Living Environment Improvement and Human Capital Accumulation: Evidence from A Schistosomiasis Control Policy in China

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Abstract

This study investigates the long and short-term effects of China's comprehensive control and prevention policy implemented in 2006 ("2006 policy" hereafter) targeting schistosomiasis, one of the seven most prevalent Neglected Tropical Diseases (NTDs). The 2006 policy, a public health policy that emphasizes infectious source control, improves living environmental conditions and reduces schistosomiasis prevalence. Regarding long-term outcomes, we observe mixed results with significant gender heterogeneity including a decrease in hospitalization likelihood among males while an increase in feeling sick incidence, a decrease in junior high school completion probability and an increase in employment rates among females. Short-term analysis reveals that boys exhibit lower sickness likelihood while girls show higher sickness likelihood. Furthermore, girls are less likely to enroll in school and more likely to work. An increased access to toilets may be a potential explanation for the observed effects.

JEL Codes: I14, I18, J13, J24, Q56
Keywords: Living environment, Schistosomiasis, Neglected tropical diseases, China

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1. Introduction

Over the past decades, economists have found various aspects of benefits of reducing the prevalence of fatal infectious disease such as malaria (Barofsky et al., 2015; Barreca, 2010; Bleakley, 2010b; Cutler et al., 2010; Fink et al., 2021; Hong, 2013; Kuecken et al., 2021; Lucas, 2010; Venkataramani, 2012), while as a comparison, the benefits of combating against the neglected tropical diseases (NTDs),[1] a group of diseases prevalent in tropical and subtropical areas that predominantly infect people in developing countries (Hotez et al., 2009), is relatively unexplored. Although NTDs have low fatality rate (Hotez et al., 2007; Molyneux et al., 2017), they still cause devastating health, social, and economic consequences for over one billion people and are among the most potent drivers of poverty traps (Hotez et al., 2009).[2] Only a few studies in the literature have examined the effects of a few NTDs, e.g., hookworm (Bleakley, 2003, 2007), onchocerciasis (Kazianga et al., 2014), and dengue (Sanfelice, 2022).

This study focuses on schistosomiasis, one of the seven neglected tropical diseases (NTDs) with a high prevalence in Asia, Africa, and the Middle East (Hotez et al., 2007, 2009). Schistosomiasis, known for approximately 5,000 years (Contis & Dawd, 1996), is considered the second most devastating parasitic disease worldwide after malaria (LoVerde, 2019).[3] According to the World Health Organization (WHO), as of 2021, schistosomiasis has even surpassed malaria in terms of prevalence with approximately 251.4 million cases compared to 247 million for malaria. Although rarely fatal, schistosomiasis significantly hampers children's growth, development, and physical fitness (Hotez et al., 2009). Various schistosomiasis control policies have been adopted by governments and organizations worldwide. The current predominant intervention strategy for both schistosomiasis and other NTDs primarily focuses on morbidity control by providing medication (praziquantel for schistosomiasis) to infected individuals (Hotez et al., 2007), mainly targeting school-age children (Bustinduy et al., 2017). Despite being generally cost-effective in reducing disease prevalence (Almond et al., 2018;

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[1] The Neglected tropical diseases are Buruli ulcer, Chagas disease, dengue and chikungunya, dracunculiasis (Guinea-worm disease), echinococcosis, foodborne trematodiases, human African trypanosomiasis (sleeping sickness), leishmaniasis, leprosy (Hansen's disease), lymphatic filariasis, mycetoma, chromoblastomycosis and other deep mycoses, onchocerciasis (river blindness), rabies, scabies and other ectoparasitoses, schistosomiasis, soil-transmitted helminthiases, snakebite envenoming, taeniasis/cysticercosis, trachoma, and yaws and other endemic treponematoses.

[2] Neglected tropical diseases -- GLOBAL (who.int)

[3] CDC - Schistosomiasis

Turner et al., 2021), morbidity control faces limitations due to medication availability issues and its inability to prevent new infections or reinfections while also leaving residual morbidity at a significant level (Bustinduy et al., 2017; Hotez et al., 2009; Miguel & Kremer, 2004).[4] Moreover, the benefits of morbidity control extend beyond worm eradication are limited (Taylor-Robinson et al., 2015). Therefore, a more comprehensive control policy that incorporates morbidity control needs to be adopted (Bustinduy et al., 2017).

The history of schistosomiasis in China, caused solely by Schistosoma Japonicum, can be traced back two thousand years (Chen & Feng, 1999). Among all provinces in China, there are 12 provinces with areas contaminated with host snail Oncomelania spp., which is amphibious and the only intermediate host snail of Schistosoma Japonicum. In 2005, there were 125.19 (236.61) million out of 670.09 million people in these 12 provinces at the risk of infection, i.e, their town (county) of residence has areas contaminated with host snails (Hao et al., 2006). In 2006, the Chinese government implemented a comprehensive policy for prevention and control of schistosomiasis (hereinafter referred to as "the 2006 policy") in all provinces that has areas contaminated with host snails (a total of 12). The distinguishing feature of the 2006 policy, in contrast to other global policies targeting the control of morbidity caused by schistosomiasis and other NTDs, lies in its emphasis on reduction source of infection. This approach aims to improve environments by reducing overall contamination area with host snails, effectively mitigating both infection and re-infection risks. The impact of the 2006 policy is significant. Figure 1 illustrates a decrease in the total area contaminated with host snails from 3,846 km^2 in 2004 to 3,560 km^2 in 2015. By 2016, merely ten years after the implementation of the 2006 policy, prevalence rates had been reduced by approximately 90%. Figure 2 presents alterations in prevalence rates for each province. For comprehensive information regarding schistosomiasis in China and detailed description of the 2006 policy, please refer to Section 2.

The early life period, including the school-age years, is widely recognized as crucial for human capital accumulation in both developed and developing countries (Almond et al., 2018; Bleakley, 2010a; Currie, 2009; Currie & Vogl, 2013; Heckman, 2007). School-age children is a vulnerable population for schistosomiasis (Hotez et al., 2007). In China, the highest prevalence

[4] [Schistosomiasis (who.int)]

of Schistosoma japonicum is observed among school-age children (Huang & Manderson, 2005). For this specific age group, the significant reduction in schistosomiasis prevalence resulting from the policy implemented in 2006 may have implications beyond health outcomes. However, the direction of these effects remains ambiguous. On one hand, improved health induced by the 2006 policy could lead to increased educational attainment by reducing school absenteeism and enhancing academic performance. This effect might be particularly pronounced among school-age girls who often bear responsibility for caring for their younger siblings when they fall ill (Alsan et al., 2017). The 2006 policy's impact extends beyond individuals aged six or above since it reduces infection risk across all age groups. Consequently, school-age girls with younger siblings are less likely to miss or drop out of school due to caregiving responsibilities towards sick siblings. Improved health and educational achievement during schooling years can potentially yield better long-term outcomes in adulthood. On the other hand, two factors might contribute to lower educational attainment levels following the implementation of the 2006. First, attending school becomes more costly due to increased potential wages that children can earn in labor markets (Bleakley, 2010b). Second, the implementation of the 2006 policy would enhance the environmental conditions and improve the health status of school-age children, thereby augmenting the efficiency in accomplishing domestic tasks (Kuecken et al., 2021). Consequently, children may withdraw from or discontinue their education and instead enter the labor market prematurely or undertake domestic duties for their household. However, for school-age children, the early entry into the labor market, even informally, not only is associated with adverse health outcomes (Ibrahim et al., 2019), but also result in diminished health literacy and knowledge that would have been acquired through formal education (Kenkel, 1991; Van Der Heide et al., 2013), ultimately leading to negative outcomes later in life. In countries where gender inequality is prevalent, the impact of the 2006 policy may differ significantly between men and women.

In this paper, we study the effects of the 2006 policy on individuals from both long- and short-term perspectives as well as its short-term effects on households. To investigate the long-term effects of the 2006 policy, we employ the 2018 wave of the China Family Panel Studies (CFPS), a nationally representative longitudinal survey that provides comprehensive information on individuals, households, and society in China. Leveraging the geographic variation in areas contaminated with host snails and temporal differences across birth cohorts, we apply a cohort Difference-in-Differences (DID) estimation strategy to examine the impact of school-age exposure to the 2006 policy aimed at reducing schistosomiasis infection risk on adult outcomes. To the best of our knowledge, only Makamu et al. (2018) have examined the effects of a morbidity control policy on school-age children in four regions (provinces) of Nigeria and found that exposure during this period increases years of education during adulthood.

We find that individuals born in endemic provinces and who were of school age (aged 7 to 18) in 2006 or later exhibit an increased probability of feeling sick (3.81 percentage points or about 25.57 %), a reduced likelihood of hospitalization (2.57 percentage points or approximately 44.70 %), and an increased probability of employment (5.13 percentage points or about 6.27 %). Interestingly, we observe significant heterogeneity in the impacts of the 2006 policy implementation. Among males, there is a decrease in the likelihood of hospitalization (3.06 percentage points or around 58.62 %). However, for females, the effects differ from those observed among males. First, there is an increase in the incidence of feeling sick (6.9 percentage points or about 43.40 %), an increased incidence of having chronic diseases (3.01 percentage points or around 55.33 %), and a reduction in weekly exercise duration by approximately 1 hour; Second, although no effect on educational attainment is found, there is a significant decline in the probability of completing junior high school education (3.98 percentage points or about 4.49 %); Third, despite no impact on income levels being detected, there is an increased likelihood of employment at the time of survey among women (7.97 percentage points or approximately 11.48%). Our results are driven by people from rural areas.

To examine the short-term effects, all of which serves as the potential mechanisms for the long-term effects, we utilize the 2000, 2004, 2006, 2009 and 2011 waves of the China Health Nutrition Study (CHNS), a longitudinal survey that started in 1989 and continued through 2015, and employ a DID identification strategy that utilizes the temporal variation among survey years and geographical variation in areas contaminated with host snails. Focusing on school-age children (aged 7 -18), we find that boys are less likely to be sick (4.55 percentage points or 146.77 %) and girls are more likely to work (9.77 percentage points or 59.21 %), less likely to enroll into school (7.92 percentage points or 8.62 %), and more likely to be sick (5.71

percentage points or 126.89 %). The substantial heterogeneity observed in the short-term effects resulting from the 2006 policy not only aligns with but also serves as evidence for its long-term implications. We also examine the short-term effects of the 2006 policy on adult outcomes but find no significant effects, this serves as a falsification test for our empirical strategies and is consistent with the low infection rate among adults. Furthermore, our analysis on household outcomes indicates that the implementation of the 2006 policy increases toilet access probability by 7.17 percentage (about 21.03 %).

The findings of this study make several contributions to the existing literature. First and foremost, existing literature studying the effects of environmental factors primarily focuses on climate change (E.g., Agarwal et al., 2021; Zhang et al., 2017, 2018), water pollution (E.g., Lai, 2017; Wang et al., 2022), air pollution (E.g., Graff Zivin et al., 2020; Qin et al., 2019; Yao et al., 2022). To the best of our knowledge, this paper contributes to the literature by being the first to study the effects of living environment improvement brought by a public health policy; Second, there is a dearth of research on the effects of NTDs (Bleakley, 2003, 2007; Kazianga et al., 2014; Makamu et al., 2018; Sanfelice, 2022). This paper fills this gap by providing evidence on the long- and short-term impact of a comprehensive control and prevention policy for schistosomiasis, one of seven most prevalent NTDs, in developing contexts; Third, while there is extensive literature examining the effects of early life shocks on adult outcomes (Almond et al., 2018), this paper contributes by investigating the effects of a control measure against an infectious disease that has low fatality rate; Fourth, although there are many epidemiological studies exploring the relationship between schistosomiasis and its control policies, most findings are correlational rather than causal. This paper complements these studies by providing causal evidence that exposure to a schistosomiasis control and prevention policy during school age has not only instantaneous effects but also spillover effects into adulthood outcomes. Finally, our results highlight gender inequality as an important factor that can attenuate or even reverse positive health intervention impacts for women, especially for those from low socio-economic status households who face credit constraints (Alsan et al., 2017; Jayachandran, 2015; Weber et al., 2019).

The subsequent sections of this paper are structured as follows: Section 2 provides the introduction to the background of schistosomiasis and the 2006 policy in China; Sections 3 and

4 describe the data and empirical strategy, respectively; Results and robustness checks are presented in Sections 5 and 6, respectively; Finally, Section 7 concludes.

2. Background: Schistosomiasis and the 2006 policy in China

Though not as fatal as other infectious diseases such as malaria, Schistosomiasis is a chronic parasitic disease caused by blood flukes (trematode worms) of the genus Schistosoma. It is one of the seven most prevalent NTDs, with a significant impact on public health and socioeconomic status in impoverished communities across Asia, Africa, and the Middle East (Hotez et al., 2007; McManus et al., 2018; Weerakoon et al., 2015). Among the six disease-causing species, Schistosoma haematobium, Schistosoma mansoni, and Schistosoma japonicum have the highest prevalence. These species differ in transmission routes, disease pathology, occurrence of reservoir hosts, habitats of intermediate host snails, and age patterns for infection acquisition and resolution (Colley et al., 2014; McManus et al., 2018; Rollinson et al., 2013).

This study focuses on Schistosoma japonicum, an intestinal schistosomiasis that is prevalent and the only type of Schistosoma in China (Colley et al., 2014; McManus et al., 2018). In China, Schistosoma japonicum has more than 40 definitive hosts, including humans and livestock (Chen & Feng, 1999). Furthermore, unlike other species of Schistosoma that have multiple intermediate hosts, the transmission of Schistosoma japonicum involves only one intermediate host snail called Oncomelania Spp (Zhang et al., 2021). The amphibian characteristics of Oncomelania Spp enable its proliferation in various habitats such as water networks in lakes and marshlands as well as diverse microhabitats in hilly and mountainous environments (Wang et al., 2009). The simplified lifecycle of Schistosoma japonicum is as follows: individuals become infected through contact with contaminated water containing larval forms known as cercariae released by infected host snails. Cercariae can penetrate human skin and subsequently develop into adult worms within the human body. Female adult worms lay eggs that are excreted in feces. Upon contact with water, the eggs develop into miracidia which then penetrate host snails to mature into cercariae. For a detailed description of the lifecycle of Schistosoma japonicum, refer to Ross et al. (2001). Although Schistosoma japonicum has the potential to infect individuals of all age groups, schistosomiasis infection exhibits the highest prevalence among school-age children in China (Huang & Manderson, 2005). Children infected with Schistosoma japonicum exhibit decreased hemoglobin levels, elevated iron-deficiency anemia, stunted growth, and cognitive impairments affecting memory and learning abilities (McGarvey, 2000; Ross et al., 2001). Consequently, Schistosoma japonicum infection exerts detrimental effects on children's developmental trajectory encompassing their nutritional status and educational achievements (Huang & Manderson, 2005; Stephenson, 1993).

Archaeological evidence indicates that Schistosomiasis has been present in China for over 2,100 years (Chen & Feng, 1999). In the early 1950s, an estimated 11.6 million people required treatment and more than 100 million were at risk of infection (Collins et al., 2012). Since then, the Chinese government has implemented a series of Schistosomiasis control policies which can be divided into four stages: preparation from 1950 to 1955; large-scale campaigns emphasizing snail control in all (a total of 12) provinces that has areas contaminated with host snails from 1956 to1985; morbidity control focused on praziquantel administration boosted by the World Bank Loan Project (WBLP) in eight provinces that has schistosomiasis patients from 1992 to 2001;[5] and current comprehensive strategy focusing on infectious source control since 2006 (the 2006 policy). See Hong et al. (2022) and Qian et al. (2019) for an overview.

Current mainstream control policies against schistosomiasis (and other NTDs) adopted worldwide primarily emphasize morbidity control and are generally cost-effective (Almond et al., 2018; Turner et al., 2021). However, the morbidity control policy, which provides medication to infected individuals, only targets existing worms in the body and does not prevent new infections or reinfections (Miguel & Kremer, 2004). Additionally, while effective in reducing prevalence, the morbidity control policy still results in a significant level of residual morbidity (Bustinduy et al., 2017), with limited benefits beyond prevalence reduction (Taylor-Robinson et al., 2015). Furthermore, the availability of praziquantel poses limitations on implementing the morbidity control policy effectively (Hotez et al., 2009). According to WHO data from 2021, only 43.3% of school-age children requiring preventive chemotherapy for

[5] Out of all provinces that has areas contaminated with host snails, there were four provinces that has areas contaminated with host snails but with no schistosomiasis patients.

schistosomiasis received treatment.[6] Therefore, a more comprehensive approach to schistosomiasis control may yield greater effectiveness (Bustinduy et al., 2017).

This paper focuses on the 2006 policy. In the early years of the 21st century, despite significant progress achieved during the boosted morbidity control stage of the WBLP (Chen et al., 2005; Li et al., 2022), schistosomiasis re-emerged due to various factors including severe flooding in the Yangtze River in 1998, termination of the WBLP, and changes in ecological, social, and economic factors (Wang et al., 2008; Sun et al., 2017). The number of national schistosomiasis cases reported by the CHSY increased from 694,788 in 2000 to 843,011 in 2003. Recognizing this resurgence, Schistosomiasis was classified as one of the top four priorities for communicable disease control by the Chinese central government in 2004 (Wang et al., 2008). In 2005, the central government decided to implement a comprehensive policy for prevention and control of schistosomiasis. The following year, on May 1st, the ordinance for schistosomiasis prevention and control came into effect, marking the beginning of the implementation of the policy in 2006.[7] The 2006 policy, which incorporates experiences and lessons from previous schistosomiasis control policies, primarily consists of three components (Hong et al., 2022; Zhang et al., 2019). First, snail control focuses on eradicating snails through measures such as environmental modification. Second, morbidity control involves providing medication to infected individuals and livestock. Last, infectious source control is the central aspect of the 2006 policy and includes strategies like raising livestock in herds, replacing bovine with machinery to reduce the number and types of susceptible animals, reconstructing sanitary toilets for environmentally-friendly excrement processing, and collecting fishermen's excrement to prevent egg contamination of water sources (Hong et al., 2022). See Sun et al. (2017) for a detailed description of the 2006 policy.

Comparing with the prevailing policy, the 2006 policy has significant implications for farmland, water sources, and the living environment. In terms of farmland environment, improvements are being made through snail eradication measures, herd-based livestock rearing practices, and mechanization replacing bovine labor to reduce snail presence in agricultural areas. Concerning water source environments, enhancements are achieved through snail

[6] https://www.who.int/news-room/fact-sheets/detail/schistosomiasis
[7] https://www.gov.cn/zwgk/2006-04/11/content_251140.htm

eradication efforts and the implementation of excrement collection from fishermen to minimize snails' presence in water bodies. As for the living environment, it is enhanced by modifying private and public toilet infrastructure to ensure increased access to sanitation facilities while adopting environmentally-friendly approaches for collecting and processing human waste.

Since the implementation of the 2006 policy, as depicted in Figure 1, there has been a reduction in total areas contaminated with host snail from approximately 3,862 km^2 in 2005 to 3,563 km^2 in 2015. Furthermore, Figure 2 demonstrates that the implementation of the aforementioned policy resulted in a significant decrease in schistosomiasis prevalence across endemic provinces. Over the period between 2004 and 2015, an average decline rate of around 79% was observed across all provinces affected by host snail contamination.

3. Data

3.1 China Family Panel Studies

In order to examine the long-term effects of the 2006 policy, we utilize the China Family Panel Studies (CFPS), a bi-annual, nationally representative panel survey that commenced in 2010 and provides comprehensive information on Chinese individuals, families, and society. Our analysis is based on data from the 2018 survey wave, with a sample restricted to individuals born between 1983 and 1999 who were aged between 19 and 35 at the time of the survey.[8] Individuals who were born in provinces with areas contaminated with host snails and were of school age (7 to 18) in or after 2006 were exposed to the 2006 policy. In total, our sample has 8,310 individuals. Table 1 presents the summary statistics of the CFPS sample. The variability in the number of observations among different outcomes is attributed to the presence of missing values.

The effects of exposure to the 2006 policy during school age have two potential directions on adulthood outcomes. One direction entails a positive impact through enhanced health status and improved environment during the school age period, subsequently influencing educational attainment and other health and non-health outcomes in later life. In developing countries,

[8] Due to the impact of the Covid-19 pandemic and a reduced number of available observations, we have made a deliberate decision to exclude data from the 2020 wave in order to ensure the robustness and reliability of our analysis.

particularly for school-age girls from households with younger siblings (typically under 5 years old), the implementation of the 2006 policy could alleviate their responsibility of providing childcare for their ill younger siblings (Alsan et al., 2017). Consequently, school-age girls would not need to be absent from or drop out of school to care for their sick younger siblings. The other direction suggests a negative impact resulting from reduced educational attainment due to better health conditions or an improved environment, which increases the opportunity cost of attending school and raises the likelihood of entering the labor market at an earlier stage (Bleakley, 2010b) or engaging in domestic work (Kuecken et al., 2021). Early entry into the labor market is negatively associated with the health outcomes of school-age children (Ibrahim et al., 2019) and reduced educational attainment also leads to a decrease in acquired knowledge about health and health literacy that should have been obtained through schooling (Kenkel, 1991; Van Der Heide et al., 2013). As such, we examine adulthood health, education, and labor outcomes.[9]

We examine four health outcomes. In the CFPS questionnaire, respondents were asked to report whether they ever felt sick and its severity (non-severe, moderate, and severe) within the previous two weeks. Consequently, we construct an indicator to determine whether individuals felt sick with a severity level categorized as either moderate or severe during this period.[10] The second outcome is an indicator of whether the individual was hospitalized last year. The third outcome we examine is whether the individual has had any chronic disease in the past six months. The last outcome is weekly total hours spent on exercise.

We evaluate two educational outcomes. Although some individuals in our sample may not have completed their education at the time of the survey, years of education remains a crucial indicator for human capital accumulation (Deming, 2022). Therefore, the first educational outcome we consider is years of education. Despite the implementation of the Compulsory Schooling Law in 1986, which mandates children aged 6-15 to attend primary school (6 years) and junior high school (3 years), there persists a concerning issue of high dropout rates at the

[9] Due to a substantial number of missing observations for the math and word tests, we are unable to examine the effects of school age exposure to the 2006 policy on cognition.

[10] We also construct two alternative indicators of feeling sick with various severity level including non-severe only and all three levels. The results of using these two alternative indicators are robust and are available from the author upon request.

junior high school level in China due to various reasons including but not limited to significant opportunity costs (Mo et al., 2013; Shi et al., 2015). Therefore, our second measure of educational outcome is an indicator reflecting completion or non-completion of junior high school education.

We examine two labor outcomes: employment status at the time of the survey and income level. Due to challenges in distinguishing individual contributions to household income in rural households (Liu et al., 2008), and considering that 87.4% of our sample individuals are from rural areas, we use per capita household income as a measure for our second labor outcome.

3.2 China Health Nutrition Survey

The China Health and Nutrition Survey (CHNS) is an ongoing collaborative project between the University of North Carolina at Chapel Hill and the Chinese Center for Disease Control and Prevention that initiated in 1989 and continued through 2015 and provides detailed information on individual, household, and community in nine provinces of China. We utilize the panel nature of the CHNS to examine the short-term effects of the 2006 policy implementation on individuals and households. Specifically, our analysis focuses on data from five waves: 2000, 2004, 2006, 2009, and 2011. We exclude individuals or households whose household status changed between 2000 and 2011 to mitigate potential confounding effects related to urbanization processes (e.g., usually transitioning from rural to urban areas). Additionally, we exclude individuals and households who changed their province of residence during this period to avoid any sample selection bias concerns. To address collinearity issues with individual/household fixed effects models, we further drop observations where individuals/households were only observed once or exclusively in either the earlier waves (i.e., before or including year 2004) or solely in the later wave starting from year 2006 onwards. Furthermore, we divide our CHNS sample into three sub-samples: school-age children (aged 7-18), adults (aged 19-60), and households. In total, we have 5,180, 31,169, and 12,776 observations for school-age children, adult, and household sub-samples, respectively. Table 2 reports the summary statistics of the CHNS sample.

We examine the effects of the 2006 policy on school-age children outcomes to explore its instantaneous effects, which also serves as the mechanisms for the long-term effects. School enrollment exhibits a negative correlation with engagement in child labor and domestic work (Björkman-Nyqvist, 2013; Kruger, 2007), which adversely correlates with the well-being of children of school age (Ibrahim et al., 2019). Therefore, we examine three school-age children outcomes. The first is an indicator of whether the school-age children were a currently enrolled student at the time of the survey. In each wave of the CHNS, individuals aged 6 and above were surveyed regarding their current labor market employment status, as well as their engagement in domestic work such as providing child care to younger siblings, cultivating homegrown vegetables and fruits, engaging in household farming or collective farming, raising livestock or poultry, and participating in fishing. We therefore construct our second outcome for school-age children: an employment indicator, where one indicates that the children were either employed or engaged in any domestic activities, and zero otherwise. It is worth mentioning that the employment status for school-age children includes both formal and informal employment. In each wave of the CHNS, both children and adults were asked about their health condition over the past four weeks. Hence, our final outcome for school-age children is a sickness indicator that determines whether they have experienced sickness, injury, or been diagnosed with chronic or acute diseases.

We examine the short-term effects of the 2006 policy on adults through whom the 2006 policy may influence school-age children in both short- and long-term perspectives. Specifically, we analyze two adult outcomes. The first outcome pertains to their current employment status, while the second outcome focuses on a sickness indicator that is constructed similarly to those used for assessing school-age children's outcomes.

We examine three household-level environmental and economic outcomes through which the 2006 policy influence the outcomes of school-age children. The 2006 policy entails reconstruction of sanitary toilets for environmentally friendly excrement processing. Consequently, we construct an indicator of toilet access with one indicating the household has either an indoor toilet or access to public restroom, while a value of zero for having no toilets or public restrooms access at all or only access to cement open or earth open pits. Additionally, in light of the epidemiological nature of schistosomiasis, which is transmitted through contact with contaminated water, individuals may opt to switch their daily water source to tap water.

To measure access to tap water, we construct an indicator where a value of one indicates that tap water is used for cooking and food washing, and zero otherwise. The last outcome is the per capita household income adjusted for the 2011 Consumer Price Index (CPI).

4. Empirical strategy

In order to assess the effects of school age exposure to the 2006 policy on adult outcomes, we employ a cohort difference-in-difference (DID) strategy. This strategy leverages the temporal variation among birth cohorts and the heterogeneity of areas contaminated with host snails across provinces to compare children born in 1988 or later (aged 7 – 18 in 2006) with those born earlier (aged 19 or older in 2006), as well as to contrast children born in provinces has areas contaminated with host snails (endemic provinces) against those born in non-endemic provinces. The model is presented below:

$$Y_{ipc} = \alpha_0 + \alpha_1 Treat_p \times Post_c + \boldsymbol{X}'\beta + \tau_p + T_c + \varepsilon_{ipc} \qquad \textbf{(1)}$$

where Y_{ipc} is the outcome of individual i who was born in province p in year *t*. The outcomes of interest include health, education and labor outcomes. $\boldsymbol{X}$ is a vector of birth province and individual characteristics control variables.[11] τ_p and T_c are birth province and birth year (cohort) fixed effects, respectively. ε_{ipc} is the error term.

The variable of interest is the interaction term $Treat_p \times Post_c$. $Treat_p$ is an indicator that takes a value of 1 if the individual was born in an endemic province in 2005, and 0 otherwise. The endemic provinces are Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Sichuan, and Yunnan. We set $Post_c$ equals to 1 for individuals born in 1988 or later (aged 7 - 18 in 2006) and 0 for those born before 1988 (aged 19 or older in 2006).[12] The coefficient of interest α_1 captures the effect of school age (7 - 18) exposure to the 2006 policy on adulthood outcomes. Robust standard errors are clustered at the province and year of birth level.

[11] Birth province characteristics control variables include GDP per capita, the number of health care facilities per 10k people, the number of beds of health care facility per capita, and the number of medical personnel per capita, all are obtained from the 1983 to 2000 China Statistical Yearbook (CSY). Individual demographic characteristics control variables include gender, rural hukou at age 12, han ethnicity, age, and age squared.

[12] Considering the cultural difference that children in northern China usually start primary school at 7 while it is 6 for children in Southern China and the general graduation age for high school students is 18, we define the school age period within 7 to 18.

We also assess the short-term effects of the 2006 policy on individuals and households by using a DID strategy that exploits the temporal variation among survey years and the variation in areas contaminated with host snails across provinces. The model for assessing individual level outcomes is presented below:

$$Y_{ipt} = \alpha_0 + \alpha_1 Treat_p \times Post_t + \boldsymbol{X}'\beta + \tau_p + \eta_t + \omega_i + \epsilon_{ipt} \quad \textbf{(2)}$$

where Y_{ipt} is the outcome of individual *i* who lives in province p in year *t*. $\boldsymbol{X}$ is a vector of individual characteristics, which includes age dummies, and province-level characteristics, which includes GDP per capita, the number of health care facilities per 10k people, the number of beds of health care facility per capita, and the number of medical personnel per capita. τ_p, η_t, and ω_i are province, survey year, individual fixed effects, respectively. The variable of interest is the interaction term, $Treat_p \times Post_t$. $Treat_p$ has the definition as that in equation (1). $Post_t$ in a binary variable with 1 indicating year's surveyed is 2006 or later and 0 otherwise. The coefficient of interest α_1 in equation (2) captures the effect of the 2006 policy on individual outcomes. Robust standard errors are clustered at the province and survey year level.

The model for assessing household level outcomes is presented below:

$$Y_{hpt} = \alpha_0 + \alpha_1 Treat_p \times Post_t + \boldsymbol{X}'\beta + \tau_p + \eta_t + \omega_h + \epsilon_{hpt} \quad \textbf{(3)}$$

where Y_{hpt} is the outcome of household *h* residing in province p in year *t*. $\boldsymbol{X}$ is a vector of province-level characteristics that is the same as those in equation (2). τ_p, η_t, and ω_h represent fixed effects for province, survey year, and household, respectively. The variable of interest is the interaction term, $Treat_p \times Post_t$, which has the same definition as that in equation (2). The coefficient of interest α_1 in equation (3) captures the effect of the 2006 policy on household outcomes. Robust standard errors are clustered at the province and survey year level.

A common practice in the literature investigating the effects of infectious diseases typically involves utilizing the interaction between the pre-policy infection rate in each province/city/county and a post-policy indicator as their variable of interest (E.g., Bleakley, 2007; Bütikofer & Salvanes, 2020). However, this approach is not suitable for our study due to several reasons: as discussed in the background, out of the 12 endemic provinces with areas contaminated with host snails, only 8 have schistosomiasis patients. Using the pre-policy provincial schistosomiasis infection rate would introduce a sample selection issue by incorrectly assigning control groups to four provinces that have areas contaminated with host snails but no patients, consequently leading to biased estimation of the true effects of the 2006 policy. Although using pre-policy provincial areas contaminated with host snails would avoid sample selection issues, it introduces measurement error since snail control is just one aspect of the 2006 policy. Utilizing an interaction between pre-policy provincial areas contaminated with host snails and post-policy indicator not only fails to fully capture all effects but also underestimates the true impact of the 2006 policy. Therefore, employing an interaction between an endemic province indicator and a post-policy indicator represents our best option.

It should be noted that the identified effects of the 2006 policy are Intention-to-treat (ITT). Obtaining individuals' childhood schistosomiasis infection records poses a challenge. Furthermore, in endemic provinces, only specific regions are affected by infected host snails. Additionally, within each province, there is a subset of people residing in urban areas or snail-free rural regions who have minimal exposure to areas contaminated with host snails. Consequently, our sample population from endemic provinces comprises both individuals impacted by the 2006 policy and those unaffected. Subsequently, our identified effects of school age exposure to the 2006 policy should be regarded as a lower bound of the true effects. Although the 2006 policy may also have a mitigating effect on the transmission risk and prevalence of other parasitic diseases such as Paragonimiasis, its spillover impact is expected to be minimal compared to that on schistosomiasis due to its specific targeting towards schistosomiasis and substantial variations in the epidemiological characteristics between schistosomiasis and other parasitic diseases.

The validity of our identification strategy hinges on the assumption that, in the absence of the 2006 policy, there would have been a parallel trend in outcomes across endemic and non-endemic provinces over time. Figures 3 - 10 present the event-study estimation results for all outcomes using the CFPS sample. Across all outcomes, the coefficients for birth cohorts between 1983 and 1986 (individuals aged 20 or older in 2006) fluctuate around zero without statistical significance, indicating no violation of the parallel trend assumption. Furthermore, Figures 11-13, which uses the CHNS sample, and Figure 14, which shows the dynamic effects of the 2006 policy on areas contaminated with host snails, also indicate the parallel trend assumption holds.

In 2006, the average total Gross Domestic Product (GDP) in endemic provinces was

1048.9 billion RMB, surpassing that of non-endemic provinces at 562.8 billion RMB. Consequently, concerns arise regarding potential systematic differences between endemic and non-endemic provinces, suggesting our results may simply compare wealthier and poorer regions. To address this concern and control for potential systematic differences, we incorporate (birth) province fixed effects into our model while also including a vector of control variables representing (birth) province characteristics. Additionally, we empirically examine whether there were any systematic differences between endemic and non-endemic provinces prior to the implementation of the 2006 policy using provincial-level statistics data from the China Statistical Yearbook. The findings are presented in Figure A.1 and indicate no significant systematic differences generally existed between endemic and non-endemic provinces before 2006.

We conduct additional robustness checks to further strengthen the validity of our identification strategy. See Section 6 for detail.

5. Results

5.1 Long-term Results

The long-term results, which uses the CFPS sample, are estimated using equation (1). The main results are presented in Table 3. Columns (1) to (4) presents the results for health outcomes. It is observed that exposure to the 2006 policy during school age leads to an increase of 3.81 percentage points (about 25.57%) in the incidence of feeling sick and a reduction of 2.57 percentage points (approximately 44.70%) in the likelihood of hospitalization. The outcomes related to education and labor are reported in Columns (5) to (8). Our analysis reveals that exposure to the 2006 policy during school age enhances employment probability by 5.13 percentage points (about 6.27%).

Our null finding on years of education contrasts with the findings of Makamu et al. (2018), who examined the impact of a schistosomiasis morbidity control policy implemented in 1999 during school age (7-14) on adulthood education outcomes in Nigeria in 2013 and observed an increase in years of education. The disparity can likely be attributed to the difference in average national educational attainment between China and Nigeria. In our sample, the mean years of education are 11.31, which exceeds that reported by Makamu et al. (2018) at 7.53. Consequently, the marginal benefit of the corresponding policy on years of education varies across these two countries.

The heterogeneous effects of school-age exposure to the 2006 policy on adulthood outcomes by gender are presented in Table 4. For women, as shown in Panel A, exposure to the 2006 policy during school age is associated with an increase in the incidence of feeling sick, an increase in the incidence of chronic diseases and a decrease in weekly total hours spent on exercise by about 6.9 percentage points (about 43.40%), approximately 3.01 percentage points (equivalent to around 55.33%) and around 1.41 hours, respectively. Furthermore, there is also a reduction of approximately 3.98 percentage points (around 4.49%) in the probability of completing junior high school education. In contrast to these negative health, behavior, and education outcomes, there is an increase of approximately 7.97 percentage points (around 11.48%) in the likelihood of being employed at the time of survey for women exposed to the policy. For men, as shown in Panel B, having school-age exposure to the 2006 policy reduces the incidence of hospitalization by 3.06 percentage points (around 58.62%). Table A.1 in the Appendix presents the heterogeneous effects of the 2006 policy by gender and hukou status, indicating our results are mainly driven by people with rural status.

Our findings, which differ from existing literature on the impact of fatal infectious diseases such as malaria, demonstrate that the 2006 policy has heterogeneous effects on men and women. Previous studies consistently show that policies against fatal infectious diseases benefit both genders or only one gender without negatively affecting the other gender in both developing and developed countries (Barofsky et al., 2015; Bleakley, 2010b; Cutler et al., 2010; Kuecken et al., 2021; Lucas, 2010). We argue that this disparity is primarily due to variations in fatality rates between fatal infectious diseases and schistosomiasis (and other NTDs). Control policies targeting fatal infectious diseases aim to reduce both morbidity and mortality, resulting in strong effects that are likely to surpass or at least be comparable to the impacts of gender inequality, which typically favor men over women. Consequently, previous literature examining the effects of control policies for fatal infectious diseases did not observe any negative consequences for women. However, since the 2006 policy primarily focuses on reducing schistosomiasis morbidity rather than mortality, its effects may not be as pronounced as those observed with respect to policies against fatal infectious diseases and could potentially be attenuated or even reversed by prevailing gender inequalities.

Furthermore, the divergent results observed between men and women also deviate from the limited existing literature on the impact of control measures against NTDs in both developed (Bleakley, 2007) and developing countries (Makamu et al., 2018). This discrepancy is likely attributed to disparities in economic development as well as other context-specific factors influencing gender equality (Jayachandran, 2015).

The 2006 policy, by reducing the risk of schistosomiasis infection, has increased the opportunity cost of attending school for children, leading to improved health outcomes and environment. However, due to the prevailing son preference that has persisted for centuries in China and is a major driver of gender inequality, credit-constrained households, particularly those with low socio-economic status, tend to allocate limited resources towards boys' education while girls are more likely to discontinue schooling or drop out in order to engage in domestic work (Kuecken et al., 2021) or enter the labor market at an earlier age (Bleakley, 2010b). Early discontinuation of education and entry into the labor markets (informally) adversely affects school-age girls in two distinct manners. First, there is an inadequate acquisition of essential health literacy and knowledge that should have been obtained through formal schooling (Kenkel, 1991; Van Der Heide et al., 2013), which subsequently negatively affect their later life outcomes. Furthermore, the early entry into the labor market, even informally, is associated with adverse health outcomes for school-age children (Ibrahim et al., 2019). The adverse impacts of early discontinuation of education and entry into the labor market among school-age girls are substantiated by a reduced likelihood of completing junior high school education, an increased incidence of feeling sick, augmented prevalence of chronic diseases, and diminished weekly exercise hours during adulthood. Although early entry into the labor market (informally) enables school-age girls to accumulate job skills that enhance their competitiveness in adulthood, these skills primarily pertain to labor-intensive tasks and do not correspond to higher income levels, as evidenced by the increased likelihood of employment but no significant impact on household per capita income. In sum, son preference perpetuates gender inequality by favoring boys over girls and generating heterogeneous effects.[13]

5.2 Short- term (contemporaneous) results

In this subsection, we estimate the short-term (contemporaneous) effects of the 2006 policy using the CHNS sample.

We use equation (2) to estimate the short-term effects of the 2006 policy on school-age (aged 7 - 18) children. The results are presented in Table 5. Specifically, there is also a considerable heterogeneity between school-age boys and girls with boys are less likely to be sick (4.55 percentage points or 146.77 %) and girls are more likely to work (9.77 percentage points or 59.21 %), less likely to enroll into school (7.92 percentage points or 8.62 %), and more likely to be sick (5.71 percentage points or 126.89 %). Table A.2 in the Appendix, which presents the heterogeneous effects by gender and urban/rural areas, indicate the results are mainly driven by school-age children from rural areas.

Similar to our long-term results, our short-term results of the effects of the 2006 policy on school-age children's school enrollment status differs from existing literature studying the short-term effects of control measures of NTDs (Bleakley, 2007; Makamu et al., 2018). Our short-term results not only corroborate but also serves as potential mechanisms behind the observed findings in our long-term results.

The effects of the 2006 policy on adult (aged 19 - 60) outcomes estimated using equation (2) are presented in Table A.3 in the Appendix. The implementation of the 2006 policy did not yield any significant effects on either the incidence of being sick over the past four weeks or employment probability among adults. These findings align with the low incidence of infection among adults, thereby serving as a falsification test for our empirical strategies.

In addition to the reduction of areas contaminated with host snails, as evidenced in Figure 14, we also examine the effects of the 2006 policy at the household level, including toilet access, access to tap water, and household income, all of which serves as the potential mechanism through which the 2006 policy affects school-age children's long- and short-term

[13] The null finding regarding household income per capita remains robust when aggregating the CFPS individual-level sample into a household-level sample, and is available upon request from the author.

outcomes. As shown in Table 6, the probability of having toilet access increases by 7.17 percentage points or 21.03 %. Having a toilet access not only reduces the risk of infection but also prevents schistosomiasis patients from contaminating the environment through feces that contains the eggs of the Schistosoma japonicum. The null finding on access to tap water is probability due to both urban and rural areas already have full coverage of access to tap water (Zhang & Xu, 2016).[14] Furthermore, the null finding on household income per capita align with the finding on adulthood outomces and rule out the possibility that the 2006 policy affects school-age children through adult. Overall, our analysis at the household level further corroborates that the 2006 policy primarily affects school-age children's long- and short-term results through improvement in environment. The results are primarily driven by rural sample.

6. Robustness checks

Given the emphasis on long-term outcomes in this study, we conduct robustness checks using equation (1) and the CFPS sample to ensure the robustness of our findings.

6.1 Confounding factors

There are several potential confounding factors that may influence our results. The robustness checks for confounding factors are presented in Table A.4 in the Appendix.

Following the Severe Acute Respiratory Syndrome (SARS) epidemic, which impacted over two-thirds of China's provinces in the first half of 2003, the Chinese government increased investment in disease prevention and control. It is plausible that the implementation of the 2006 policy was influenced by this outbreak. Additionally, Fan et al. (2021) has demonstrated that early-life exposure to SARS can affect later-life outcomes. To examine potential confounding effects from the SARS epidemic, we included an indicator variable in our model with a value of 1 for individuals born in SARS-endemic provinces who were aged 18 or younger in 2003 and a value of 0 otherwise. The results are presented in Panel A and remain robust.

As discussed in Section 2, the Chinese government implemented a schistosomiasis control policy between 1992 and 2001, focusing on morbidity control and receiving funds through the

[14] The results remain statistically insignificant when constructing our tap water access indicator using the questionnaire: "What is the source of your drinking water?" This questionnaire offers four response options, namely indoor tap water, in-yard tap water, in-yard wells, and other locations.

World Bank Loan Project (WBLP) in eight provinces that has schistosomiasis patients (Chen et al., 2005; Li et al., 2022).[15] Moreover, the implementation of the 2006 policy was driven by a resurgence of schistosomiasis prevalence at the beginning of the 21st century, partly attributed to the termination of WBLP support (Wang et al., 2008). Therefore, it is important to consider that potential confounding effects from WBLP should be accounted for when evaluating the impacts of the 2006 policy. To address this concern as a robustness check for WBLP's influence, we introduce an indicator variable into our model. This indicator takes a value of one if individuals were born in those eight provinces affected by WBLP and had some or full exposure during school age (born in or before 1994), otherwise it takes zero. As presented in Panel B, our results remain robust.

The epidemiological literature has demonstrated that the Three Gorges Dam, one of the world's largest hydroelectric projects situated in Yichang City, Hubei Province at the upper reaches of Yangtze River and started operation since 2003, may have accelerated host snail elimination leading to a reduction in schistosomiasis infection risk for individuals residing in provinces located at the middle and lower reaches of Yangtze River (Zhou et al., 2016).[16] To address potential bias arising from correlation with the implementation of the 2006 policy and Three Gorges Dam, we add an indicator variable taking on a value of 1 if an individual was aged 18 or younger in 2003 (born after 1985) within provinces located at middle and lower reaches of Yangtze River and 0 otherwise into our model. The results presented in Panel C remain robust.

6.2 Sample selection and measurement errors

Table A.5 in the Appendix presents the results of robustness checks for sample selection and measurement errors

Another potential source of bias arises from the possibility that individuals born in endemic provinces may choose to migrate to non-endemic provinces during their childhood. In this study, we employ birth province as a proxy for the location where individuals receive their education,

[15] The eight provinces are Anhui, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, Yunnan, and Zhejiang.
[16] Hunan, Hubei, Jiangxi, Anhui, Jiangsu, and Shanghai are the six provinces that are located in the middle and lower reaches of the Yangtze River and are also schistosomiasis endemic.

assuming implicitly that there is no inter-provincial migration during school-age years. Among our sample population of 8,310 individuals, we observe that 160 people have a different province of residence at age 12 compared to their province of birth. These individuals might have relocated to other provinces due to factors such as improved living conditions, better educational resources, or increased opportunities. To address this issue, we exclude those whose birth province differs from their province of residence at age 12 and present the results in Panel A. The results are consistent both qualitatively and quantitatively with our main findings.

The schistosomiasis prevention and control ordinance came into effect in May 2006, coinciding with the final stages of high school education for individuals born in the first three quarters of 1988 and the last quarter of 1987.[17] Consequently, their exposure to the 2006 policy during their school years was limited to a maximum duration of two months. Additionally, there was an erroneous exclusion of individuals born in the last quarter of 1987 from endemic provinces who turned 19 in 2006, resulting in an underestimation of their exposure to the policy. This introduces a potential bias due to measurement error when estimating the effects of school age exposure to the 2006 policy. To address this issue, we exclude individuals born in 1987 and 1988 from our regression. The results are presented in Panel B and are robust.

6.3 Placebo tests

We conducted two placebo tests by assuming the implementation of the 2006 policy in 2003 and 2004, respectively. Consequently, individuals born in 1985 and 1986 would have reached the age of 18 during those years. For each placebo test, our model incorporates both a 'placebo' interaction term, constructed using the same methodology as our actual interaction term, and the actual interaction term. The results are presented in Panels A and B of Table A.6 in the Appendix. Notably, all coefficients associated with the 'placebo' interaction term are either statistically insignificant or exhibit incorrect signs. Most importantly, all coefficients related to the actual interaction term demonstrate robustness.[18]

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[17] High school education uniformly ends in June of each year in China. The Compulsory Education Law, which was implemented in 1986, mandates children ages 6 in Sep 1st to enter school to receive compulsory education, which consists of 6 years of primary education and 3 years of junior high school education.

[18] In Panel B of Table A.6 in the Appendix, the coefficient of the actual interaction term on the probability of hospitalization exhibits marginal insignificance with a p-value of 0.115.

6.4 Regional trend

In our model, the inclusion of fixed effects for birth province accounts for any time-invariant differences among provinces. However, we acknowledge the potential confounding effect of differential provincial trends, particularly between endemic and non-endemic provinces, on our estimated results. To address this concern, we conduct three regional trend robustness checks in Table A.7 in the Appendix separately: 1. Incorporating birth province cohort trend (Panel A); 2. Including interactions between provincial health-related characteristics in 1987 and the birth year variable (Panel B); and 3, considering the interaction between snail area in each province in 2005 and the birth year variable (Panel C). The findings suggest that variations in trends across provinces should not be a concern.

6.5 Others

We conduct multiple hypothesis testing to explore the possibility of multiple inferences. The results are presented in Table A.8 in the Appendix. Specifically, we computed adjusted False Discovery Rate (FDR) p-values for nine outcomes (Benjamini & Hochberg, 1995). The adjusted FDR p-values are presented in Panel B. Despite generally being higher than the original p-values presented in Panel A for comparison purposes, all significant outcomes still have adjusted FDR p-values below 0.1. P-values obtained through wild cluster-bootstrap with clustering on province and year of birth are presented in Panel C and demonstrate robustness.

7. Conclusion

We estimate the long- and short-term impacts of a public health policy targeting schistosomiasis, one of the most prevalent neglected tropical diseases (NTDs) with a burden second only to malaria, by employing CFPS and CHNS, respectively. Our analysis leverages the implementation of a comprehensive control and prevention strategy that sets itself apart from current mainstream NTDs control policies by focusing on infectious source control. This approach not only reduces the prevalence of schistosomiasis, but also significantly enhances environmental conditions.

Our long-term findings on individuals exposed to the 2006 policy during their school years reveal an elevated incidence of feeling sick, a reduced likelihood of hospitalization, and an increased probability of employment. Furthermore, we observe significant gender heterogeneity in these effects. Specifically, males exhibit a decreased probability of hospitalization, while females demonstrate a higher incidence of feeling sick, an increased occurrence of chronic diseases, diminished engagement in physical exercise, lower completion rates for junior high school education, and an enhanced likelihood of employment. Our findings from the school-age children sample indicate a similar gender heterogeneity between girls and boys. Specifically, we observe that girls are less likely to stay in school, more likely to enter the labor market either informally or formally, and have an increased probability of being sick. On the other hand, boys are more inclined to stay in school. Regarding households, which serve as a potential mechanism for both short- and long-term outcomes, our results suggest an improvement in toilet access. However, no significant short-term effects were found among adults who would have benefited less from the 2006 policy due to their low infection rate.

The policy implications of this paper are threefold. First, the findings of this paper are of great importance for all NTDs endemic countries. Reducing the prevalence of schistosomiasis and other NTDs have simultaneous and sustainable effects on poverty reduction (Hotez et al., 2009). Although morbidity control, the current mainstream policy or intervention against schistosomiasis and other NTDs, is generally cost-effective (Almond et al., 2018; Turner et al., 2021), its impact is limited by the availability of medication, limited benefits beyond prevalence reduction, inability to prevent new infections and re-infections, and high levels of residual morbidity (Bustinduy et al., 2017; Hotez et al., 2009; Miguel & Kremer, 2004). Moreover, while mass vaccination has demonstrated effectiveness in reducing disease prevalence and promoting human capital development (Bütikofer & Salvanes, 2020), unfortunately, vaccines are currently available for NTDs (Hotez et al., 2007, 2009). A comprehensive control and prevention policy that focuses on infectious source control can overcome limitations faced by morbidity control and absence of available vaccines. As such, it may be more effective in reducing NTD prevalence and exert a lasting impact on various aspects of individuals', households', and society's well-being.

Second, the management of certain infectious diseases such as Hepatitis C and Acquired Immunodeficiency Syndrome (AIDS) often necessitates lifelong medication due to their incurable nature. Therefore, implementing a comprehensive public health policy that prioritizes controlling the sources of infection may prove to be a more pragmatic and efficacious approach in reducing the prevalence of infectious diseases and alleviating the associated burden on individuals, households, and society.

Third, despite significant advancements in reducing gender inequality, it remains a prevailing global issue today. The divergent findings between men and women underscore the imperative for public health policymakers worldwide to consider gender inequality when formulating and implementing policies, as it has the potential to mitigate or even reverse the intended impacts of these measures on women. Moreover, this necessitates an urgent call for achieving gender equality.

We acknowledge the limitations of our study in two aspects. First, we are unable to access data at the prefecture or county level, which would have provided a more comprehensive understanding than what is presented in this study. Moreover, a more extensive dataset would have allowed for a broader examination of the effects of school age exposure to the 2006 policy on adulthood outcomes. Second, it should be noted that the effects identified in this study encompass morbidity control, snail control, and infectious source control. Disentangling these specific effects falls beyond the scope of our research.

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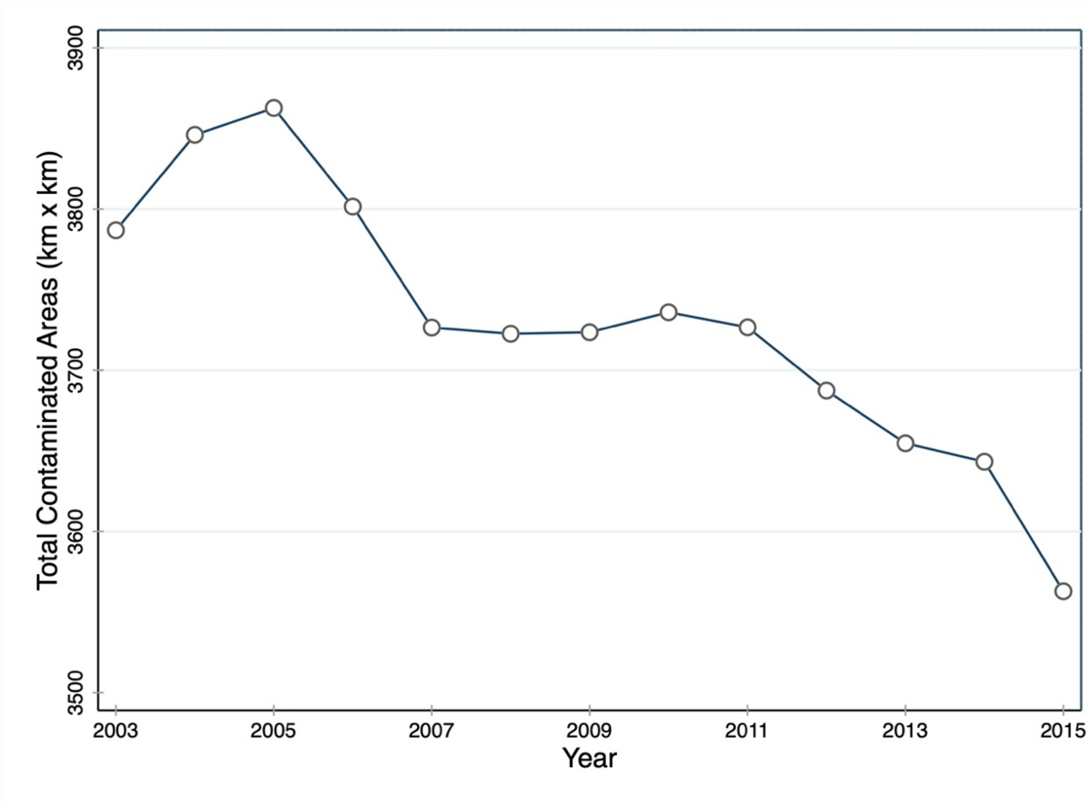


Figure 1: Time trend of contaminated areas

Notes: This figure shows the time trend of areas contaminated with host snail in China between 2003 and 2015. Source: CHSY 2004-2016.

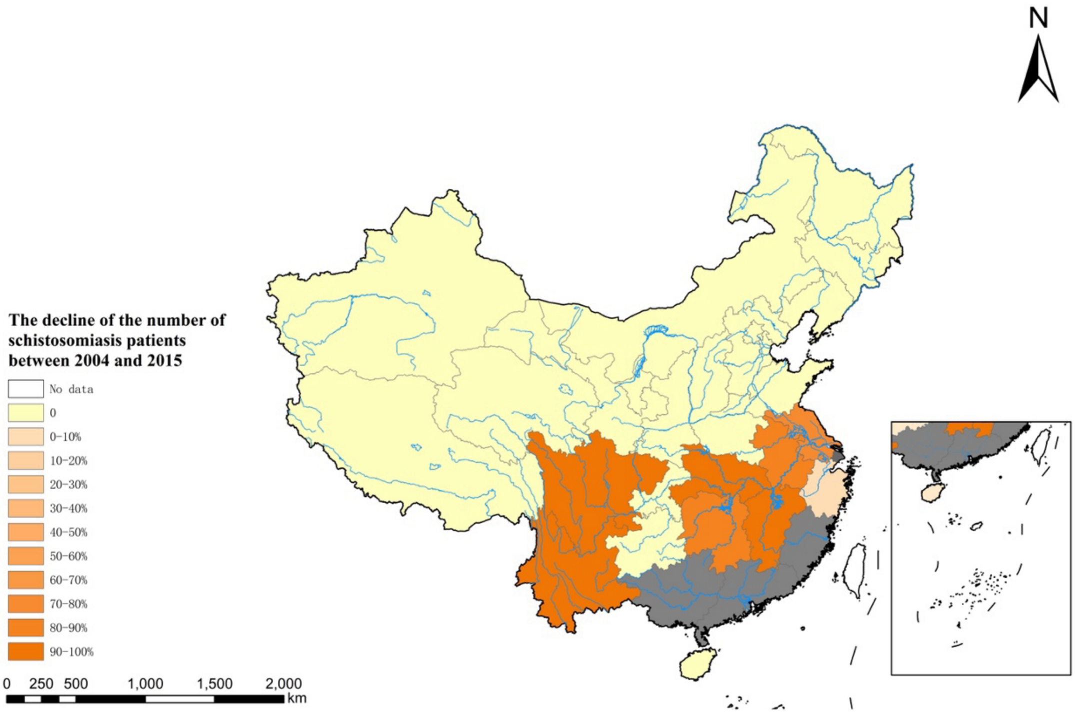


Figure 2: Map of schistosomiasis prevalence

Notes: This figure shows the decline rate of the number of schistosomiasis patients in China between 2004 and 2015. The gray areas are provinces that has zero number of patients in 2004 and areas being contaminated by infected host snails (Guangdong, Guangxi, Shanghai, and Fujian). Source: CHSY 2005 and 2016.

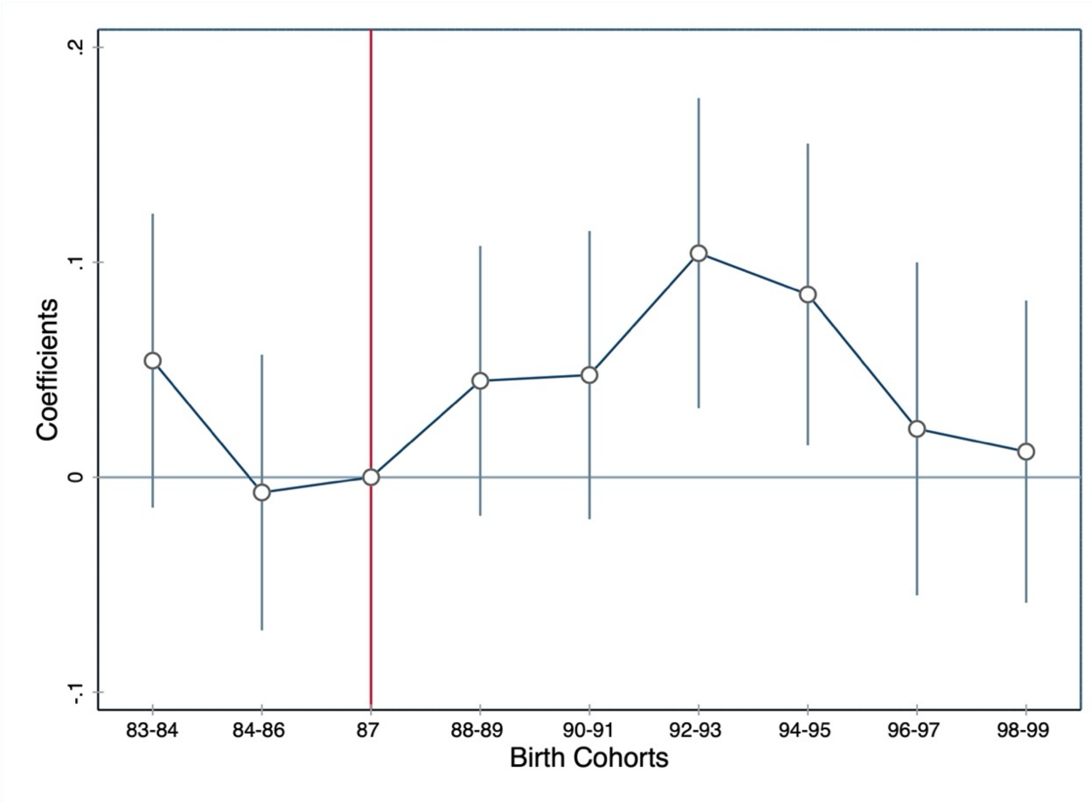


Figure 3: Event study results of the effects of the 2006 policy on feeling sick

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

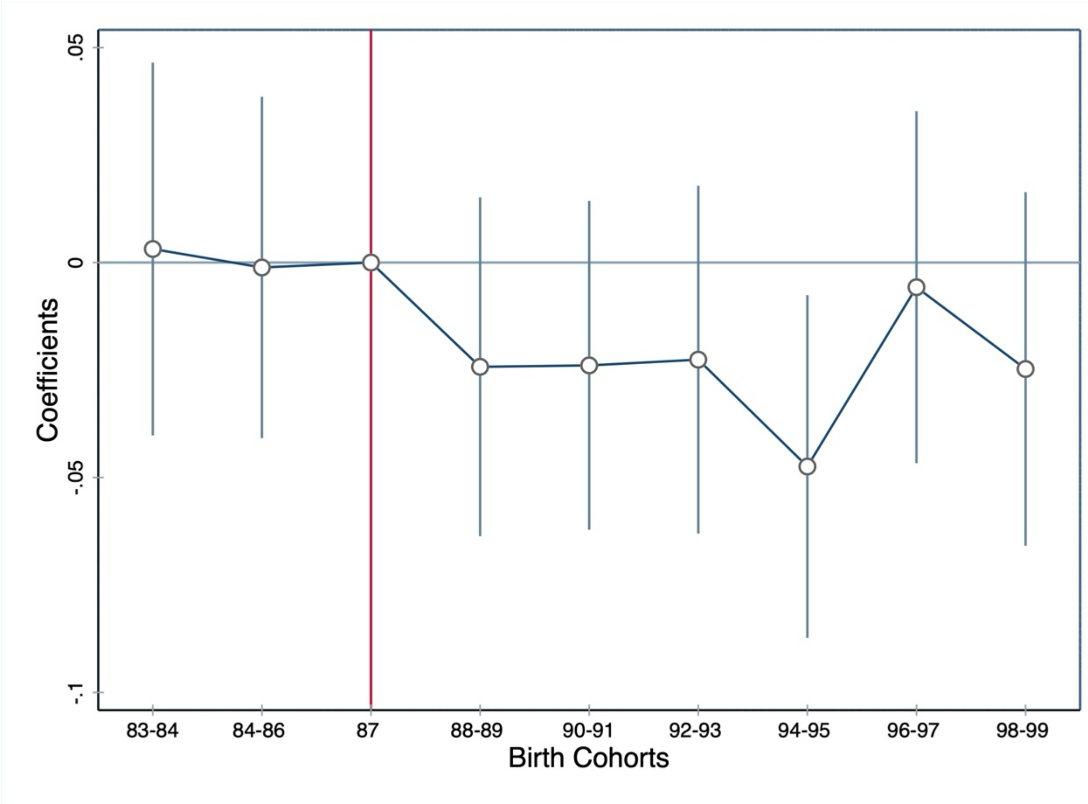


Figure 4: Event study results of the effects of the 2006 policy on hospitalization

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

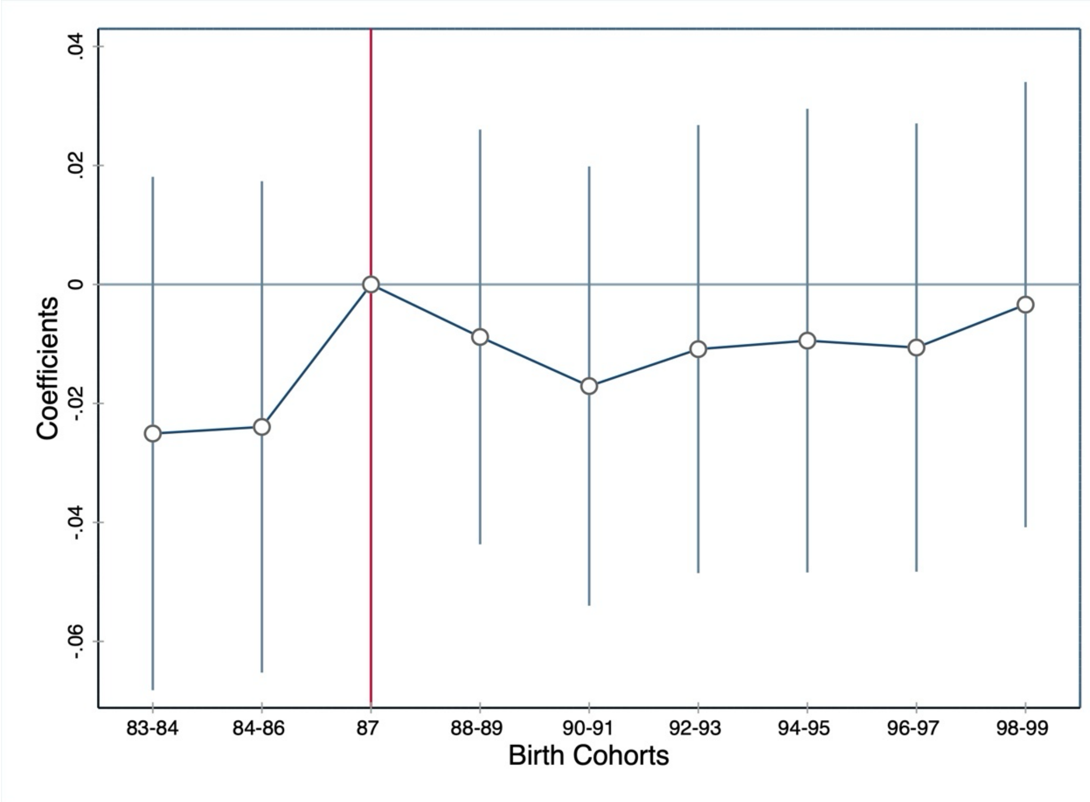


Figure 5: Event study results of the effects of the 2006 policy on chronic disease

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

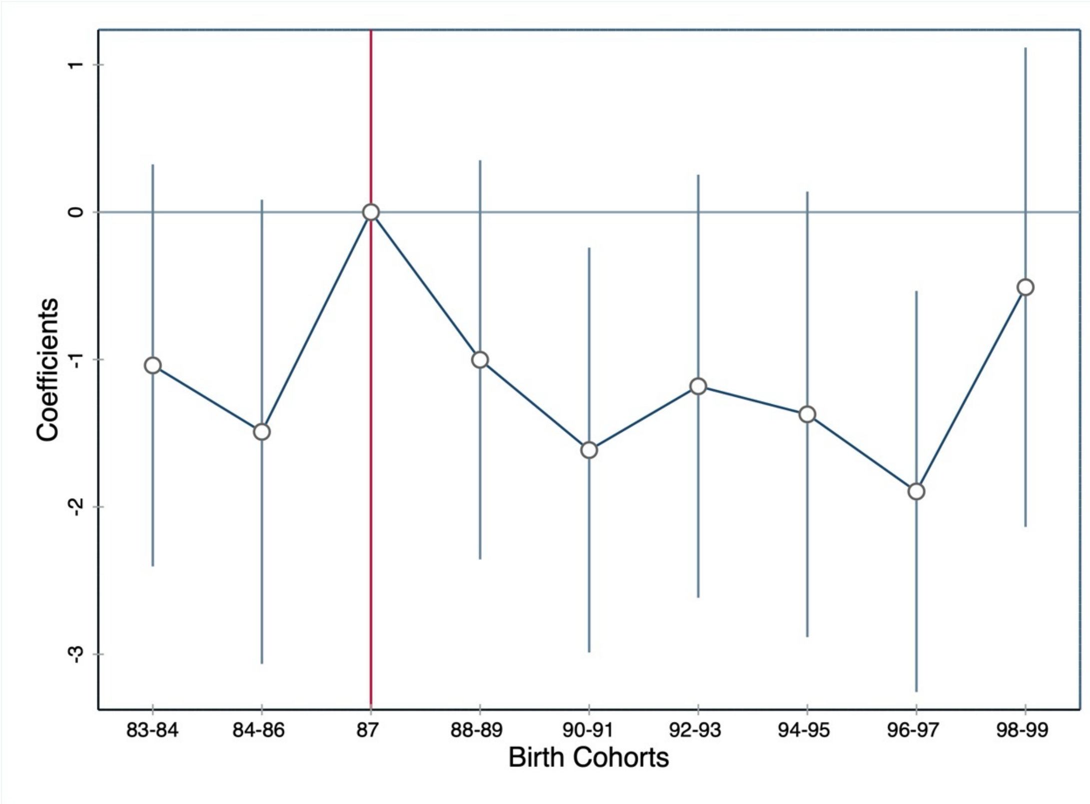


Figure 6: Event study results of the effects of the 2006 policy on exercise hours

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

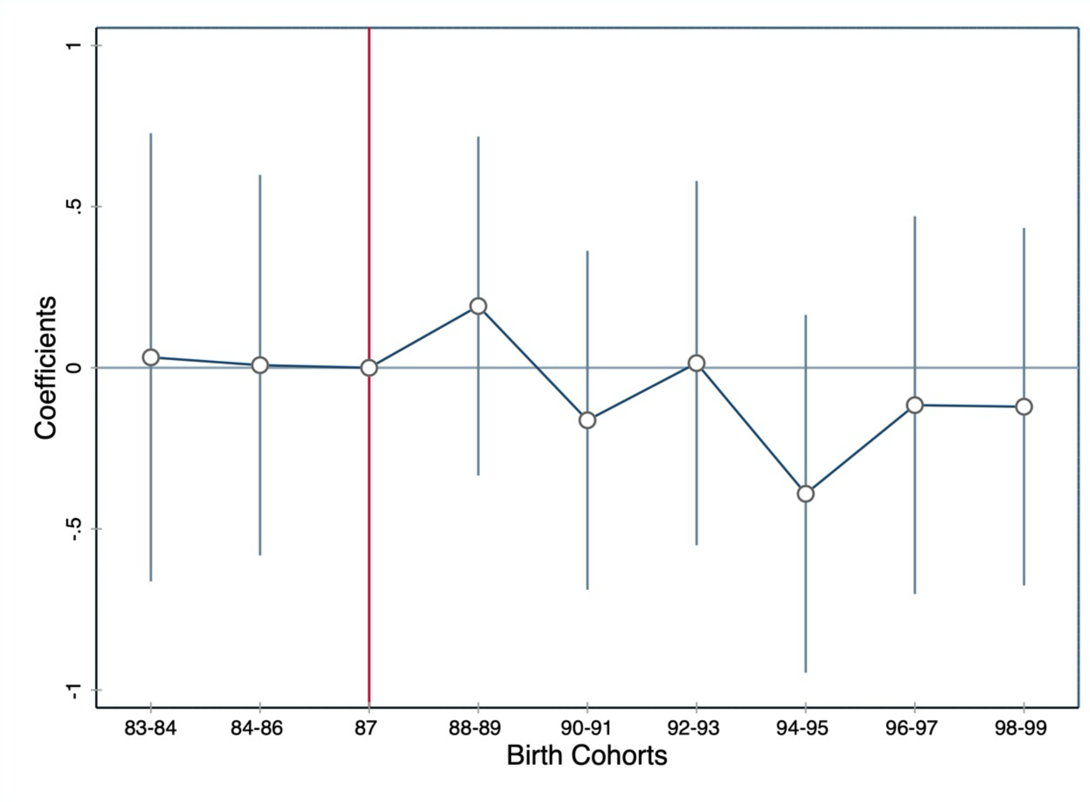


Figure 7: Event study results of the effects of the 2006 policy on years of education

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

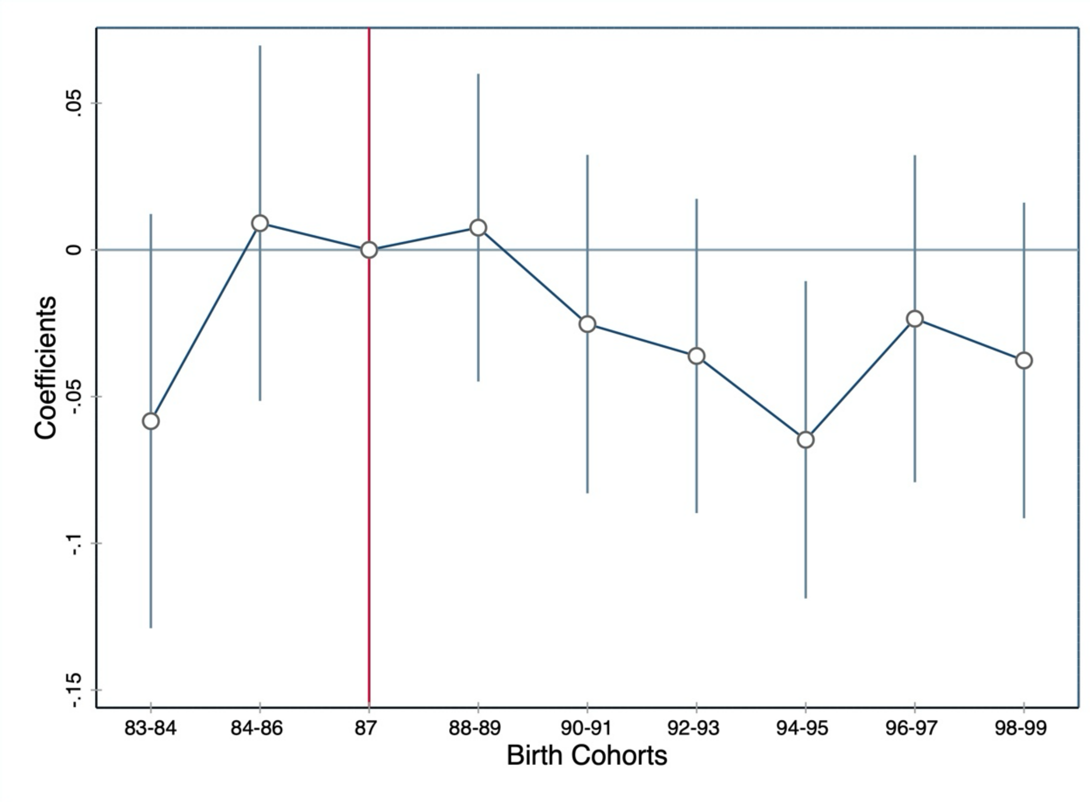


Figure 8: Event study results of the effects of the 2006 policy on junior high school completion probability

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

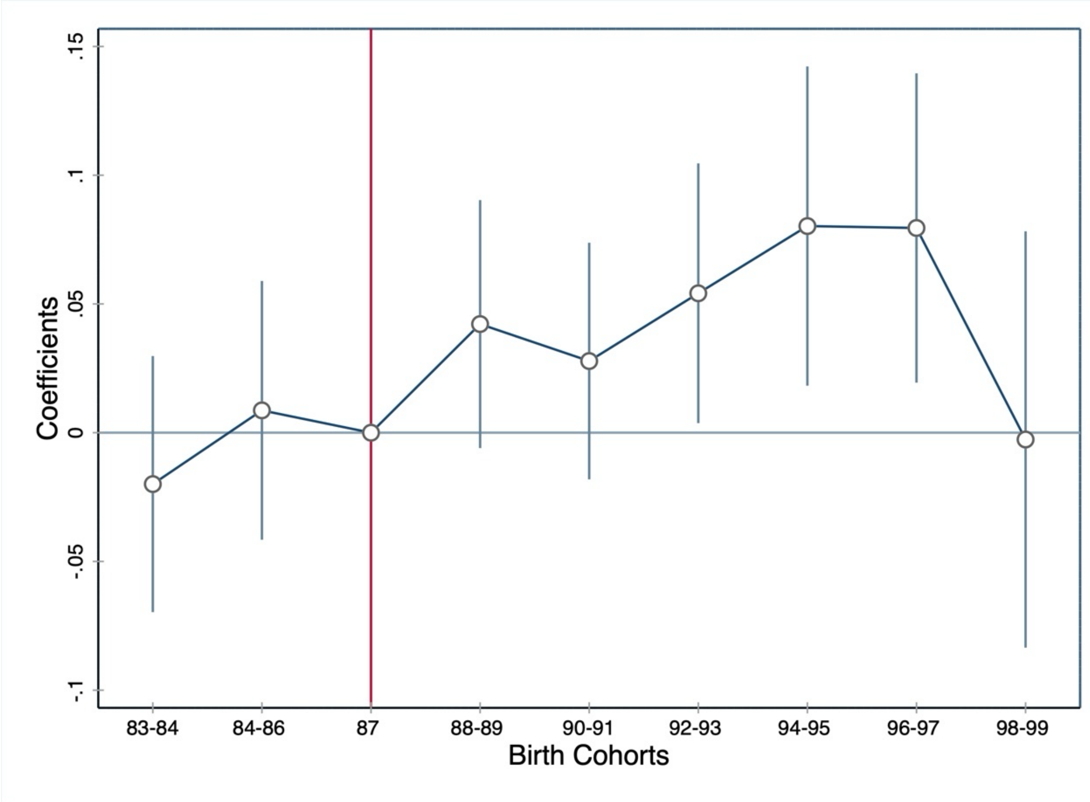


Figure 9: Event study results of the effects of the 2006 policy on employment

Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.

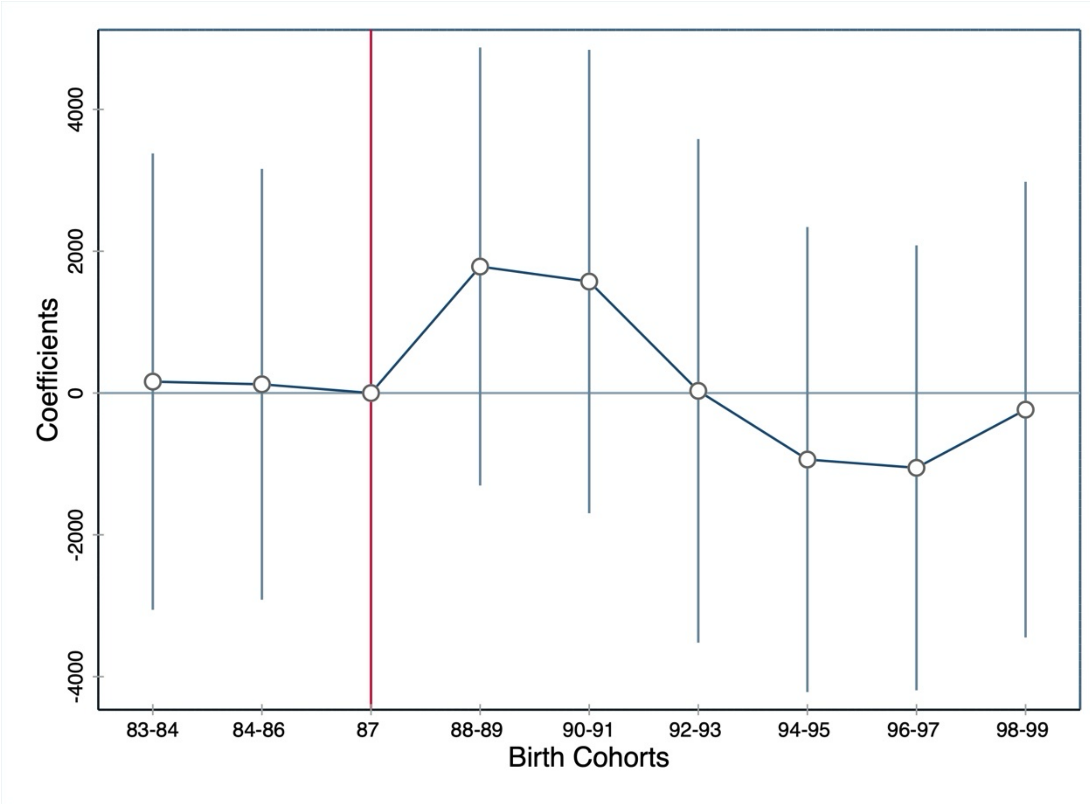
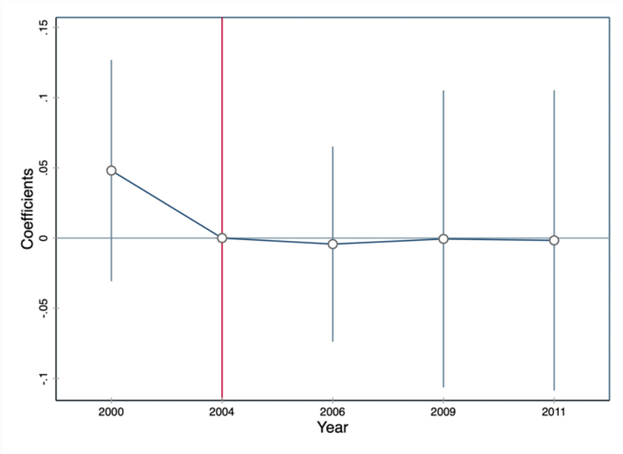
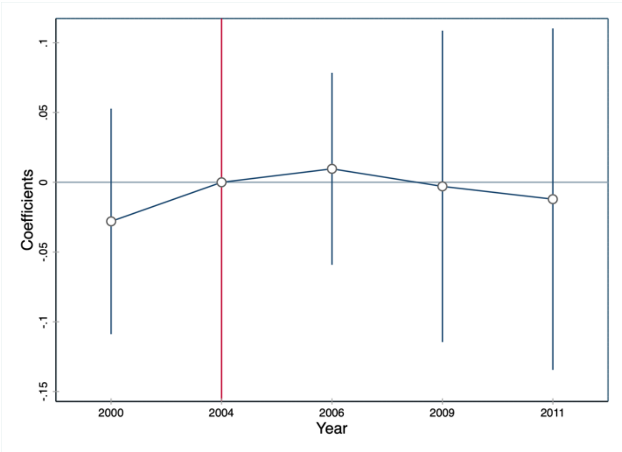


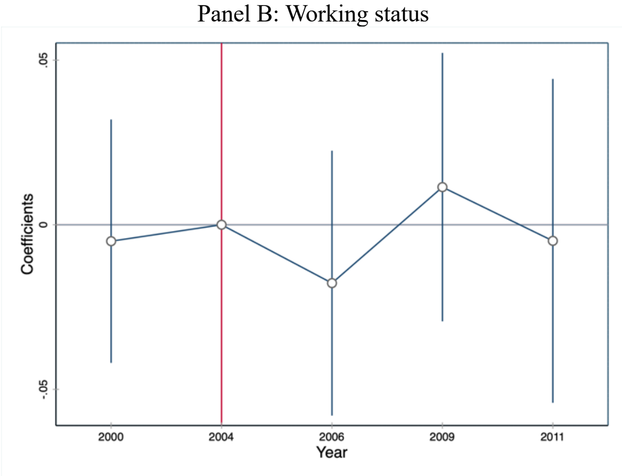
Figure 10: Event study results of the effects of the 2006 policy on household income per capita
Notes: The model includes birth province fixed effects, birth year fixed effects, individual characteristics, and birth province characteristics. Source: CFPS 2018.



Panel A: School enrollment



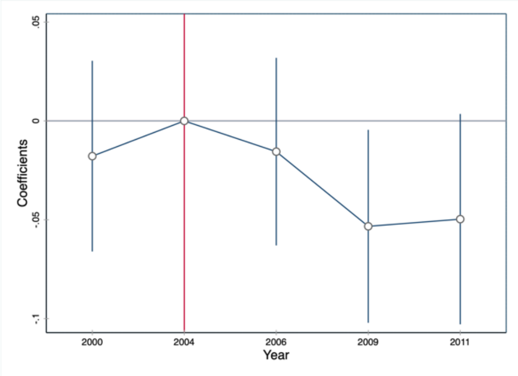
Panel B: Working status



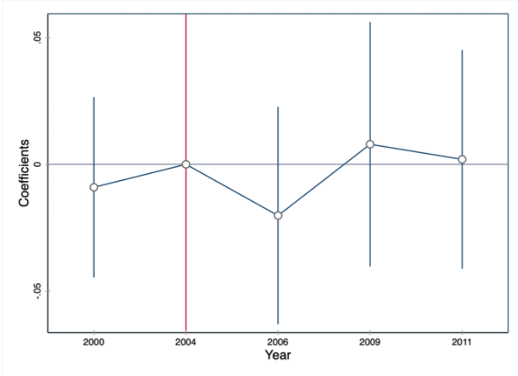
Panel C: Sick

Figure 11: Event study results of the effects of the 2006 policy on school-age children outcomes

Notes: All models include province characteristics, and fixed effects for province, survey year, and individual. Source: CHNS 2000-2011.



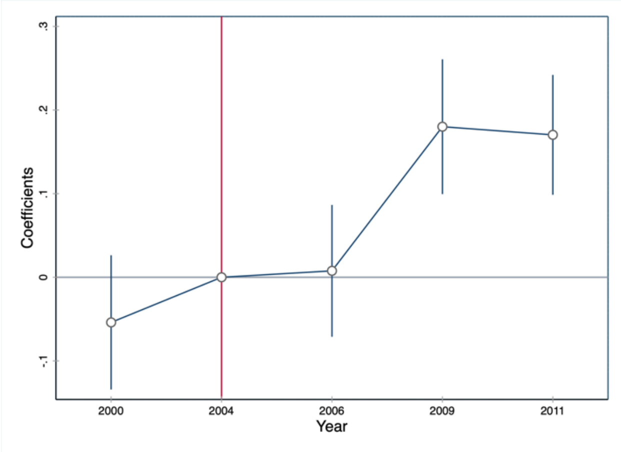
Panel A: Working status



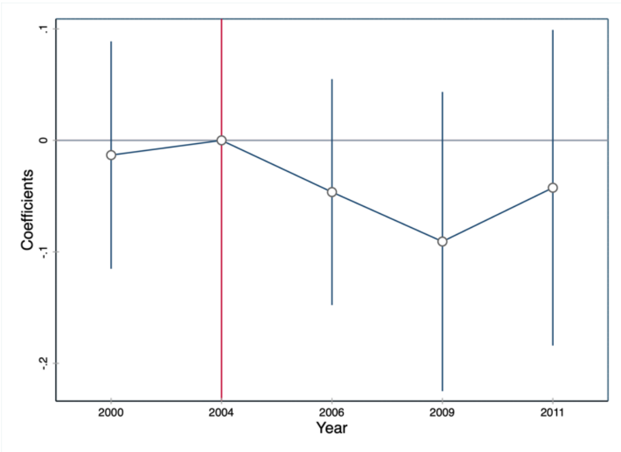
Panel B: Sick

Figure 12: Event study results of the effects of the 2006 policy on adult outcomes

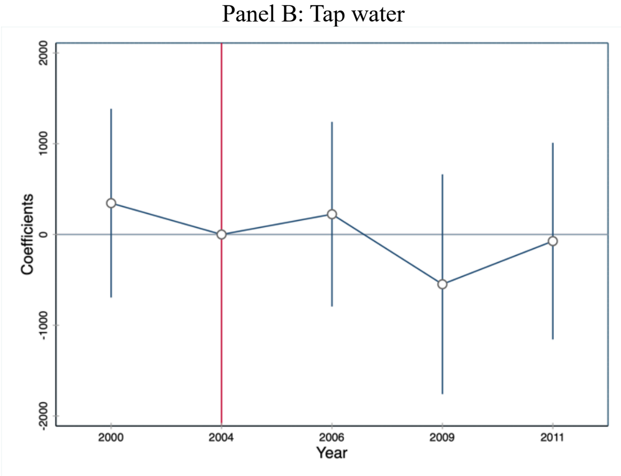
Notes: All models include province characteristics, and fixed effects for province, survey year, and individual. Source: CHNS 2000-2011.



Panel A: Toilet access



Panel B: Tap water



Panel C: Per capita household income

Figure 13: Event study results of the effects of the 2006 policy on household outcomes

Notes: All models include province characteristics and fixed effects for province, survey year, and household. Source: CHNS 2000-2011.

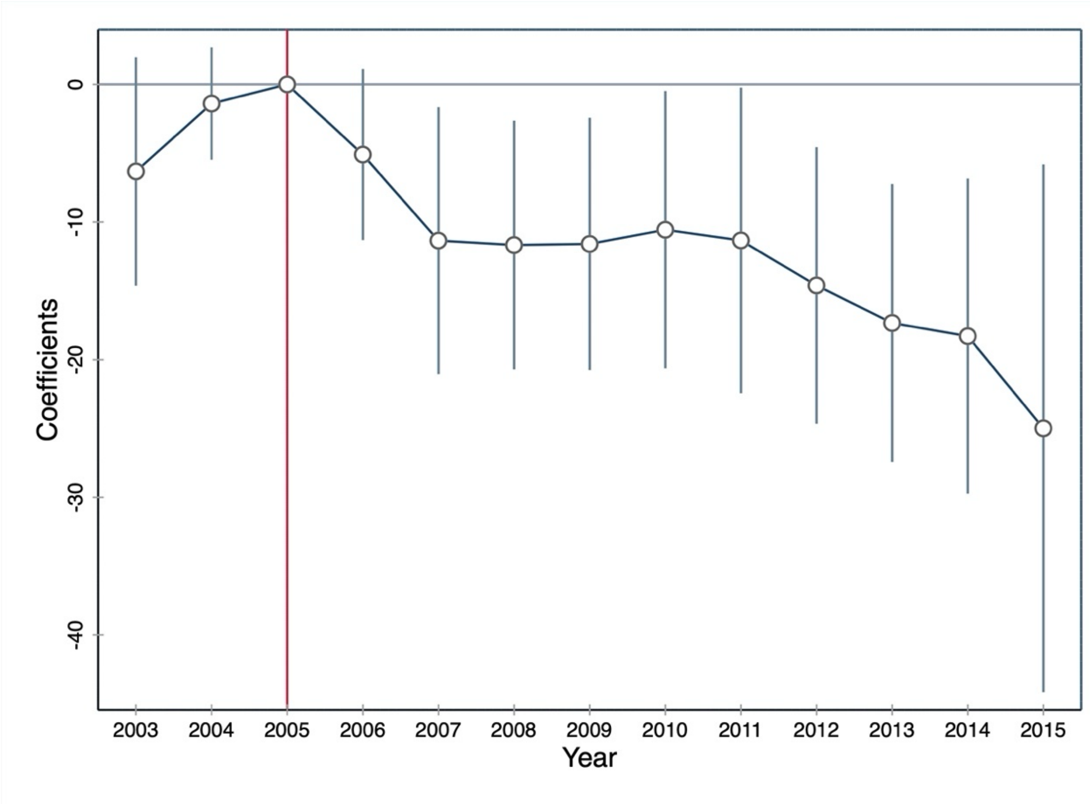


Figure 14: Event study results of the effects of the 2006 policy on areas contaminated with host snails

Notes: The model includes province fixed effects and year fixed effects. Each observation is at the province-year level. Robust standard errors are clustered at province level. Source: CHSY 2004-2016.

Table 1: Summary statistics of the CFPS sample

Variables	Overall		Treated Group		Control Group		Men				Women			
							Treated Group		Control Group		Treated Group		Control Group	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Feeling sick	8,310	0.159	3,159	0.177	5,151	0.149	1,541	0.153	2,550	0.138	1,618	0.199	2,601	0.159
Hospitalization	8,188	0.059	3,107	0.0615	5,081	0.0575	1,510	0.0543	2,508	0.0522	1,597	0.0683	2,573	0.0626
Chronic disease	8,188	0.0537	3,107	0.0595	5,081	0.0502	1,510	0.055	2,508	0.0459	1,597	0.0639	2,573	0.0544
Exercise hour	8,177	3.007	3,100	3.05	5,077	2.98	1,508	3.592	2,504	3.597	1,592	2.537	2,573	2.38
Years of education	8,310	11.49	3,159	11.48	5,151	11.49	1,541	11.52	2,550	11.48	1,618	11.44	2,601	11.5
Junior high school completion	8,310	0.882	3,159	0.873	5,151	0.887	1,541	0.875	2,550	0.887	1,618	0.872	2,601	0.887
Employed	7,537	0.833	2,862	0.858	4,675	0.817	1,392	0.945	2,328	0.941	1,470	0.776	2,347	0.694
Household income per capita	8,199	24213.3	3,114	28432.4	5,085	21629.7	1,525	30318.5	2,522	24119.0	1,589	26622.3	2,563	19180.1
Age	8,310	27.72	3,159	27.66	5,151	27.77	1,541	27.56	2,550	27.85	1,618	27.75	2,601	27.68
Gender	8,310	0.492	3,159	0.488	5,151	0.495	1,541	1	2,550	1	1,618	0	2,601	0
Rural at 12	8,310	0.878	3,159	0.862	5,151	0.888	1,541	0.853	2,550	0.887	1,618	0.87	2,601	0.889
Han Ethnicity	8,310	0.9	3,159	0.872	5,151	0.917	1,541	0.877	2,550	0.916	1,618	0.867	2,601	0.919
Birth Year	8,310	1990.3	3,159	1990.4	5,151	1990.3	1,541	1990.5	2,550	1990.2	1,618	1990.3	2,601	1990.4

Source: CFPS 2018

Table 2 Summary statistics of the CHNS sample

Variables	Overall		Treated Group		Control Group		Men				Women			
							Treated Group		Control Group		Treated Group		Control Group	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Panel A: School-age children (7-18)														
Age	5,180	12.883	2,261	12.911	2,919	12.862	1,473	13.091	1,907	12.96	788	12.574	1,012	12.678
School enrollment	5,180	0.838	2,261	0.844	2,919	0.834	1,473	0.810	1,907	0.789	788	0.907	1,012	0.919
Working status	5,180	0.242	2,261	0.229	2,919	0.251	1,473	0.260	1,907	0.297	788	0.171	1,012	0.165
Sick	5,180	0.042	2,261	0.050	2,919	0.036	1,473	0.042	1,907	0.031	788	0.065	1,012	0.045
Panel B: adult (19-60)														
Age	31,169	38.579	13,815	38.563	17,354	38.592	6,731	38.585	8,208	38.772	7,084	38.542	9,146	38.431
Working status	31,169	0.803	13,815	0.802	17,354	0.804	6,731	0.855	8,208	0.868	7,084	0.753	9,146	0.748
Sick	31,169	0.068	13,815	0.083	17,354	0.056	6,731	0.076	8,208	0.053	7,084	0.089	9,146	0.059
Panel C: household														
Toilet access	12,776	0.440	5,542	0.569	7,234	0.341								
Tap water	12,776	0.492	5,542	0.605	7,234	0.405								
Per capita household income	12,776	8,744.953	5,542	8,787.653	7,234	8,712.24								

Source: CHNS 2000 - 2011

Table 3. The effect of the 2006 policy on the later-life outcomes of health, education and employment (CFPS Sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat*post	0.0381**	-0.0257**	0.0080	-0.2864	-0.0871	-0.0100	0.0513***	343.6513
	(0.0167)	(0.0118)	(0.0113)	(0.3885)	(0.1896)	(0.0191)	(0.0147)	(1,112.5275)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Heterogeneity effects by gender (CFPS Sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Women								
Treat*post	0.0690***	-0.0237	0.0301**	-1.4077***	-0.1695	-0.0398*	0.0797***	413.6782
	(0.0246)	(0.0176)	(0.0147)	(0.4800)	(0.2568)	(0.0239)	(0.0261)	(1,470.7949)
Observations	4,219	4,170	4,170	4,165	4,219	4,219	3,817	4,152
Panel B: Men								
Treat*post	0.0045	-0.0306*	-0.0139	0.9129	0.0172	0.0212	0.0189	-185.0304
	(0.0249)	(0.0163)	(0.0174)	(0.5992)	(0.2414)	(0.0230)	(0.0140)	(1,659.6963)
Observations	4,091	4,018	4,018	4,012	4,091	4,091	3,720	4,047

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table 5: The short-term effects of the 2006 policy on school-age children outcomes (CHNS Sample)

	School enrollment	Working status	Sick
	(1)	(2)	(3)
Panel A: School-age children			
Treat*post	-0.0179	0.0133	-0.0088
	(0.0411)	(0.0416)	(0.0153)
Observations	5,180	5,180	5,180
Panel B: School-age boys			
Treat*post	0.0061	-0.0199	-0.0455**
	(0.0427)	(0.0436)	(0.0174)
Observations	3,380	3,380	3,380
Panel C: School-age girls			
Treat*post	-0.0792**	0.0977**	0.0571**
	(0.0385)	(0.0412)	(0.0273)
Observations	1,800	1,800	1,800

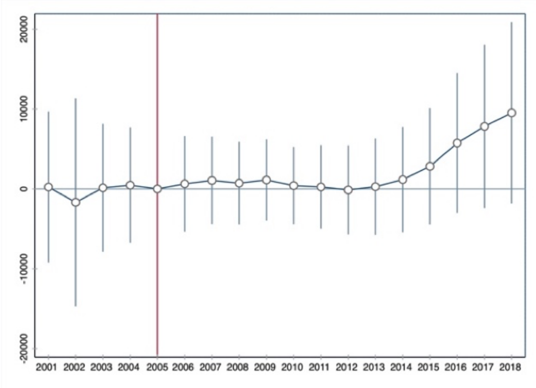
Notes: Robust standard errors in parentheses. All models include individual characteristics, province characteristics, and fixed effects for province, survey year, and individual. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: The short-term effects of the 2006 policy on household outcomes (CHNS Sample)

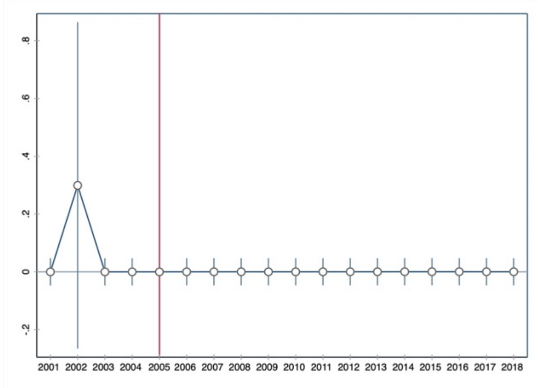
	Toilet access	Tap water	Per capita household income
	(1)	(2)	(3)
Panel A: whole sample			
Treat*post	0.0850***	-0.0371	-464.2363
	(0.0258)	(0.0262)	(455.7988)
Observations	12,776	12,776	12,776
Panel B: urban sample			
Treat*post	-0.0001	-0.0086	-1,171.7162
	(0.0179)	(0.0308)	(778.5293)
Observations	4,410	4,410	4,410
Panel C: rural sample			
Treat*post	0.1293***	-0.0526	-240.5520
	(0.0356)	(0.0410)	(406.5756)
Observations	8,366	8,366	8,366

Notes: Robust standard errors in parentheses. All models include province fixed effects, year fixed effects, household fixed effects, and province characteristics. *** p<0.01, ** p<0.05, * p<0.1.

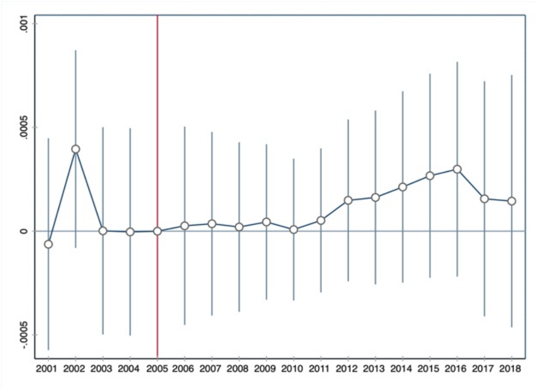
Appendix



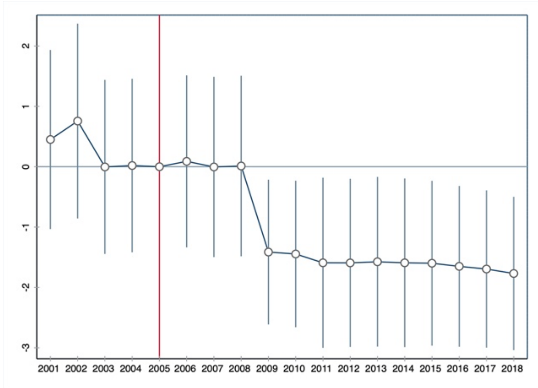
Panel A: GDP per capita



Panel B: Medical personnel per 10k people



Panel C: Health care facilities bed per capita



Panel D: health care facilities per 10k people

Figure A.1: Systematical difference check

Notes: All models include province fixed effects and year fixed effects. Observations are at the province-year level. Source: China Statistical Yearbook (2002-2019).

Table A.1. Heterogeneity effects by gender and hukou status (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Rural Female								
Treat*post	0.0671**	-0.0188	0.0334**	-1.4915***	-0.1210	-0.0424	0.0958***	1,905.5427
	(0.0267)	(0.0191)	(0.0160)	(0.5286)	(0.2748)	(0.0262)	(0.0286)	(1,394.1699)
Observations	3,718	3,675	3,675	3,672	3,718	3,718	3,414	3,663
Panel B: Urban Female								
Treat*post	0.1268	-0.0388	-0.0060	-1.0779	-0.2505	-0.0058	-0.0754	-9,438.7766
	(0.0825)	(0.0410)	(0.0568)	(0.8969)	(0.5091)	(0.0235)	(0.0778)	(7,086.9605)
Observations	501	495	495	493	501	501	403	489
Panel C: Rural Male								
Treat*post	-0.0138	-0.0359**	-0.0128	0.9247	0.0581	0.0195	0.0178	723.0710
	(0.0264)	(0.0175)	(0.0178)	(0.6605)	(0.2565)	(0.0254)	(0.0148)	(1,599.2242)
Observations	3,577	3,509	3,509	3,503	3,577	3,577	3,290	3,539
Panel D: Urban Male								
Treat*post	0.1761**	0.0218	0.0102	0.8147	-0.2822	0.0493	0.0036	-6,325.3071
	(0.0786)	(0.0415)	(0.0619)	(1.2233)	(0.5577)	(0.0353)	(0.0591)	(7,926.4374)
Observations	514	509	509	509	514	514	430	508

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table A.2: The short-term effects of the 2006 policy on school-age children outcomes by hukou and gender (CHNS sample)

	School enrollment	Working status	Sick
	(1)	(2)	(3)
Panel A: Urban boys			
Treat*post	0.0564	-0.0833	-0.0666
	(0.0575)	(0.0562)	(0.0580)
Observations	577	577	577
Panel B: Urban girls			
Treat*post	-0.0714	0.1344*	-0.0042
	(0.0464)	(0.0708)	(0.0879)
Observations	408	408	408
Panel C: Rural boys			
Treat*post	-0.0053	-0.0040	-0.0456**
	(0.0455)	(0.0464)	(0.0176)
Observations	2,803	2,803	2,803
Panel C: Rural girls			
Treat*post	-0.0833*	0.0912*	0.0683**
	(0.0478)	(0.0483)	(0.0319)
Observations	1,392	1,392	1,392

Notes: Robust standard errors in parentheses. All models include individual characteristics, province characteristics, and fixed effects for province, survey year, and individuals. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3. The short-term effects of the 2006 policy on adult outcomes (CHNS sample)

	Working status	Sick
	(1)	(2)
Panel A: whole sample		
Treat*post	-0.0275	-0.0029
	(0.0177)	(0.0152)
Observations	31,169	31,169
Panel B: male		
Treat*post	-0.0190	-0.0160
	(0.0133)	(0.0167)
Observations	14,939	14,939
Panel A: female		
Treat*post	-0.0363	0.0098
	(0.0289)	(0.0157)
Observations	16,230	16,230

Notes: Robust standard errors in parentheses. All models include province fixed effects, year fixed effects, individual characteristics, and province characteristics. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4. Robustness Checks: controlling for the potential confounding factors (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: SARS								
Treat*post	0.0382**	-0.0257**	0.0081	-0.2885	-0.0873	-0.0101	0.0512***	345.1665
	(0.0167)	(0.0118)	(0.0113)	(0.3868)	(0.1902)	(0.0191)	(0.0147)	(1,106.5616)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199
Panel B: World Bank Loan Project								
Treat*post	0.0395**	-0.0243**	0.0074	-0.3225	-0.1798	-0.0131	0.0467***	421.5059
	(0.0171)	(0.0118)	(0.0115)	(0.3891)	(0.1902)	(0.0190)	(0.0148)	(1,175.9569)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199
Panel C: Three Gorges Dam								
Treat*post	0.0387**	-0.0260**	0.0106	-0.4671	-0.0416	-0.0034	0.0449***	688.2190
	(0.0174)	(0.0125)	(0.0120)	(0.4071)	(0.1943)	(0.0199)	(0.0153)	(1,087.4903)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table A.5. Robustness Checks: sample selection bias and measurement errors (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Exclusion of migrating sample								
Treat*post	0.0367**	-0.0251**	0.0026	-0.265	-0.059	-0.0089	0.0514***	341.2818
	(0.0170)	(0.0118)	(0.0114)	(0.3916)	(0.1919)	(0.0194)	(0.0153)	(1,104.5797)
Observations	8,150	8,029	8,029	8,018	8,150	8,150	7,393	8,044
Panel B: No 1987 and 1988 birth cohorts								
Treat*post	0.0381**	-0.0277**	0.0116	0.013	-0.2184	-0.014	0.0554***	-167.5891
	(0.0191)	(0.0134)	(0.0130)	(0.4200)	(0.2232)	(0.0227)	(0.0163)	(1,314.9124)
Observations	6,994	6,893	6,893	6,885	6,994	6,994	6,226	6,899

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table A.6. Robustness Checks: placebo tests (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Placebo test of constructing fake intervention in 2003								
Treat*post (actual)	0.0584***	-0.0244*	0.0045	-0.3244	-0.0773	-0.0321	0.0426**	373.4075
	(0.0186)	(0.0134)	(0.0133)	(0.5206)	(0.2021)	(0.0197)	(0.0175)	(1,235.7011)
Treat*post (1985)	-0.0586**	-0.0039	0.0101	0.1095	-0.0283	0.0639*	0.0254	-85.4612
	(0.0277)	(0.0215)	(0.0215)	(0.5914)	(0.3759)	(0.0373)	(0.0236)	(1,851.0748)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199
Panel B: Placebo test of constructing fake intervention in 2004								
Treat*post (actual)	0.0620***	-0.0250	-0.0023	-0.3315	-0.1497	-0.0368	0.0495***	180.5186
	(0.0207)	(0.0158)	(0.0146)	(0.6113)	(0.2353)	(0.0226)	(0.0189)	(1,302.3348)
Treat*post (1986)	-0.0444*	-0.0014	0.0192	0.0839	0.1167	0.0498	0.0033	302.2788
	(0.0262)	(0.0198)	(0.0200)	(0.6913)	(0.3209)	(0.0322)	(0.0230)	(1,686.4496)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table A.7. Robustness Checks: Regional trend (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Inclusion of birth province cohort trend								
Treat*post	0.0569**	-0.0273	0.0021	-0.5651	0.1191	0.0093	0.0397*	2,419.2105
	(0.0235)	(0.0169)	(0.0148)	(0.5503)	(0.2403)	(0.0242)	(0.0220)	(1,695.9095)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199
Panel B: Inclusion of the interactions between 1987 provincial characteristics and birth year variable								
Treat*post	0.0482***	-0.0210*	0.0119	-0.4552	-0.1848	-0.0240	0.0473***	683.3870
	(0.0166)	(0.0120)	(0.0113)	(0.4033)	(0.1880)	(0.0193)	(0.0153)	(1,060.3013)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199
Panel C: Inclusion of the interaction between 2005 provincial snail area and birth year variable								
Treat*post	0.0331*	-0.0225*	0.0067	-0.4753	-0.1340	-0.0049	0.0453***	514.0541
	(0.0177)	(0.0122)	(0.0116)	(0.4104)	(0.1991)	(0.0200)	(0.0150)	(1,181.9062)
Observations	8,310	8,188	8,188	8,177	8,310	8,310	7,537	8,199

Notes: Robust standard errors in parenthesis. All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects. For Panel B: the provincial characteristics are the number of health care facilities per 10k people, the number of beds of health care facility per capita, and the number of medical personnel per capita. *** p<0.01, ** p<0.05, * p<0.1

Table A.8. Robustness Checks: P values of FDR and wild cluster bootstrap (CFPS sample)

Dependent variable	Feeling sick	Hospitalization	Chronic disease	Exercise hour	Years of education	Junior high school completion	Employed	Household income per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Original								
p-value	0.023	0.030	0.478	0.461	0.646	0.599	0.001	0.758
Panel B: FDR								
p-value	0.079	0.079	0.739	0.739	0.739	0.739	0.004	0.758
Panel C: Wild cluster bootstrap								
p-value	0.04	0.034	0.515	0.531	0.651	0.599	0.002	0.763

Notes: All models include individual characteristics, birth province characteristics, birth province fixed effects, and birth year fixed effects.