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The impact of family size on preventive health behaviors: Evidence from older adults' vaccination decisions in China

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Abstract

Variations in family size may significantly shape the adoption of preventive health behaviors, particularly among aging populations. Using data from the 2021 Chinese General Social Survey (CGSS), this study investigates the causal impact of the number of children on preventive health behaviors of older adults, focusing primarily on COVID-19 vaccination. To address the endogeneity issue, we employ an instrumental variable approach exploiting exogenous variations in policy exposure induced by China's "Later, Longer, Fewer" (LLF) family planning campaign.

Our results reveal that having more children reduces the likelihood of older adults receiving the vaccine. This negative impact is particularly pronounced among urban residents and in regions with lower pandemic severity. Mechanism analyses suggest a health-penalty pathway, where parents with more children experience poorer physical health, increasing their likelihood of medical ineligibility for vaccination. Crucially, we find that this negative effect extends beyond pandemic contexts to routine preventive behaviors, including influenza vaccinations and regular health examinations. Our findings highlight how historical fertility decisions shape health behaviors, providing novel insights into the determinants of preventive healthcare among aging populations.

Keywords Older Adults · Children number · Vaccination · Preventive Health Behavior

Introduction

Preventive health behaviors represent a critical component of human capital investment and a cornerstone of sustainable aging societies [1]. While vaccination is crucial for preventing communicative disease, the socioeconomic determinants of their uptake, especially among older populations, remain underexplored. During the COVID-19 pandemic, individuals faced a dual challenge of the immediate risk of infection versus the uncertainty regarding vaccine safety. Although the COVID-19 vaccines are distributed worldwide [2], only 81% of the older population completed a primary series by 2024 [3]. In China, there was a continuous low vaccination rate among the older population, despite the overall high COVID-19 vaccination coverage [4]. In this context, family structure, a fundamental pillar of informal social support in many cultures, may play a paradoxical role in shaping preventive health decisions.

Vaccines are widely promoted as a key defense against health risks, a large literature has therefore examined vaccine hesitancy. Typically, researchers frame vaccine hesitancy and other anti-vaccine attitudes in terms of the 3Cs model (complacency, confidence, and convenience) [5]. The recognized determinants include a lack of trust [6] and interpersonal isolation [7]. In the case of the COVID-19 vaccines, studies have linked lower vaccine acceptance to lower cognitive ability [8], stronger individualistic values [9], higher discount rates [10], and historical injustices [11]. Moreover, pre-existing anti-vaccine sentiment significantly amplifies skepticism toward COVID-19 vaccination [12].

Given the increasing number of parents who delay or refuse to vaccinate their children all around the globe, extensive studies have particularly focused on parental vaccine hesitancy. The literature documents that parents' negative communication experiences with healthcare providers [13] and socioeconomic characteristics, such as income and education, are important influencing factors [14]. However, the impact of children on parents' vaccination behaviors has been largely overlooked, and little is known about factors influencing vaccination behaviors among older adults.

To promote vaccination coverage, various interventions have been attempted. Studies have shown that reminders and financial incentives [15, 16] can significantly increase vaccination rates. Moreover, existing research has shown that the positive impact of vaccination programs can spill over among siblings [17] and spouses [18]. Therefore, family members could potentially shape individuals' vaccination decisions.

For older adults, children are particularly influential on their healthcare decisions. As the closest family members, children's informal care reduces older people's formal healthcare usage[19, 20], and children's education is found to have positive impacts on older people's overall cognitive function [21]. Research also suggests that the number of children can affect parents' mental health [22, 23] and cognitive health [19] in complex ways. The present study provides new evidence on how the number of children affects older parents' vaccination decision in the context of COVID-19.

The relationship between the number of children and vaccine uptake is conceptually ambiguous. The heavier burdens of childbearing and parenting over the years may adversely affect parental well-being[19, 20]. Considering the potential health disadvantages, older adults with more children may be more likely to forgo vaccination due to medical ineligibility. Nevertheless, they could also be more willing to vaccinate because a larger family size may increase the risk of exposure to infectious diseases. Besides, it is common to view children as a form of old-age security [24], and the number of children is a key determinant of old-age support [25]. Parents raise children with the expectation of receiving emotional, financial, and instrumental support in later life[26]. In times of illness, parents may rely on their children for informal care [27]. As a result, older adults with more children may perceive themselves to be better protected and supported, thus lowering their perceived health risks and urgency to adopt preventive measures.

Understanding the impact of children on parental vaccination behavior is integral to designing more effective public health interventions in the context of the demographic transition characterized by an aging population and falling birth rates. These demographic changes are accompanied by emerging trends in the modern intergenerational support systems. On the one hand, the growing old-age dependency ratio has prompted more young adults to take on primary caregiving responsibilities [28]. On the other hand, evolving family norms and rapid urbanization have contributed to a transition to an “empty nest” [29]. In this dynamic demographic landscape, the role of children in shaping their parents’ health behaviors has become increasingly complex yet critically important.

To investigate the relationship between the number of children and older adults' vaccination behavior, this study employs an instrumental variable approach that leverages exogenous shock from China's "Later, Longer, Fewer" (LLF) campaign initiated in 1969. We construct a Policy Exposure Index (PEI) capturing the intensity of a woman's exposure to the LLF campaign. By instrumenting the number of children with the policy-induced variations in family size, the present study minimizes concerns of endogeneity stemming from unobserved health beliefs, risk preferences, or other confounding factors that may jointly affect fertility and older people's vaccination decisions.

The contributions of this paper are multifaceted. First, while existing research has largely focused on parents' attitudes toward vaccinating their children [30], little is known about how children affect their aging parents' vaccine uptake. Therefore, this paper shifts the focus to the role of children in their parents' vaccination behavior. Second, although the importance of familial support has been well recognized, few studies have specifically looked into how family members might affect health decisions during an unexpected public health crisis. Furthermore, we show that the negative impact of family size generalizes to routine preventive behaviors, such as flu shots and health examinations. This broadens our understanding of how fertility history shapes preventive health decisions in old age. Lastly, our findings illustrate the value of considering family structure when designing interventions to promote preventive healthcare among older adults.

Family Planning Programs in China

China's family structure dynamics and demographic transitions are marked by extensive government intervention aimed at managing population growth [31]. The exogenous policy shocks provide unique opportunities to identify the causal impact of family size on parents' vaccine decisions. In particular, this paper utilizes China's "Later, Longer, Fewer" (LLF) family planning policy as an instrumental variable for the number of children. This section briefly outlines the history of family planning programs in China, and explains why LLF is a proper choice for the research design.

Throughout the period of the 1950s and early 1960s, the Chinese government actively encouraged population growth to strengthen national development. However, by the late 1960s, concerns over rapid population expansion and resource scarcity were intensifying. The government began to discuss birth control strategies. In the late 1970s, the LLF campaign was implemented to encourage families to delay marriage and childbirth, promote longer intervals between births, and advocate the birth of two or three children. Unlike subsequent birth control policy, the LLF campaign offered a relatively flexible and less coercive approach to family planning, recognizing the need for population control while allowing families some free reproductive choice. Introduced in 1979, the subsequent "One-Child Policy" (OCP) represented a drastic shift toward strict population control. As one of the most stringent population control measures, the OCP mandated that most families could only have one child, with severe penalties for violations.

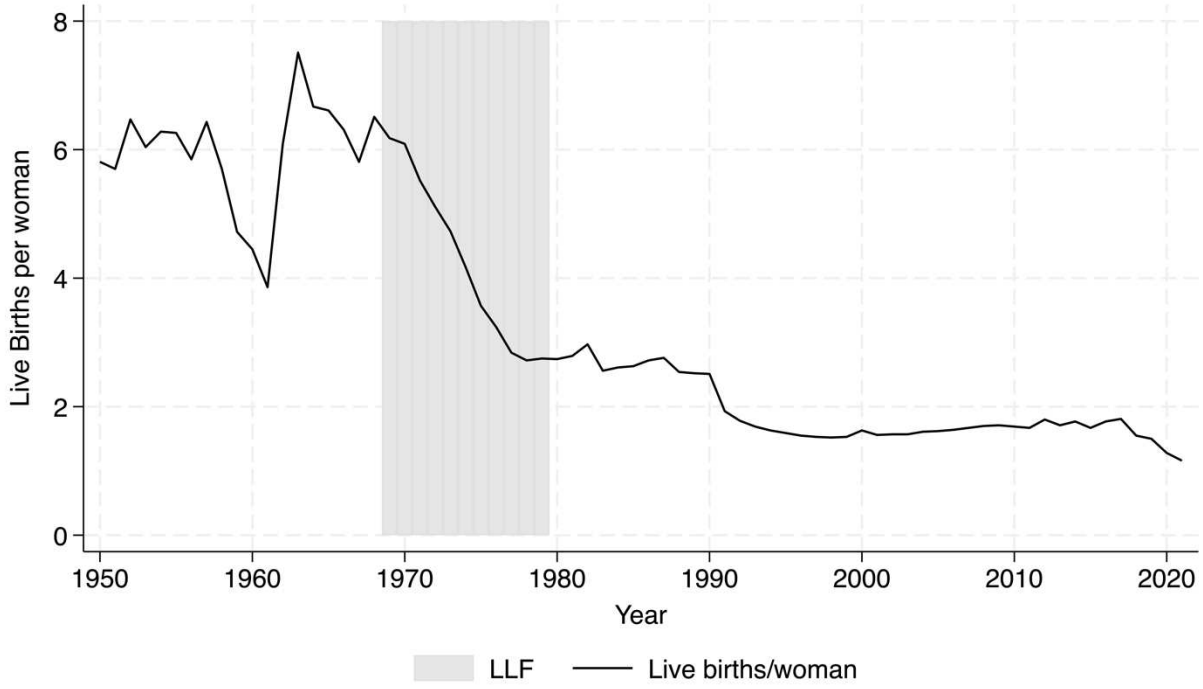


Fig. 1 Live birth per woman over time in China (1950-2021)

Fig. 1 depicts the historical trend of live births per woman in China from 1950 to 2021. The shaded region corresponds to the period (1969-1979) when the LLF campaign was implemented. The sharp decline in fertility during this period represents one of the most significant reductions in birth rates in Chinese history. The OCP, which followed the LLF, maintained lower fertility levels but reduced the variation in the number of children per family due to its strict limitations on births. The LLF campaign allowed greater heterogeneity in family size across households, providing necessary exogenous variation for identifying the causal effects of family size on health-related decisions. This characteristic makes LLF a more appropriate choice to instrument the number of children.

Data

This paper uses data from the 2021 wave of the Chinese General Social Survey (CGSS). The CGSS is a nationally representative interdisciplinary survey conducted in China, and it provides individual and household-level information on a wide range of demographic, economic, and social topics. The 2021 wave is particularly suited to this study because it includes a specialized Vaccine Module that collects unique data on COVID-19 vaccination status information.

The sample is restricted to respondents aged 50 and above, whose spouses or partners, if present, are also at least 50 years old (N=3,596). This age restriction helps to ensure that most of the respondents are beyond their regular reproductive period, reducing potential bias from the concern that a substantial portion of respondents may have future fertility plans. To further improve the accuracy and validity of the analysis, the following selection criteria are applied. First, this paper attempts to explore the role of children, thereby childless individuals (206 observations) are dropped. Second, ethnic minorities, who might be subject to more relaxed birth control regulations, are removed, resulting in the exclusion of 211 observations. Third, to measure the exposure to the LLF policy more accurately, the sample is limited to individuals who had moved to their current province of residence by age 16 or earlier (excluding 151 observations). This is to make sure that respondents were fully exposed to the local fertility policy during their reproductive years, minimizing the issue resulting from moving or migration. Finally, observations with missing values on key variables are dropped. The above steps leave 2,649 observations in the final analytic sample.

Table 1 Descriptive statistics

N= 2,649	Definition	Mean (S.D.)	Min	Max
Dependent variables				
Vaccinated	Vaccinated=1, 0 otherwise	0.6569 (0.4749)	0	1
Independent variables				
Number of children	Number of children	2.0257 (1.1582)	1	22
Age	Age of respondent	63.4311 (8.6468)	50	90
Gender	Male=1, 0 otherwise	0.4677 (0.4991)	0	1
Per capita household income (log)	Per capita household income (log)	8.5425 (4.5162)	0	16.1181
Partnered status	1= have spouse or partner, 0 otherwise	79.6900 (0.4024)	0	1
Rural/Urban	Rural resident=1, 0 otherwise	0.4768 (0.5000)	0	1
			Frequency	Percent
Education	1= below high school (reference)	1.3352 (0.6072)	1,954	73.76%
	2= high school		502	18.95%
	3= college and above		193	7.29%

Notes. Data source is CGSS 2021.

Table 1 reports the summary statistics for the analytic sample. Around 66% of the respondents got the COVID-19 vaccine. On average, each respondent has more than two children. This Fig. is substantially lower than the average of six live births per woman recorded before 1969, when the LLF launched (see Fig. 1). The significantly smaller household sizes observed in the study sample, relative to those before 1969, provide initial evidence of the LLF policy's effectiveness in controlling population growth. The average age of the respondents is approximately 63, and the majority did not complete high school. In terms of gender composition, 46.77% of the sample are male. Approximately 80% of the respondents are in a partnered relationship, either through marriage or cohabitation. Urban residents account for 62.32% of the

sample, and this proportion is similar to the 64.72% urbanization rate reported by the Chinese official government media [32], adding credibility to the representativeness of the sample.

Methods

To estimate the impact of the number of children on parents' COVID-19 vaccination decision, the baseline empirical specification is as follows:

$$Vaccined_{ipc} = \beta_0 + \beta_1 \times number\ of\ children_{ipc} + \beta_2 \times X_{ipc} + \lambda_a + \delta_p + \varepsilon_{ipc} \quad (1)$$

$Vaccined_{ipc}$ is a binary indicator for whether individual i of cohort c from province p took the COVID-19 vaccine. The key independent variable, $number\ of\ children_{ipc}$, refers to the number of children individual i has. X_{ipc} denotes controls variables including gender, education level, partnership status, rural/urban indicator, and per capita household income; λ_a represents the age fixed effects; δ_p represents the province fixed effects, and ε_{ipc} is the error term. β_1 measures the impact of family size on older parents' vaccination decision.

Instrumental Variable Approach

One concern in estimating equation (1) is that the number of children may be endogenous. Unobservable factors, such as health beliefs or risk preferences, may simultaneously influence both fertility choices and vaccination decisions, leading to biased estimates of β_1. To address the endogeneity issue, this paper adopts an instrumental variable approach using policy exposure to China's "Later, Longer, Fewer" (LLF) campaign as an instrumental variable for the number of children**.**

The LLF campaign, launched in 1969, promoted later marriage, longer birth intervals, and fewer children. Compared to the subsequent one-child policy (OCP), the LLF campaign offers several advantages as an instrumental variable for the number of children. First, the LLF campaign accounts for the majority of the decline in fertility rate in China since the Chinese government began to control population growth in the mid-1960s [33, 34]. The shaded area in Fig. 1 highlights the period of LLF implementation. It is evident that during this period, the average live births per woman sharply dropped by approximately four. Whereas the later OCP primarily consolidated and maintained the already low fertility level. Hence, LLF is a more relevant and powerful predictor of family size. Second, the LLF campaign did not impose strict birth quotas on family size [35], thereby allowing variations in the number of children across households. Since this study seeks to estimate how family size affects older adults' vaccination behavior, such variation is essential for identification. However, the rigid restrictions of the OCP tend to homogenize family size. Therefore, this paper employs exposure to the LLF campaign as the instrumental variable for the number of children.

Specifically, this paper leverages variation in exposure intensity to the LLF campaign as the instrumental variable for the number of children. We construct a policy exposure index (PEI) that measures a woman's intensity of exposure to the LLF campaign. The focus is placed on women's exposure, rather than men's, because women's fertility capacity is more age-dependent compared to men; thus, their exposure to fertility policies is more directly relevant to the number of children a couple can have.

The policy exposure index combines the initial provincial age-specific fertility rate in a given province and the duration of a woman's exposure to the policy during her reproductive years. A higher PEI value indicates greater exposure to LLF, which is expected to result in fewer children. PEI is defined in equation (2):

$$PEI_{pc} = \sum_{a=15}^{49} F_{ap1968} \times I(c + a > Office_p) \quad (2)$$

where PEI_{pc} denotes the policy exposure intensity for women from province p born in year c. The term of F_{ap1968} represents the fertility rate of women aged at a in province p in 1968, preceding the implementation of the LLF policy in any province. A greater value of the provincial age-specific fertility rate in 1968 means a greater initial fertility rate in that province and age group, possibly suggesting that a woman aged at a in province p experienced greater exposure to the fertility control policy. $Office_p$ denotes the year when the family planning office responsible for implementing fertility control policies was established in province p, which marks the official commencement of the LLF fertility controls in that province. $I(.)$ is an indicator function, which implies whether a woman born in year c aged at a is affected by the fertility policy during their reproduction period ($15 \leq a \leq 49$). It takes the value of 1 if the local family planning office in province p was established after a woman entered her reproductive period (i.e., between the ages of 15 and 49); otherwise, it takes the value of 0. The aggregate of $I(.)$ reflects the reproductive period of women overlapping with the local implementation of policy. A longer overlap implies greater exposure to the policy. Thus, higher PEI values indicate more intensive exposure to the LLF campaign, likely leading to fewer children per couple. This index captures both regional

heterogeneity in fertility changes and individual variation in exposure timing.

IV Validity

The LLF campaign's impact on fertility decisions, as reflected in the substantial decline in birth rates, satisfies the relevance condition for a valid instrument. Meanwhile, the LLF campaign was introduced decades before COVID-19 emerged, targeting fertility rather than future health behavior. It is implausible that policymakers in the 1970s could have anticipated or designed the LLF campaign to directly influence people's vaccination decisions.

The validity of the instrumental variable approach relies on the exclusion restriction, which requires that exposure to the LLF campaign affects parents' vaccination decisions only through its impact on family size and is not correlated with other factors that might directly influence vaccination behavior. One potential violation of this assumption would arise if the LLF campaign also affected individuals' health insurance choices. Those more inclined to adopt health insurance may be either more likely to vaccinate due to greater risk awareness or less likely to vaccinate because of a reduced sense of vaccination urgency. Either scenario would violate the validity of the instrumental variable. To test this concern, the first three columns in Table A1 examine correlations between the policy exposure index (PEI) and public and commercial health insurance adoption. The dependent variable in column 1 equals one if the respondent is covered by public health insurance only (i.e., has public insurance but no commercial insurance) and zero otherwise. In column 2, the dependent variable equals one if the respondent has commercial health insurance only (i.e., has commercial insurance but no public insurance) and zero otherwise. Column 3 defines

the dependent variable as equal to one if the respondent is covered by either public or commercial health insurance and zero if uninsured. The coefficients are small and statistically insignificant. Hence, the estimations suggest no evidence that the LLF campaign predicts people's health insurance decisions.

In addition, we test whether the policy exposure intensity is correlated with respondents' pre-policy characteristics, and the results are presented in columns 4 and 5 of Table A1. The reliability of the instrumental variable estimates decreases if people's policy exposure intensity is correlated with pre-policy conditions, such as their economic status or place of residence. The CGSS collects data on family economic status and residence location (rural or urban) when respondents were 14 years old. As the age of 14 is well before typical ages for marriage and fertility, we utilize the information to examine whether the PEI is correlated with people's pre-policy characteristics. The results in columns 4 and 5 of Table A1 indicate that people's pre-policy characteristics do not significantly differ by the policy exposure intensity. Taken together, these results suggest no direct link between LLF exposure and these potential confounders, strengthening the credibility of the instrumental variable choice.

Two-Stage Least Squares (2SLS) Regression

In the two-stage-square (2SLS) specification, the first-stage regression models the number of children as a function of the policy exposure index (PEI) and control variables. Equation (3) represents the first-stage regression:

$$number\ of\ children_{ipc} = \alpha_0 + \alpha_1 \times PEI_{pc} + \theta \times X_{ipc} + \xi_a + \gamma_p + e_{ipc} \quad (3)$$

where PEI_{pc} denotes the policy exposure index, and $number\ of\ children_{ipc}$ refers to the number of children individual i has. X_{ipc} denotes controls variables including gender, education level, partnership status, rural/urban indicator, and per capita household income. ξ_a represents the age fixed effects, γ_p represents the province fixed effects, and e_{ipc} is the error term.

In the second stage, the regression estimates how the number of children influences parents' likelihood of receiving the COVID-19 vaccine:

$$Vaccined_{ipc} = \beta_0 + \beta_1 \times \widehat{number\ of\ children}_{ipc} + \vartheta \times X_{ipc} + \lambda_a + \delta_p + \epsilon_{ipc} \quad (4)$$

The dependent variable $Vaccined_{ipc}$ equals one if individual i took the vaccine, and zero otherwise. $\widehat{number\ of\ children}_{ipc}$ is the estimated number of children from equation (3). X_{ipc} denotes controls variables including gender, education level, partnership status, rural/urban indicator, and per capita household income. λ_a represents the age fixed effects, δ_p represents the province fixed effects, and ϵ_{ipc} is the error term. β_1 is the coefficient of interest, capturing the causal impacts of the number of children on parents' vaccination decisions.

Results

Main results

Column 1 in Panel A of Table 2 reports the marginal effect of the Probit estimation. The estimated coefficient is –0.0014 ($p > 0.1$), indicating that each additional child was associated with a 0.14% decrease in the probability of vaccination, but this effect is not statistically significant at

conventional levels. Column 2 presents the local average treatment effects from the 2SLS estimates, with the corresponding marginal effects from the IV-Probit model. On average, each additional child reduces the probability of older adults receiving vaccination by 18.03% ($p < 0.01$). Wu-Hausman test results support the benefit of using IV analysis over the Probit model ($p < 0.01$).

Table 2 Impact of family size on parents' COVID vaccination

Panel A: Dependent variable=Number of children		
	All Children #	
PEI	-0.3532***	
	(0.0516)	
F test of excluded instrument	45.70	
(p value)	(0.0000)	
Kleibergen-Paap rk LM statistic	11.937	
(p value)	(0.0006)	
Wu-Hausman statistics	8.44	
(p value)	(0.0037)	
Panel B: Dependent variable=Vaccination status		
	Probit	IV-Probit
	(1)	(2)
Number of children	-0.0014	-0.1803***
	(0.0114)	(0.0390)
Control	Yes	Yes
Age FE	Yes	Yes
Province FE	Yes	Yes
N	2,649	2,649

Notes. Panel A reports the first-stage estimation results, where number of children is the dependent variable and the policy exposure index is the key explanatory variable. Panel B reports results from the Probit estimation (column 1) and the second-stage 2SLS estimation (column 2), with vaccination status as the dependent variable. Marginal effects from Probit and IV-Probit estimations are also reported. All specifications control for gender, education, per capita household income, rural/urban residence, marital status, age fixed effects, and province fixed effects. Robust standard errors adjusted for clustering on provinces are in parentheses.

*p<0.1; **p<0.05; ***p<0.01

Panel B of Table 2 reports the first-stage estimates from the 2SLS estimation. The

coefficient on the Policy Exposure Index (PEI) indicates that a one-unit increase in LLF exposure is associated with a statistically significant reduction of 0.3532 children ($p<0.01$). Given that the sample average of PEI is 5.6619, the coefficient implies an average fertility reduction of approximately two children per woman. The size of this estimated effect is comparable to previous studies using different datasets, such as census and the China Family Panel Study (CFPS)[33], and the China Health and Retirement Longitudinal Study (CHARLS)[34]. Furthermore, the F tests of the excluded instrument and the Kleibergen-Paap rk LM statistic both support that PEI is not a weak IV. The first-stage results help validate the relevance of the LLF campaign as an instrumental variable for the number of children.

Robustness

Table 3 presents the results of a series of robustness checks. Columns 1 to 3 report the marginal effect from the IV-Probit method, and columns 4 and 5 report the estimated coefficients from the IV-OLS regressions. The corresponding first-stage estimation results are provided in Table A2.

Column 1of Table 3 only controls predetermined characteristics, that is, gender, age fixed effects, and province fixed effects. The coefficient of the number of children remains negative and statistically significant, indicating that with an alternative specification, the inverse relationship between family size and older parents' vaccine uptake holds. Column 2 tests whether the observed effect is sensitive to how the number of children is measured. Column 2 classifies the number of children into parity categories based on WHO definitions. Specifically, the key explanatory variable equals one for low parity (have one child), two for medium parity (have two to four

children), and three for high parity (have more than four children). The estimated coefficient is again statistically significant, suggesting the negative impact of having more children on older parents' vaccine uptake is robust, regardless of the specific categorization of family size.

The primary analytic sample requires that both the respondents and their spouses or partners, if present, are at least 50 years old. Column 3 relaxes the age restriction to include all respondents aged 50 or above, removing the restriction on their spouses or partners. Column 4 applies an IV-OLS approach instead of IV-Probit. Overall, the finding that having more children reduces older parents' likelihood of vaccinating is robust to the age restrictions and the alternative estimation method.

In the main analysis, the dependent variable is the binary variable indicating whether a respondent took the vaccine. To obtain a more comprehensive understanding of older adults' attitudes towards vaccination, we extend the analysis to their willingness to vaccinate in the robustness analysis. In particular, we examine whether people's willingness to vaccinate varies among those who actually took the vaccine. In column 5 of Table 3, the dependent variable is "Willingness to vaccinate". This variable ranges from one to three, with a higher value referring to a stronger willingness to vaccinate. The estimated coefficient of -0.1412 ($p<0.05$) suggests that having more children also diminishes older people's vaccination willingness, even among those who got vaccinated. This finding points out that a larger family size negatively affects both actual behavior and the underlying attitudes shaping vaccination decisions among older adults.

Table 3 Robustness (IV)

Outcome variable	Vaccinated	Vaccinated	Vaccinated	Vaccinated	Willingness to vaccinate
	Keep predetermined characteristics	Measure children number by parity category	Only restrict respondents' age>=50	IV-OLS	Willingness to vaccinate among those vaccinated
	(1)	(2)	(3)	(4)	(5)
Number of children	-0.1744***	-0.8840***	-0.1773***	-0.1739***	-0.1412**
	(0.0406)	(0.2763)	(0.0382)	(0.0452)	(0.0612)
Control	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
N	2,649	2,649	2,781	2,649	1,736

Notes. Column 1 includes gender, age fixed effects, and province fixed effects. Columns 2-4 include the following covariates: gender, education, per capita household income, rural/urban residency indicator, marital status, age fixed effects, and province fixed effects. In column 3, family size is defined as 1 for low parity (have one child), 2 for medium parity (have two to four children), and 3 for high parity (have more than four children). Column 4 uses the IV-OLS approach. Dependent variable of column 5 is willingness to vaccinate among those actually vaccinated, a higher value refers to more willingness to vaccinate. Marginal effects from the IV-Probit estimations are reported in columns 1 to 3, and the estimated coefficients from the IV-OLS regression are reported in columns 4 and 5. Robust standard errors adjusted for clustering on provinces are in parentheses. First-stage estimation results are presented in Table A2.

*p<0.1; **p<0.05; ***p<0.01

Heterogeneity

The main analysis reveals that having more children reduces parents' likelihood of COVID-19 vaccination. This section examines the heterogeneous effects across rural/urban residency and the severity of the pandemic. Table 4 presents the heterogeneity results estimated with 2SLS, and the first-stage estimation results are presented in Table A3.

Panel A of Table 4 explores heterogeneity over rural and urban residency. The estimated effect of family size on vaccination is stronger among urban residents (–0.3556, p<0.01) than among rural residents (–0.1066, insignificant). One possible explanation is that urban residents

often have better access to healthcare resources, which may give them more confidence in managing potential health risks without vaccination. Similarly, Wu et al. (2023) and other studies have found that the COVID-19 vaccine hesitancy was more pronounced among urban residents compared to their rural counterparts in China. The heterogeneous analysis of the present study adds to their findings that having more children reinforces vaccine hesitancy among urban older adults.

Table 4 Heterogeneity

	Vaccinated	Vaccinated
Panel A: Rural/Urban Residency		
	Rural	Urban
Number of children	-0.1066	-0.3556***
	(0.0652)	(0.1130)
Control	Yes	Yes
Age FE	Yes	Yes
Province FE	Yes	Yes
N	1,254	1,395
Panel B: Severity of Pandemic		
	Provincial mortality ratio<national average mortality rate	Provincial mortality ratio>=national average mortality rate
Number of children	-0.2655***	-0.1851***
	(0.0827)	(0.0374)
Control	Yes	Yes
Age FE	Yes	Yes
Province FE	Yes	Yes
N	1,274	1,375

Notes. This table presents the heterogeneous impacts with respect to residency (Panel A), and severity of pandemic (Panel B). All regressions include the following covariates: gender, education, per capita household income, rural/urban residency indicator (Panel B only), marital status, age fixed effects, and province fixed effects. Marginal effects from the IV-Probit regressions are reported. Robust standard errors adjusted for clustering on provinces are in parentheses. First-stage estimation results are presented in Table A3.

*p<0.1; **p<0.05; ***p<0.01

Panel B of Table 4 examines whether the relationship between the number of children and

older adults' vaccination decisions varies with the mortality risk of the pandemic. We use the provincial COVID-19 mortality rates to measure the mortality risk. In provinces with mortality rates below the national average, the marginal effect of family size is –0.2655 ($p<0.01$), which is larger in magnitude than the effect observed in provinces with higher-than-average mortality rates (–0.1851, $p<0.01$). These results imply that people's perceived health risk might play a role. In regions where the perceived pandemic danger was less threatening, older people with more children may have further underestimated the risk, leading to a lower likelihood of vaccination. In contrast, when mortality risk is more severe, the negative impact of having more children on parents' vaccine uptake diminishes.

Overall, the heterogeneity analyses suggest that the effect of having more children on older adults' vaccination is not uniform. Instead, it might interact with individuals' residency location, their perceived health risks, and other factors. The next section turns to an examination of the potential pathway through which the number of children affects older adults' vaccination behavior.

Mechanism

To further understand why having more children discourages older adults from receiving COVID-19 vaccines, this section investigates the potential mechanism: health issues. Raising more children could impose greater physical and emotional demands over time, which can result in poorer health in later years. Those people's health issues might prevent them from getting vaccinations.

Two additional variables are defined. The variable, "Health condition", is derived from the question, "In the past four weeks, how often has your daily life been affected by health issues?"

Responses are coded as follows: 1=always, 2=often, 3=sometimes, 4=rarely, and 5=never. Therefore, higher values indicate better health status. The second variable is a binary indicator of COVID-19 vaccine ineligibility, coded as one if the respondent reported being ineligible for the vaccine and zero otherwise.

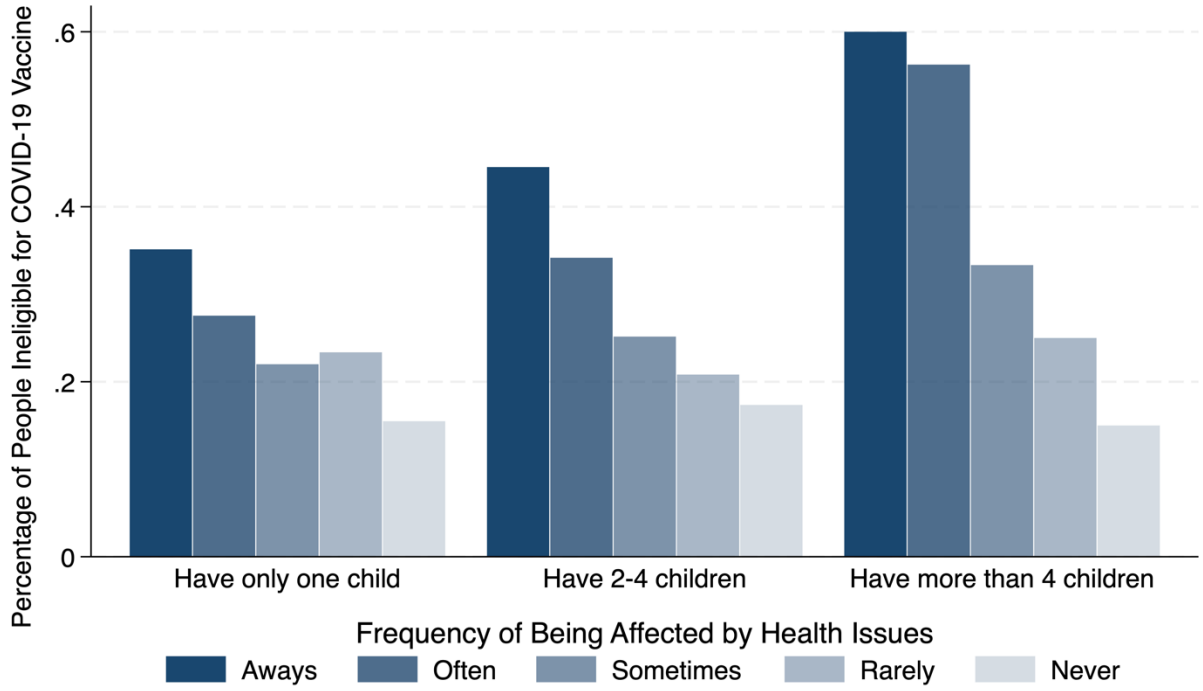


Fig. 2 Percentage of people ineligible for COVID-19 vaccination over health and parity

Fig. 2 provides a graphic illustration of this pathway. First, the overall health condition declines with parity. People with one child report the best health (mean=3.9947), followed by those with two to four children (mean=3.6186), and those with more than four children report the poorest health (mean=3.2192). Second, within each parity group, the share of people reporting vaccination ineligibility declines as their health conditions improve. Third, as family size grows, the overall

proportion of older adults who are ineligible for vaccination increases. Specifically, 20.34% of individuals who have only one child report being ineligible for the COVID-19 vaccine, compared to 24.48% among those who have two to four children and 35.62% among those who have more than four children. Together, the bar chart illustrates a logical chain whereby older adults with more children are in poorer health, and older adults in poorer health are more likely to be ineligible for vaccinations.

Table 5 Evidence of mechanism

	Health Condition	Ineligible for vaccine
	(1)	(2)
Number of children	-0.3060**	0.0978**
	(0.1435)	(0.0460)
Control	Yes	Yes
Age FE	Yes	Yes
Province FE	Yes	Yes
N	2,639	2,644

Notes. All columns include the following covariates: gender, education, per capita household income, rural/urban residency indicator, marital status, age fixed effects, and province fixed effects. Dependent variable of column 1 is health condition, which ranges from 1 to 5, with a higher value referring to a better health status. Dependent variable of column 2 is a dummy variable that indicates whether the respondent is not eligible for the COVID-19 vaccine. Estimated coefficient from the IV-OLS regression is reported in column 1, and marginal effect from the IV-Probit regressions is reported in column 2. Robust standard errors adjusted for clustering on provinces are in parentheses. First-stage estimation results are presented in Table A4.

*p<0.1; **p<0.05; ***p<0.01

Table 5 presents the instrumental variable estimation results, with the corresponding first-stage estimates reported in Table A4. The dependent variable in column 1 is “Health condition”, and the dependent variable in column 2 is the binary indicator for the respondent’s ineligibility for the COVID-19 vaccination. The IV-OLS estimate in column 1 of Table 5 confirms that having

more children is significantly associated with poorer health (coefficient= –0.3061, $p<0.05$). Poorer health, in turn, is linked to vaccination ineligibility. According to the Chinese Center for Disease Control and Prevention, individuals with severe chronic diseases, acute illnesses, or a history of severe allergic reactions to vaccines are ineligible for the COVID-19 vaccination [37]. Column 2 of Table 5 provides supporting evidence that older adults with more children are more likely to report being ineligible for vaccination (0.0978, $p < 0.05$). Taken together, both the graphical and regression evidence support that having more children reduces vaccine uptake in part through poorer health and the consequential medical contraindications.

Further analysis

The primary analysis focuses on vaccine uptake during the unexpected public health crisis of the COVID-19 pandemic. However, uncertainties regarding the vaccine's novelty and the limited evidence on its long-term efficacy may have aggravated hesitancy. We therefore further examine whether the negative impact of having more children applies to regular preventive health behaviors.

In the mechanism analysis, this study finds that older adults with more children are more likely to be ineligible for COVID-19 vaccination, suggesting that health-related issues may partly explain their lower vaccination rates. However, column 1 of Table 6 shows that after excluding respondents who reported ineligibility for the vaccine, the negative effect of the number of children on vaccine uptake remains (coefficient= –0.1407, $p<0.05$). This suggests that other factors, beyond health issues, could also contribute to the negative impact of having more children.

Table 6 Further Analysis

	Removing ineligible respondents	Took flu shot last year	Physical examination	Contact frequency	Vaccination status if live with any child	Vaccination status if live alone
	(1)	(2)	(3)	(4)	(5)	(6)
Number of children	-0.1407**	-0.8115**	-0.5678**	0.0094	0.1406	-0.2480***
	(0.0586)	(0.3881)	(0.2815)	(0.1154)	(0.1097)	(0.0585)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1,900	757	895	2,643	503	2,127

Notes. All columns include the following covariates: gender, education, per capita household income, rural/urban residency indicator, marital status, age fixed effects, and province fixed effects. Dependent variable of column 1 is an indicator for individuals' COVID-19 vaccination status, but the sample excludes those who state that they are ineligible for the vaccination. Dependent variable of column 2 is a dummy variable that indicates whether the respondent took a flu shot last year. Dependent variable of column 3 ranges from 1 to 3, where 1 refers to the respondent never taking a physical examination in the past three years, 2 refers to the respondent taking physical examinations occasionally in the last three years, and 3 refers to the respondent taking regular physical examinations in the past three years. Dependent variable of column 4 is contact frequency with families and friends; a higher value refers to more frequent contacts. Column 5 examines the COVID-19 vaccination status of respondents who co-reside with at least one child, while column 6 examines the COVID-19 vaccination status of respondents who live alone. Marginal effects from the IV-Probit regressions are reported in columns 1, 2, 5, and 6, and estimated coefficients from the IV-OLS regression are reported in columns 3 and 4. Robust standard errors adjusted for clustering on provinces are in parentheses. First-stage estimation results are presented in Table A5.

*p<0.1; **p<0.05; ***p<0.01

Previous literature points to two important arguments. First, the availability of informal care from children crowds out the formal healthcare utilization among older adults [38, 39]. Second, existing literature has established that perceived risk is a fundamental predictor of precautionary behavior [40]. As shown in Table 4, the negative effect of having more children is weaker in regions with higher mortality risks. The arguments from the literature imply that having more children may enhance parents' expectation of the children' support. This expectation could lower parents' perceived health risks, thereby weakening their motivation to engage in preventive health behaviors. In this vein, it is plausible to observe that the negative impact of having more

children also extends to more routine preventive health actions as well.

To test whether the negative impact of having more children generalizes to regular health preventive practices, columns 2 and 3 of Table 6 examine flu vaccination and physical examination behavior using the instrumental variable estimation. The corresponding first-stage results are presented in Table A5. Column 2 of Table 6 shows that older adults with more children are significantly less likely to have received a flu shot (coefficient= –0.8114, $p<0.05$), and column 3 shows that they are also less likely to undergo routine physical checkups (coefficient= –0.5678, $p<0.05$). These results confirm that the negative effect of family size is not limited to the COVID-19 vaccination but also extends to broader preventive health actions.

Although the present study has suggested that having more children reduced older adults' likelihood of COVID-19 vaccine uptake, one may argue the alternative that a larger family increases disease exposure risk, and people who have more children should have been more motivated to vaccinate. This alternative explanation is examined from the following two perspectives.

First, the risk of disease exposure among those who have more children increases only if there is greater family interaction during the pandemic. Yet, there is no evidence that older adults with more children had more frequent contact with family or friends, according to the empirical analysis. In column 4 of Table 6, the dependent variable, "Contact frequency", ranges from one to five, with higher values indicating more frequent contacts. The estimated coefficient is close to zero and statistically insignificant. The insignificant effect of having more children on older

people's contact frequency could be attributed to China's more stringent control policies in response to the pandemic, such as broad application of modern contact tracking technology, family outdoor restrictions, and community-level lockdowns [41].

Second, older adults who co-reside with their children may have stronger incentives to vaccinate, either to protect themselves from infection or to protect their co-residing family members. This possibility suggests that the impact of family size on vaccination decisions could vary by living arrangement. Columns 5 and 6 of Table 6 present separate analyses for older adults who live with at least one child and those who live alone. The results from the IV-Probit estimates show that for older adults living with at least one child, the number of children does not significantly affect their chances of getting vaccinated. In contrast, for those living alone, having more children significantly lowers the likelihood of being vaccinated. These findings suggest that living with children is associated with a higher probability of vaccination, although it remains uncertain whether this reflects self-protection motives or altruism to protect their household members.

It is worth noting that only approximately 19% of the respondents reside with their children. Therefore, the sample sizes for the subgroups in columns 5 and 6 of Table 6 are noticeably different. Nevertheless, the distinctive sample sizes coincide with the emerging trend that the tradition of living with offspring for old-age care has been refreshed due to the demographic changes and urbanization [29]. This shift calls to reconsider how children provide intergenerational support, given the changes in family structures and caregiving norms.

Although this study provides many valuable insights, the following limitations should be acknowledged. First, the data were collected in 2021, when COVID-19 vaccines had recently become widely available. As public understanding and institutional arrangements changed in subsequent periods, individuals' vaccination behavior could change. Future studies could expand this work by incorporating longitudinal data that capture vaccination attitudes and behaviors across multiple time points following the vaccine's release. Second, the role of children could be examined more precisely if detailed information on intergenerational interactions, such as caregiving activities, emotional support, and financial transfers, were available. Third, China is a classic example of a country with strong family ties, among which are the majority of East Asian countries [42] and Mediterranean countries [43]. Future research could investigate whether comparable results are applied in countries with distinctive cultural contexts and family structures. Despite these limitations, the study contributes to a deeper understanding of how children can influence older adults' health behaviors, particularly in times of public health crisis.

Conclusions

Using a unique, nationally representative dataset and an instrumental variable approach, this study presents novel evidence on how the number of children affects COVID-19 vaccination behavior among older adults. Our results demonstrate that having more children significantly reduces the likelihood of vaccine uptake in this population. This negative impact is particularly pronounced among urban residents, though it diminishes when perceived mortality risks are high. Mechanistically, we find that older adults with more children are more likely to experience

underlying health issues, thereby increasing their risk of medical ineligibility for vaccination. Importantly, beyond the context of unexpected public health crises, this negative relationship generalizes to routine preventive health behaviors, such as flu shots and physical examinations. Alongside these findings, our supplementary analysis reveals that living arrangements further complicate older adults' vaccine decisions, collectively highlighting the profound importance of family structure in shaping preventive health behaviors. More generally, these findings imply that older adults with larger families tend to systematically underinvest in preventive health measures, identifying them as a critical target group for future public health interventions. Ultimately, this study contributes to the literature by demonstrating that a deep understanding of family context is essential for effectively predicting and influencing health behaviors across both routine and crisis settings.

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Declarations

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Conflict of interest

The authors declare no potential conflict of interests.

Ethics approval and consent to participate

Not applicable.

Consent for publication

The authors are consent for publication.

Data availability

The primary data set used in this article is publicly available at http://cgss.ruc.edu.cn/English/Home.htm.

Materials availability

Not applicable.

Code availability

The code is provided when needed.

Author contributions

C.Z. provided the methodology, analyzed the results and wrote the manuscript; Z.W. analyzed the results and wrote the manuscript; C.Z. supervised the research. All authors edited the manuscript and approved the final version of the manuscript.

References

1. Grossman, M.: On the Concept of Health Capital and the Demand for Health. Journal of Political Economy. 80, 223–255 (1972)
2. Schaffer DeRoo, S., Pudalov, N.J., Fu, L.Y.: Planning for a COVID-19 Vaccination Program. JAMA. 323, 2458 (2020). https://doi.org/10.1001/jama.2020.8711
3. Zheng, W., Dong, J., Chen, Z., Deng, X., Wu, Q., Rodewald, L.E., Yu, H.: Global landscape of COVID-19 vaccination programmes for older adults: a descriptive study. The Lancet Healthy Longevity. 5, 100646 (2024). https://doi.org/10.1016/j.lanhl.2024.100646
4. Wang, G., Yao, Y., Wang, Y., Gong, J., Meng, Q., Wang, H., Wang, W., Chen, X., Zhao, Y.: Determinants of COVID-19 vaccination status and hesitancy among older adults in China. Nat Med. 29, 623–631 (2023). https://doi.org/10.1038/s41591-023-02241-7
5. Wu, J., Shen, Z., Li, Q., Tarimo, C.S., Wang, M., Gu, J., Wei, W., Zhang, X., Huang, Y., Ma, M., Xu, D., Ojangba, T., Miao, Y.: How urban versus rural residency relates to COVID-19 vaccine hesitancy: A large-scale national Chinese study. Social Science & Medicine. 320, 115695 (2023). https://doi.org/10.1016/j.socscimed.2023.115695
6. Nurmi, J., Jaakola, J.: Losing trust: Processes of vaccine hesitancy in parents' narratives. Social Science & Medicine. 331, 116064 (2023). https://doi.org/10.1016/j.socscimed.2023.116064
7. Galgali, M.S., Helm, P.J., Arndt, J.: Feeling too isolated to be vaccinated? The contributing role of subjective interpersonal isolation factors towards COVID-19 vaccine hesitancy and resistance. Social Science & Medicine. 323, 115865 (2023). https://doi.org/10.1016/j.socscimed.2023.115865
8. Elinder, M., Erixson, O., Öhman, M.: Cognitive ability, health policy, and the dynamics of COVID-19 vaccination. Journal of Health Economics. 91, 102802 (2023). https://doi.org/10.1016/j.jhealeco.2023.102802
9. Bian, B., Li, J., Xu, T., Foutz, N.Z.: Individualism during Crises. The Review of Economics and Statistics. 104, 368–385 (2022). https://doi.org/10.1162/rest_a_01107
10. Attema, A.E., Antonini, M., Genie, M., Torbica, A., Paolucci, F.: Time preferences and COVID-19 vaccination uptake. Eur J Health Econ. 27, 47–63 (2026). https://doi.org/10.1007/s10198-025-01801-7
11. Hou, X., Jiao, Y., Shen, L., Chen, Z.: The lasting impact of the Tuskegee Syphilis Study: COVID-19 vaccination hesitation among African Americans. J Popul Econ. 37, (2024). https://doi.org/10.1007/s00148-024-01013-y
12. Beccari, G., Giaccherini, M., Kopinska, J., Rovigatti, G.: Refueling a Quiet Fire: Old Truthers and New Discontent in the Wake of COVID-19. Demography. 61, 1613–1636 (2024). https://doi.org/10.1215/00703370-11587755
13. Nayar, R.K., Nair, A.T., Shaffi, M., Swarnam, K., Kumar, A., Abraham, M., Lordson, J., Grace, C.: Methods to overcome vaccine hesitancy. The Lancet. 393, 1203–1204 (2019). https://doi.org/10.1016/S0140-6736(19)30218-1
14. Sakai, Y.: The Vaccination Kuznets Curve: Do vaccination rates rise and fall with income? Journal of Health Economics. 57, 195–205 (2018).

https://doi.org/10.1016/j.jhealeco.2017.12.002
15. Bronchetti, E.T., Huffman, D.B., Magenheim, E.: Attention, intentions, and follow-through in preventive health behavior: Field experimental evidence on flu vaccination. Journal of Economic Behavior & Organization. 116, 270–291 (2015). https://doi.org/10.1016/j.jebo.2015.04.003
16. Gibson, D.G., Ochieng, B., Kagucia, E.W., Were, J., Hayford, K., Moulton, L.H., Levine, O.S., Odhiambo, F., O'Brien, K.L., Feikin, D.R.: Mobile phone-delivered reminders and incentives to improve childhood immunisation coverage and timeliness in Kenya (M-SIMU): a cluster randomised controlled trial. The Lancet Global Health. 5, e428–e438 (2017). https://doi.org/10.1016/S2214-109X(17)30072-4
17. Humlum, M.K., Morthorst, M.O., Thingholm, P.R.: Sibling spillovers and the choice to get vaccinated: Evidence from a regression discontinuity design. Journal of Health Economics. 94, 102843 (2024). https://doi.org/10.1016/j.jhealeco.2023.102843
18. Bouckaert, N., Gielen, A.C., Van Ourti, T.: It runs in the family – Influenza vaccination and spillover effects. Journal of Health Economics. 74, 102386 (2020). https://doi.org/10.1016/j.jhealeco.2020.102386
19. Bonsang, E., Skirbekk, V.: Does Childbearing Affect Cognitive Health in Later Life? Evidence From an Instrumental Variable Approach. Demography. 59, 975–994 (2022). https://doi.org/10.1215/00703370-9930490
20. Sloan, C.J., Mailick, M.R., Hong, J., Ha, J.-H., Greenberg, J.S., Almeida, D.M.: Longitudinal changes in well-being of parents of individuals with developmental or mental health problems. Social Science & Medicine. 264, 113309 (2020). https://doi.org/10.1016/j.socscimed.2020.113309
21. Ma, M.: Does children's education matter for parents' health and cognition? Evidence from China. Journal of Health Economics. 66, 222–240 (2019)
22. Grundy, E., van den Broek, T., Keenan, K.: Number of Children, Partnership Status, and Later-life Depression in Eastern and Western Europe. The Journals of Gerontology: Series B. 74, 353–363 (2019). https://doi.org/10.1093/geronb/gbx050
23. Kruk, K.E., Reinhold, S.: The effect of children on depression in old age. Social Science & Medicine. 100, 1–11 (2014). https://doi.org/10.1016/j.socscimed.2013.09.003
24. Cunningham, S.A., Yount, K.M., Engelman, M., Agree, E.: Returns on Lifetime Investments in Children in Egypt. Demography. 50, 699–724 (2012). https://doi.org/10.1007/s13524-012-0147-3
25. Zimmer, Z., Kwong, J.: Family size and support of older adults in urban and rural China: current effects and future implications. Demography. 40, 23–44 (2003). https://doi.org/10.1353/dem.2003.0010
26. Ho, C., McGarry, K.: Brothers, sisters, and support to older parents: separate spheres across and within support types? J Popul Econ. 38, (2025). https://doi.org/10.1007/s00148-025-01059-6
27. Mommaerts, C., Truskinovsky, Y.: The cyclicality of informal care. Journal of Health Economics. 71, 102306 (2020). https://doi.org/10.1016/j.jhealeco.2020.102306

28. Miller, K.E.M., Hart, J.L., Useche Rosania, M., Coe, N.B.: Youth Caregivers of Adults in the United States: Prevalence and the Association Between Caregiving and Education. Demography. 61, 829–847 (2024). https://doi.org/10.1215/00703370-11383976
29. Lancet, T.: Global elderly care in crisis. The Lancet. 383, 927 (2014). https://doi.org/10.1016/S0140-6736(14)60463-3
30. Hirani, J.L.-J.: Inattention or reluctance? Parental responses to vaccination reminder letters. Journal of Health Economics. 76, 102439 (2021). https://doi.org/10.1016/j.jhealeco.2021.102439
31. Lavely, W., Freedman, R.: The origins of the Chinese fertility decline. Demography. 27, 357–367 (1990)
32. Xinhua: China's urbanization rate hits 64.72% in 2021, https://english.www.gov.cn/archive/statistics/202202/22/content_WS62149dc7c6d09c94e48a5517.html
33. Chen, Y., Huang, Y.: The power of the government: China's family planning leading group and the fertility decline of the 1970s. Demographic Research. 42, 985–1038 (2020). https://doi.org/10.4054/DEMRES.2020.42.35
34. Chen, Y., Fang, H.: The long-term consequences of China's "Later, Longer, Fewer" campaign in old age. Journal of Development Economics. 151, (2021). https://doi.org/10.1016/j.jdeveco.2021.102664
35. Zeng, Y., Hesketh, T.: The effects of China's universal two-child policy. The Lancet. 388, 1930–1938 (2016). https://doi.org/10.1016/S0140-6736(16)31405-2
36. Miao, Y., Bai ,Junwen, Shen ,Zhanlei, Li ,Yi, Zhang ,Wanliang, Zhu ,Dongfang, Ren ,Ruizhe, Zhang ,Jingbao, Guo ,Dan, Tarimo ,Clifford Silver, Dong ,Wenyong, Liu ,Rongmei, Zhao ,Qiuping, Hu ,Jianping, Li ,Miaojun, and Wei, W.: How urban versus rural population relates to COVID-19 booster vaccine hesitancy: A propensity score matching design study. Human Vaccines & Immunotherapeutics. 20, 2297490 (2024). https://doi.org/10.1080/21645515.2023.2297490
37. China CDC Weekly: Technical Vaccination Recommendations for COVID-19 Vaccines in China (First Edition). China CDC Wkly. 3, 459–461 (2021). https://doi.org/10.46234/ccdcw2021.083
38. Costa-Font, J., Courbage, C.: Crowding Out of Long-Term Care Insurance: Evidence from European Expectations Data. Health Economics. 24, 74–88 (2015). https://doi.org/10.1002/hec.3148
39. Van Houtven, C.H., Norton, E.C.: Informal care and health care use of older adults. Journal of Health Economics. 23, 1159–1180 (2004). https://doi.org/10.1016/j.jhealeco.2004.04.008
40. Boss, S.R., Galletta, D.F., Lowry, P.B., Moody, G.D., Polak, P.: What Do Systems Users Have to Fear? Using Fear Appeals to Engender Threats and Fear that Motivate Protective Security Behaviors. MIS Quarterly. 39, 837–864 (2015)
41. Burki, T.: China's successful control of COVID-19. The Lancet Infectious Diseases. 20, 1240–1241 (2020). https://doi.org/10.1016/S1473-3099(20)30800-8
42. Raymo, J.M., Park, H., Xie, Y., Yeung, W.J.: Marriage and Family in East Asia: Continuity

and Change. Annu. Rev. Sociol. 41, 471–492 (2015). https://doi.org/10.1146/annurev-soc-073014-112428
43. Reher, D.S.: Family Ties in Western Europe. In: Zuanna, G.D. and Micheli, G.A. (eds.) Strong Family and Low Fertility: A Paradox? New Perspectives in Interpreting Contemporary Family and Reproductive Behaviour. pp. 45–76. Springer Netherlands, Dordrecht (2004)

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