changes in China's family planning policy on the younger generation through rigorous empirical studies using data from experimental designs. Finally, effects other than education and income as determinants of happiness may not have been adequately considered. For example, social capital as a determinant of happiness was only examined for party membership in this study. Further study of the above points will hopefully lead to the further development of happiness studies in China.

Data availability

The data for this study is based solely on data from the survey conducted by the other organisation (Chinese General Social Survey), which can be applied for and obtained with permission at <http://cgss.ruc.edu.cn/index.htm>.

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Note

1 Households are registered as urban or rural in Hukou, China's household registration system. The status of these two identities is different, and the allocation of social resources is completely different. Households registered as urban can obtain better resources, like education, subsidies, welfare, social security, and medical care, but households registered as rural cannot obtain these resources. The unfair distribution of social resources may result in different levels of individual happiness in urban and rural.

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Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was not required as the data in this study are based solely on publicly available data. Personal information is kept confidential and medical data are not included.

Informed consent

Informed consent was not required as the data in this study are based solely on publicly available data. Personal information is kept confidential and medical data are not included.

Additional information

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