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Do More Grandchildren Lead to Worse Health Status of Grandparents? Evidence from the China Health and Nutrition Survey

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Abstract

China is rapidly aging and the social security system provides insufficient pension coverage. Consequently, almost 80 percent of elderly people depend on their children or other relatives for financial support. We use China Health and Nutrition Survey data to test if more grandchildren adversely affects elder health. This could occur because grandparents and grandchildren compete for financial support from the working adults in a family and because grandparents often have to care for young grandchildren and may neglect their own health. Since the number of grandchildren is a choice variable, we use exogenous variation in fertility for two generations under local implementation of the one child policy. We also take advantage of the panel data to deal with unobservable factors. The health of the elderly appears to be adversely affected by the number of grandchildren, especially for grandmothers and especially in urban areas.

Keywords

elderly
grandchildren
health one-child policy
China

JEL Codes

I12; J14

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1. Introduction

China is becoming an aging society due to the rapid fall in the fertility rate in recent decades and to increases in life expectancy. However, the social security system has not developed to the level of providing adequate pension coverage (Giles and Mu 2007 and Mu and Du 2017). For example, almost 80 percent of the very elderly, which we define as people aged 85 years and above, are dependent on their children or other relatives for financial support (UNFPA, 2006).

The well-being of the elderly may be endangered by these circumstances, especially with regard to financial security and health conditions. Several studies in the literature consider aspects of this well-being. For example, Giles, Wang and Zhao (2010) study the family support available to the rural elderly, in relation to the rural-to-urban migration of their adult children, while Feng *et al.* (2012) and Zhang (2013) analyze the policy challenges posed by meeting the escalating demands of care for the elderly. A particular feature, given the long-term effects from the family planning policy, is the pressure on the working generation to support retired parents, since one couple might have to support four parents (World Bank, 1997). In this regard, Islam and Smyth (2015) show a negative effect of the number of children on parental health, for elderly parents when they focus on self-reported health, although this is not apparent for other health measures. Mu (2014) also studies self-reported health for older Chinese adults and highlights the disparities, while Xu *et al.* (2015) focus on an objective input into health by evaluating the macronutrient intake status of older Chinese people.

In contrast to Islam and Smyth (2015), we examine the relationship between the number of grandchildren and the health of the elderly in China. To the best of our knowledge, this is the first paper in the literature to examine effects in China from the size of the third generation on the health of the first generation, using the exogenous variation provided by the local implementation of the population control policy as a source of identification. In particular, we control for both whether the elderly in our sample, which is those age 55 years and above, were eligible to have a second child under the local implementation of the one-child policy (OCP), and also if their children were eligible to have a second child. Since we use both of these instrumental variables, we can rule out that our results are just due to any adverse effect on health from own-fertility, which is the relationship studied by Islam and Smyth.

Although less studied, there are plausible reasons to expect that the higher the number of grandchildren the worse will be the health of grandparents. First, the grandparents and grandchildren are competing for resources (money and attention) from the prime-age adults in the family; thus more grandchildren could potentially reduce the value of resources transferred or the amount of care available to the elderly. Second, it is common in China that grandparents (and particularly grandmothers) are a major help in taking care of young grandchildren; the need for the grandparents to carry out this duty could see them paying insufficient attention to their own health and well-being.

While there is an existing literature that examines the relationship between outcomes for grandchildren and grandparents, the focus is on the effects on grandchildren rather than the effects that we study, on the grandparents. For example, Boca *et al.* (2017) use data from the Millennium Cohort Study in the United Kingdom and find significant differences in the ability of children to perform certain tasks, depending on whether they were cared for by their grandparents rather than cared for in formal child care centers. Moreover, the association between grandparent care and child outcomes differs according to levels of social advantage.

In this paper we use four different health measures, which cover both objective and subjective assessments. Specifically, we consider difficulties in performing activities of daily living (ADL), being overweight (defined as the body mass index exceeding 25), having high blood pressure (HBP) and having self-reported poor health. We perform regressions of these variables on the number of grandchildren (along with various control variables) with and without consideration of the potential endogeneity of grandchild numbers. We also report the results of a panel analysis, where the identification relies on changes in the number of grandchildren. The results are somewhat sensitive to which of the health measures is considered, and to the sub-sample of respondents who are studied. In general, it is the ADL scores that are most adversely affected by the number of grandchildren. Among the different sub-population groups, the health of elderly urban residents is more adversely affected by the number of grandchildren than is the case for the rural residents, and females are more likely to be adversely affected than are males.

2. Background

2.1 China's Population Planning Policy

According to the 2010 China Population Census, over 13 percent of people in that year were aged above 60. This share is predicted to rise to be over a quarter by the year 2030 (UN, 2017). The legacy of the population planning policy is argued to be a major source of this rapid increase in the share of the elderly, which is not matched by the other demographic 'giant' India, where the fertility rate fell more smoothly over time.

To briefly recap, over the last several decades China has developed a series of policies to control fertility that are described in more detail in Liang and Gibson (2017). In 1979, the most strict fertility control policy, the one child policy (OCP), was introduced to restrict each couple to have just one child. After four years as a national-level policy, the OCP was decentralized and started to become less restrictive (Greenhalgh 1986), where this change was possibly in response to various problems caused by the initial policy, including rapid growth in the number of abortions (Hesketh *et al.* 2005).

Starting in 1984, different exceptions to the strict rule of one child per couple were introduced, and these were applied in different areas, and also changed over time. Specifically, in 1984, Document 7 was issued to allow decentralization of the policy. Various exceptions, such as allowing a second birth when the first child was handicapped, were then applied in different areas. In 2002, the Law on Population and Family Planning was adopted and this formalized the family planning principle of ‘advocate one-child per couple’ while allowing local exceptions for a second child (The Legislative Affairs Commission of the Standing Committee of the National People’s Congress of the People’s Republic of China, 2002). Under the 2002 law, couples who volunteered to have only one child, regardless of the local exceptions which may have allowed more, would get a 'Certificate of Honour for Single-Child Parents' and were eligible for small cash rewards until their child reached a certain age. On the other hand, couples with more children than local policy allowed had to pay a social maintenance fee for unsanctioned birth(s), which was often a multiple of the previous year’s average household disposable income in the area where they resided.

In addition to fertility control policies varying by area, they also varied according to *hukou* (household registration) status. Since many people with non-agricultural *hukou* lived in rural areas, and *vice versa* for agricultural *hukou* holders living in the cities, there was further variation in local fertility according to the interaction of *hukou* status and residential location (Liang and Gibson 2017b). It was not until 2015 that the fertility control policies were once again put on a national basis, by letting all couples have two children, irrespective of their circumstances (Xinhua Net 2015). Thus, for 31 out of the 35 years that some variant of the OCP operated, there was local variation in the strength of its implementation and this provides a source of exogenous variation in fertility. Moreover, with the policy being in place for so long it affected the fertility of two generations of women and we exploit that feature in our instrumental variables strategy, distinguishing between the constraints applying to the fertility of the elderly people we study and those applying to the fertility of their children.

2.2 Public and Private Transfers

The public pension system in China is far from universal, and reflects historical divisions in the centrally-planned economy between the comprehensive welfare support offered to urban people (the so-called ‘iron rice bowl’) compared to the much lower benefits for rural dwellers, who were largely meant to be self-reliant. In 1991, China introduced the Rural Old-Age Pension Program, which was a voluntary contributions-based program to be operated by local governments (Tao 2016). The proportion of the rural population who had joined this program (as contributors before they could be recipients) peaked at 15 percent in 1997 and then fell to 11 percent by 2004. Around that time, only about seven percent of the rural elderly aged 60 and older were receiving old-age insurance or pension benefits (Ebenstein and Leung 2010). For rural residents who had not been in formal employment and had no deposits in their pension account, they could start receiving the money after reaching age 60, under the condition that their children had contributed to the system if those children were employed. If a broader definition of the rural population is used, coverage may be even lower, since rural migrants in urban areas, of which there are over 220 million (Gibson and Li 2017), may not be covered by either the urban or rural pension systems.

Urban pensions in the centrally-planned era were provided by the state-owned enterprises but this system was reformed from 1997. The urban public pension consists of a pay-as-you-go (PAYG) system funded by a 20 percent payroll tax from employers which is supplemented with a funded system based on individual accounts which are financed by employee contributions of eight percent of their wages (Mu and Du 2017). However the funded accounts have suffered because some local governments took capital out of these to fund pension payments for the PAYG component since obligations often exceeded the incoming revenue from payroll taxes. Individuals start receiving this pension if they have a history of at least 15 years of depositing into the pension account, and have formally retired after they reach the legal retirement age.

The value of the pension received is determined by the amount of contribution to the system during the employed phase of life, the retirement age, and the average income level in the province. The pension payments can range from 20% to 200% of average provincial income, showing a large inequality in the financial well-being of China's elderly. Family support, in particular, financial transfers and health care from adult children, remain the main source of old age support in China. Thus it is not surprising that Lei *et al.* (2012) find that the financially more capable adult children are able to provide more transfers to their parents. A corollary to this finding is that, to the extent that there is a lack of other sources of support to the elderly, the adult children will face a bigger financial burden. Since young children in the family will also tend to reduce the surplus financial resources of the working adults, these children may cause a reduction in the financial support that can be provided to the elderly. It is this potential competition for resources that may generate some adverse effects from a larger number of grandchildren on the health of the elderly, in addition to the direct health effects caused by grandparents caring for their grandchildren.

3. Empirical Methods

We start by regressing health outcomes on measures of the number of grandchildren, along with other control variables, using Ordinary Least Squares (OLS). Our general estimation approach is as seen below:

$$H = \alpha_0 + \alpha_1 G + \alpha_2 \boldsymbol{X} + \alpha_3 \boldsymbol{Z} + \varepsilon \quad (1)$$

where H is the vector of the selected health outcomes for the respondents, including whether they have been diagnosed with high blood pressure (HBP), whether their body mass index exceeds 25 (overweight), whether they report poor health from a four-level self-reported health question, and their level of difficulty in carrying out activities of daily living (ADL).[1] The last outcome is a composite measure made up from indexes of whether the respondent has difficulties in doing twenty routine day-to-day activities, which are: running a kilometer, walking a kilometer, walking 200 meters, walking across the room, sitting for two hours, standing up after sitting, climbing a flight of stairs, climbing a few steps with no pause, lifting a five-kilogram bag, bathing themselves, eating alone, putting on clothes, combing hair, using the toilet, shopping, cooking, using public transportation, managing money, using a telephone and squatting, kneeling or bending. The raw scores range from one for no difficulty to four for not being able to perform the task. The ADL score that we use in the analysis is a standardized total of the 20 indexes with mean zero and standard error one, and higher values of the index indicate worse health. We run linear regressions for the ADL score, and Probit regressions for the other three health outcomes.

The variable *G* is the number of grandchildren, which is our main variable of interest. The vector ***X*** has a set of time-varying individual characteristics, including age (in quadratic form), *hukou* status, marriage status, employment status, education level, household per-capita income, whether the person is a regular smoker and the daily amount of cigarettes smoked, whether they are a tea/coffee drinker and their daily consumption of tea/coffee, whether they drink alcohol, household size, whether they live in an owner-occupied dwelling and whether they live with their children. The vector ***Z*** has a set of time-invariant factors, including gender, urban/rural status of residence and province of residence.[2]

A concern with OLS estimation of equation (1), where the number of grandchildren is a covariate, is that the estimated coefficients may be biased due to endogeneity. The number of grandchildren is a combined result of the birth behaviors of the respondents and of their adult children. These fertility decisions are (partly) a choice variable that can be affected by health and financial status, which are also correlated with the outcome variables.

The direction of this potential bias is ambiguous. On the one hand, in the absence of fertility control constraints, financially secure and healthier adults may choose to have more children, and thus end up with more grandchildren. This channel could lead to a positive

[1] The question used to create the variable 'Poor Health' asks the respondent to state if their health status is either '1=Excellent', '2=Good', '3=Fair' or '4=Poor'. We define the 'Poor Health' dummy variable to be equal to one if the respondents selected the response '4' for this question and zero otherwise. If we had included 'Fair' health as part of the 'Poor Health' dummy, the proportion of elderly respondents defined to be in poor health would have increased from 12% to 57%.

[2] CHNS is a longitudinal survey that follows people in the same households who are typically surveyed at the same addresses in each wave. The question of whether the respondent has always lived in the area has a very low response rate, but we have reason to believe that the sampled respondents are mostly permanent residents in the community. The sampled communities maintain their urban or rural status which is why the urban-rural status of respondents is treated as time-invariant. Consequently we are not able to contribute findings on how the health of temporary migrants (those without local *hukou*) may be affected by their number of grandchildren.

relationship between the number of grandchildren and the health outcomes of the grandparents. Relatedly, having healthier elderly parents may reduce the burden on working-age adults and thereby positively affect their birth decisions, which again would show up as a positive relationship between the higher number of grandchildren and the better health of the grandparents. On the other hand, high parity could be associated with some chronic diseases (Kington *et al.* 1997), and this could be manifested as a relationship between having those diseases in old age and a higher number of grandchildren. In other words, there would be a negative relationship between the number of grandchildren and the health status of grandparents.

We use two methods to get robust estimates that should overcome these threats to identification. One approach is to take advantage of the panel data, which enable us to deal with the unobservable factors that affect both the number of grandchildren and the health outcomes of the elderly. The panel regression model takes the following form, where H, G and $\boldsymbol{X}$ are as defined in equation (1). Any unobserved individual factors that are time-invariant, where these γ_i may be part of the ε in equation (1) and are potentially correlated with G, will be dropped out of the panel data model once differencing is applied, for any individual who appears in the sample more than once, where all respondents in our sample satisfy this condition. Consequently, the coefficient β_1 is for the estimated effect from the change in the number of grandchildren on the change in the health outcome, and the error term μ should not have a component that is possibly correlated with the change in the number of grandchildren.

$$\Delta H = \beta_0 + \beta_1 \Delta G + \beta_2 \Delta \boldsymbol{X} + \mu \quad (2)$$

The other approach we used to deal with potential endogeneity is to use the one child policy as the source of exogenous variation in the number of grandchildren. We define a legally married woman in China as being eligible to have an extra child if she satisfied the exceptions allowed by the local implementation of the OCP at any stage up to the year prior to the survey (Liang and Gibson 2017). Along with the birth gap constraints to prevent closely-spaced births, and the *hukou* constraints which depended on whether a woman held agricultural or non-agricultural *hukou,* and the age constraints on the minimum allowable age of the mothers for giving birth a second time, we consider three OCP exceptions:

(a) Whether the community allowed all women to have two children;
(b) Whether the community allowed women to have two children if the first child was a girl, which was called the 'girl-exception', and
(c) Whether the community let women have two children if both parents are only-children, or one parent is an only-child, or one parent and both grand-parents are only-children, which was called the 'only-child-exception'.[3]

[3] Amongst the three exceptions, the first is very rare, the girl-exception is primarily applied to rural *hukou* holders, and the only-child exception is normally consistent with the OCP at provincial level.

A legally married man is defined to be eligible for fathering a second child if his wife is eligible. Thus, all adults who were ever-married up to one year prior to each survey waves will have a value of zero or one indicating their eligibility of having two children under the local OCP.

We design three instrument variables to deal with the potentially endogenous nature of the number of grandchildren, based on this eligibility definition. First, we consider the eligibility of the respondent. This variable E_r, takes a value of one for respondents who were ever eligible and zero for others. Second, we count the total number of adult children of the respondent who were ever eligible to have two children under the local implementation of the OCP that they faced during their child-bearing years (E_k). For example, if a respondent has three children, and none of these children were ever eligible for a second birth, the variable E_k will take the value of zero. Finally, we consider the overall strength of the OCP in each community, as measured by the percentage of women aged 20 to 49 in the community (at the time of each survey wave) who were eligible for a second child (E_c).

The main source of variation in these measures over time for each individual is the change in local OCP implementation during the period covered by the data, and the change in personal conditions, primarily age and *hukou* status. The respondents in this research are people aged 55 and above, and only some of them were directly constrained in their fertility decisions by the OCP. The others had already had enough of their child-bearing years elapse to have time for a second (or more) birth before the one-child policy was introduced. Their adult children, on the other hand, are all covered by the OCP during their child-bearing period and so the combination of these two variables should be relevant to the number of grandchildren. Moreover, the values of these two instrumental variables are not affected by the health outcomes of the elderly respondents, and they have no direct effect on the health outcomes of the elderly respondents other than through the channel of the number of grandchildren. Likewise, the community OCP strength is a measure that is calculated based on all local women of child-bearing age, which is clearly exogenous to any individual respondent and will not be affecting the health outcomes except through fertility. In other words, E_r, E_k, and E_c should all meet the requirements of valid instrumental variables.

The first stage regression, which is estimated using OLS, where G, $\boldsymbol{X}$ and $\boldsymbol{Z}$ are as defined in equation (1) and $\boldsymbol{OCP}$ is the vector of the three instrumental variables described above, is as follows:

$$G = \gamma_0 + \gamma_1 \boldsymbol{OCP} + \gamma_2 \boldsymbol{X} + \gamma_3 \boldsymbol{Z} + \delta \quad (3)$$

We use the residuals from equation (3) in the second stage, instead of the predictions as in the usual two-stage least-squares analysis because we are running probit models for three of the four health outcomes. To be specific, the estimated residuals are included as an additional regressor in the second stage, which is equivalent to control function estimation

(Islam and Smyth 2015). A further advantage of using this added variable approach is that it allows a Durbin-Wu-Hausman (DWH) test for endogeneity, where statistically significant coefficients on the residuals imply that OLS results will be inconsistent, due to the endogeneity in the number of grandchildren, and this would then support the use of the IV results.

4. Data and Descriptive Analysis

The data we use for this research is from the China Health and Nutrition Survey (CHNS), a longitudinal survey from an international collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety, and the Chinese Center for Disease Control and Prevention. The survey began in 1989, with follow-up waves every three-to-four years up to the year 2011. The sample covers up to 15 of the 30 provinces in China, although only a subset of provinces is present in all waves. A multistage, random cluster process was used to draw the samples from each province. A poor, middle-income, and rich county are sampled per province, along with the provincial capital or other large city, and a lower income city. The surveyed villages and townships within the selected counties, and the urban and suburban neighbourhoods within the selected cities, were chosen at random.

We use four waves of the CHNS data, for 1997, 2000, 2004 and 2006, because these waves have the required variables. There are only eight provinces covered by all four of these selected waves: Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou, so we restrict our attention to these areas. Although there is not national coverage for China with our sample, it does cover a wide area, extending from the northern to the southern part of China, and including coastal and inland areas, with these provinces exhibiting a lot of heterogeneity.[4] We therefore expect the results to be broadly representative.

We restrict attention to respondents who are of Han ethnicity, aged 55 and above, who stayed in the survey for at least two of the four selected waves.[5] This sample yields over four thousand observations, including 1444 unique individuals. Amongst the sampled respondents, 40 percent lived in urban areas, and about half held urban *hukou* (noting that rural people who previously worked for a state-owned enterprise or attended university retain the urban *hukou* that was granted from that activity even if they return to live in the countryside). The share of female respondents slightly exceeds that of male respondents. The respondents are fairly evenly distributed among the sampled provinces, except the share living in Heilongjiang and Guizhou is slightly lower than for the other provinces.

[4] Figure 1 shows the map of China, with the surveyed provinces shaded darker green.

[5] Minority respondents faced different OCP exemptions than those faced by the Han majority roup. Different life styles between minorities and the Han group may also cause different health status due to the factors that are not of core interest in this paper. Finally, the number of minority respondents is quite small, so we only consider the Han ethnic group in this research.

Figure 1: CHNS Provinces in the Sample

Table 1 contains summary statistics for each of the health outcomes, for the control variables, and for the three instrument variables. We present the descriptive results for all observations and also for males and females, and urban and rural residents separately. It appears that men are less impaired in performing activities of daily living than are women. Rural residents are more limited than are urban residents in performing these daily activities. Almost one-third (31 percent) of the sample are overweight, in that their body mass index exceeds 25. The share of overweight men is similar to that of overweight women, but is much higher for urban residents than for rural residents. The share of respondents with high blood pressure is around one-fifth, and is much higher for urban residents than for rural residents. Across all of the sub-populations, from 10-14 percent of respondents rate themselves as having poor health.

Table 1: Summary Statistics

	All	Male	Female	Rural	Urban
Outcomes					
ADL score	0.05	-0.09	0.18	0.08	0.02
Overweight	31%	29%	33%	23%	42%
High Blood Pressure (BP)	19%	18%	20%	14%	26%
Poor Health	12%	10%	14%	13%	11%
Instrument Variables					
Own Eligibility for having 2 children	89%	92%	86%	93%	83%
# children eligible to have a 2nd child	0.45	0.43	0.47	0.58	0.26
Community One-Child Policy strength	71%	71%	71%	78%	60%
Time-Varying Controls					
Number of Grandchildren	0.99	0.94	1.05	1.17	0.74
Annual per-capita Real Household Income (000)	17.33	18.69	16.12	15.96	19.37
Owner-occupied Household	85%	86%	83%	94%	71%
Household Size	3.32	3.36	3.28	3.49	3.07
Urban Hukou	49%	50%	48%	19%	93%
Mean Age	68.01	67.84	68.17	67.60	68.62
Currently Married	76%	88%	64%	76%	76%
Not Employed	66%	59%	72%	51%	88%
Working as a Farmer, Fisherman or Hunter	25%	28%	22%	41%	1%
Working in other Occupations	9%	13%	5%	8%	11%
No Qualification	62%	45%	77%	70%	50%
Primary School	18%	25%	12%	19%	17%
Lower Middle School	9%	14%	5%	7%	12%
Qualifications above Lower Middle School	10%	15%	6%	4%	21%
Live with Children	44%	43%	45%	45%	42%
Regular Smoker	26%	46%	8%	30%	20%
Daily Cigarette	3.15	5.87	0.73	3.70	2.32
Regular Tea/Coffee Drinker	43%	54%	33%	37%	52%
Daily frequency of Tea/Coffee	1.22	1.62	0.86	1.01	1.53
Alcohol Drinker	27%	48%	9%	29%	25%
Time-Invariant Controls					
Female	53%			52%	54%
Urban residence	40%	39%	41%		
Heilongjiang	6%	7%	5%	6%	6%
Jiangsu	16%	17%	16%	15%	18%
Shandong	13%	13%	14%	14%	12%
Henan	13%	13%	14%	13%	13%
Hubei	13%	13%	13%	10%	17%
Hunan	11%	12%	11%	12%	10%
Guangxi	16%	15%	18%	19%	12%
Guizhou	10%	10%	9%	9%	11%
Waves					
1997	28%	28%	28%	27%	29%
2000	26%	26%	25%	25%	27%
2004	25%	25%	25%	26%	23%
2006	22%	21%	22%	22%	20%
Observations	4,436	2,089	2,347	2,650	1,786

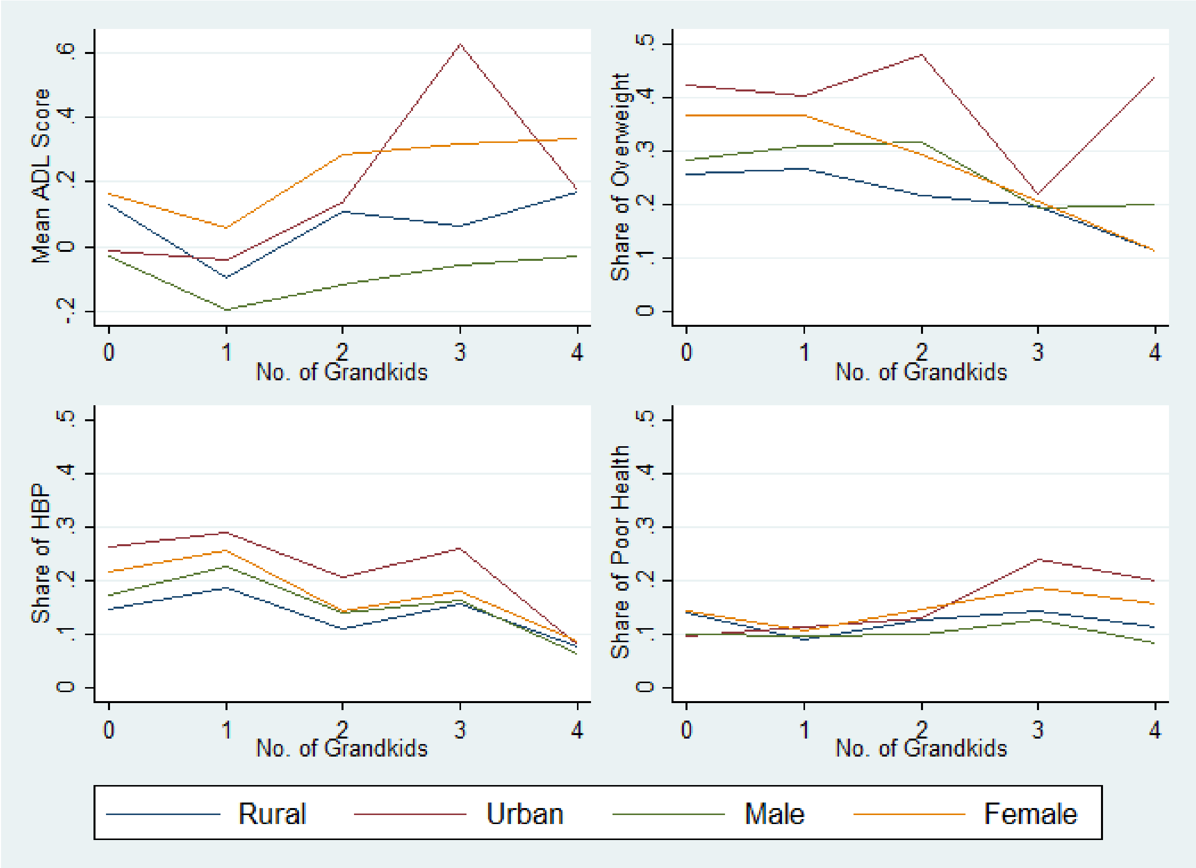
In terms of the instrumental variables, around 90% of the respondents had been eligible to have two children during their birth years. However, amongst their adult children, less than two-fifths (38.6%) were eligible to have an extra child, and the average number of adult children eligible for an extra child ranged from 0.26 in urban areas to 0.58 in rural areas. At the community level, an average of 78% of rural women aged between 20 and 49 met the eligibility criteria to have a second birth while in urban communities the proportion eligible for a second birth was just 60%. These rates also varied quite widely between provinces, with Jiangsu having over 90 percent of women eligible for a second birth but in Henan it was below 60 percent. This variation suggests that at the level of an individual woman and her husband, the exogenous constraint on the number of children (and, indirectly, on the number of grandchildren) varies over time and space and this aids our identification of causal effects. It is not surprising that in urban areas there are only two-thirds as many grandchildren (an average of 0.74) as in rural areas (an average of 1.17).

In terms of the control variables, about 90 percent of the respondents are either not employed (which includes being retired), or work as a farmer, fisherman or hunter. In other words, most of them do not have wage income and need to use savings or get financial support from others as a source of their living costs. Smoking, alcohol drinking and tea/coffee consumption have strong effects on health and in our sample men had higher consumption of these items than women. In particular, nearly half of male respondents are regular smokers and alcohol drinkers, while the corresponding share for female respondents is below one-tenth. Smoking and drinking are also more prevalent in rural areas. Although there are big differences in many variables by rural and urban location, the proportion of our sample of elderly who live with their adult children is roughly the same in both sectors, at just over 40 percent.

Figure 2 plots the relationship between the number of grandchildren and the four health outcomes for the elderly respondents.[6] The ADL scores are higher for individuals with more grandchildren, which means that these respondents have more difficulty in carrying out daily activities. The likelihood of having high blood pressure is lower for individuals with more grandchildren. The likelihood of females being overweight declines with the number of grandchildren, while patterns are less clear for the other groups. The likelihood of reporting poor health seem to have a weak relationship with the number of grandchildren, except that urban respondents and old women are more likely to report poor health if they have more than two grandchildren. As shown by the graphs, the relationship between the number of grandchildren and the health outcomes differ across the different sub-groups of elderly. In the next section, we will run regressions to see if these patterns remain the same once we control for other social-economic factors.

[6] The number of grandchildren is truncated at four in the figure. About two percent of the respondents had more than four grandchildren.

Figure 2: Number of Grandchildren and Health Outcomes, CHNS, 1997-2006



5. Regression Results

In this section, we present the regression results from the three models described in section 3. For each model we estimate it on the full sample, and then on the male and female sub-samples, and on the urban and rural sub-samples.

5.1 Cross-Sectional Analysis

We first run cross-sectional regressions that ignore the panel structure of the data. The coefficients from the OLS and probit models (where probit coefficients are transformed into marginal effects) for the effects of the number of grandchildren on the four health outcomes are reported in Table 2. The models also include all of the control variables in Table 1, but coefficients on these are not reported for reasons of space. For the ADL score, positive coefficients indicate adverse effects from the number of grandchildren, that is, the more grandchildren, the more likely one is to have difficulties in performing daily activities. This relationship is positive, albeit statistically insignificant, for the overall sample, and is positive and precisely estimated for female respondents (p<0.05) and for urban residents (p<0.10).

Table 2: Effect of the Number of Grandchildren on Grandparents' Health

Not Instrumented

	All	Male	Female	Rural	Urban
ADL score	0.0174	-0.0161	0.0501*	0.00948	0.0578+
	(0.019)	(0.029)	(0.024)	(0.022)	(0.035)
Overweight	-0.00138	0.0260+	-0.0261+	-0.00284	0.00797
	(0.011)	(0.015)	(0.014)	(0.011)	(0.023)
High BP	-0.0104	-0.00777	-0.0132	-0.00643	-0.0137
	(0.008)	(0.012)	(0.010)	(0.008)	(0.019)
Poor Health	0.00378	-0.000377	0.00802	-0.000163	0.0175+
	(0.005)	(0.007)	(0.008)	(0.006)	(0.010)
Observations	4,436	2,089	2,347	2,650	1,786

Notes

Estimation is by OLS for the ADL score and by Probit for the other health outcomes, with marginal effects reported in the table. Coefficients on the control variables (all those listed in Table 1) are not reported here. Robust standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.1

For the other three outcomes, positive marginal effects mean that more grandchildren will result in having a higher likelihood of having these health problems. For example, males are more likely to be overweight, and females less likely, the more grandchildren they have. For urban residents, having more grandchildren is associated with reporting poor health. For the probability of having high blood pressure in all samples, and for being overweight and reporting poor health in rural areas, there is no apparent effect of having more grandchildren on health outcomes.

Next, we report instrumental variables models that are designed to deal with the possible endogeneity of grandchild numbers. Before discussing the results for the effects on health outcomes, we report on tests of the validity of the instruments. Appendix 1 has the results of the first-stage regressions. The coefficients for the three instrument variables are statistically significant, and the F-statistics for the joint test of the coefficients on the instrumental variables equalling zero all exceed 30 (while the threshold for a 'weak' instrument is that the F-test exceeds 10). Given we are using three instrumental variables as the source of exogenous variation for one potentially endogenous variable, we have an over-identified model. The tests of the over-identifying restrictions show no evidence to doubt the validity of the instrumental variables.[7]

In Table 3 we report two types of results from our instrumental variables analysis. In the top panel of the table there are coefficients for the ADL scores and marginal effects for the other three health outcomes, to show the impact of an additional grandchild on grandparent health. The values are derived from models that have all of the control variables from Table 2 but, in addition, also include residuals from the first stage equations (which are

[7] Amongst the 20 regressions (four outcomes and five samples) using instrumental variables, the smallest p-value from the over-identification tests was 0.21 (for the overweight outcome and urban resident sub-sample), and the largest p-value was 0.99 (for the overweight outcome with the full sample). Thus, these tests provide no significant evidence to doubt the validity of the three instrumental variables.

reported in Appendix Table 1). With the addition of these residuals, the coefficients on the number of grandchildren can be interpreted as instrumental variables estimates (Vella 1993), and this approach is equivalent to control function estimation (Islam and Smyth 2015). The second panel shows the coefficients on the added residuals; when these coefficients are statistically significant an added-variable form of the Durbin-Wu-Hausman test suggests significant differences between OLS (or probit) and instrumental variables estimates. In this case, the instrumental variables estimates should be favoured since they should be consistent irrespective of whether the number of grandchildren is endogenous or not.

Table 3: Effect of the Number of Grandchildren on Grandparents' Health

Instrumented

	All	Male	Female	Rural	Urban
Coefficients of Number of Grandchildren					
ADL score	-0.145*	-0.227*	-0.0902	-0.203*	0.0803
	(0.072)	(0.096)	(0.102)	(0.086)	(0.159)
Overweight	0.0279	0.0639	-0.00174	0.0183	0.00356
	(0.046)	(0.068)	(0.060)	(0.049)	(0.105)
High BP	-0.00693	0.0243	-0.0229	-0.0855*	0.181*
	(0.036)	(0.051)	(0.048)	(0.038)	(0.079)
Poor Health	-0.0112	0.0173	-0.0363	-0.042	0.0837
	(0.024)	(0.030)	(0.034)	(0.027)	(0.052)
Coefficients of Residuals					
ADL score	0.172*	0.222*	0.149	0.224*	-0.0289
Overweight	-0.0978	-0.135	-0.0796	-0.0807	-0.0194
High BP	-0.0148	-0.147	0.0402	0.401*	-0.707*
Poor health	0.0842	-0.118	0.225	0.232	-0.438
Observations	4,436	2,089	2,347	2,650	1,786

Note

The first-stage equations are reported in Appendix Table 1. For other notes, see Table 2.

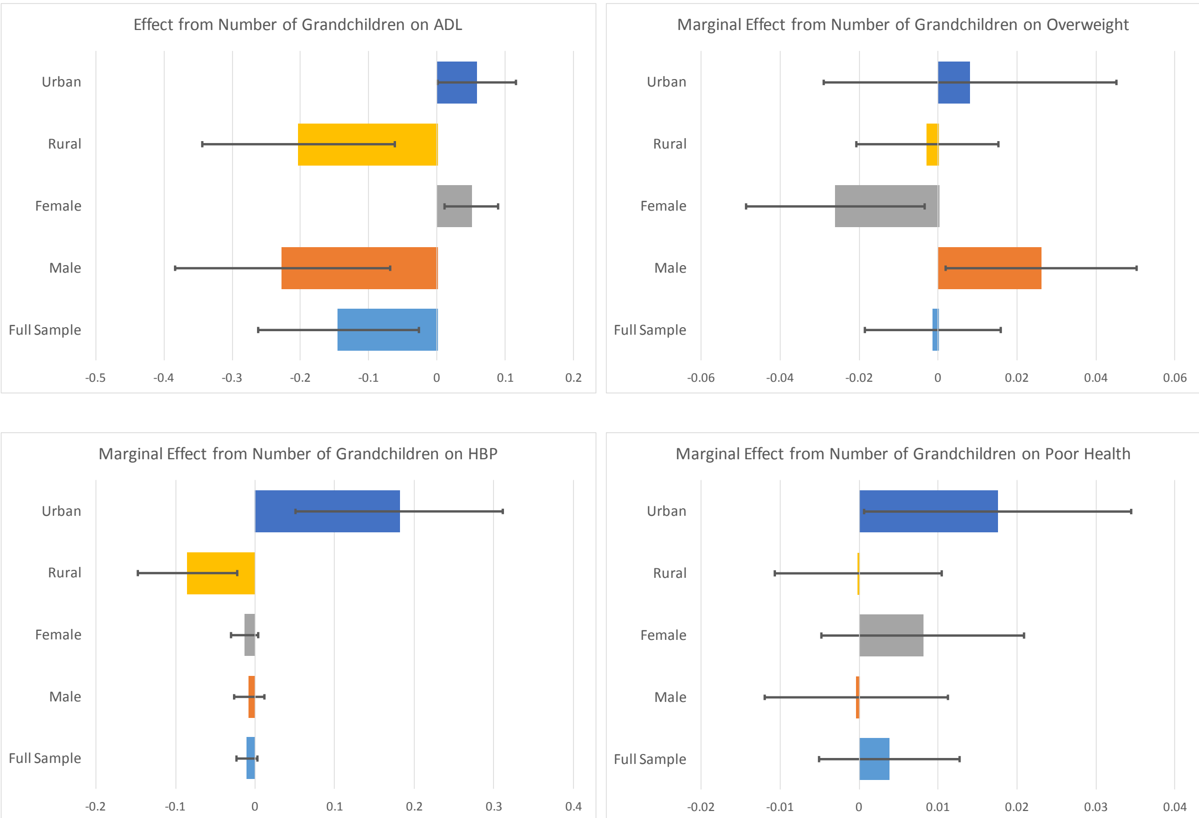
The results in the lower panel of Table 3 suggest that for the analysis of being overweight, and for self-reporting poor health, the probit results in Table 2 should be used. Thus, we do not dwell on the IV results for those two outcomes, which are all statistically insignificant. However, for the likelihood of having high blood pressure, and for the activities of daily living scores, at least some of the residuals are statistically significant and so the OLS and Probit results in Table 2 may be affected by an endogeneity bias.

In terms of the likelihood of having high blood pressure, having more grandchildren makes this more likely for urban residents but less likely for rural residents according to the results in the top panel of Table 3. Likewise, for males and females there are offsetting effects, although these are not precisely estimated unlike for the division by place of residence. Consequently, the overall sample shows no net effect of grandchild numbers on the likelihood of being hypertensive, but that is because of the pooling of opposing effects. For the impacts on the ADL score, the coefficient for the number of grandchildren is significant and negative for the pooled sample (indicating fewer difficulties in performing the daily activities of living). However, this is driven by large effects for males and for rural dwellers, while there are insignificant effects for females and for urban dwellers (and the residuals for these two sub-samples are also not significant, so the OLS results should be used for them, since OLS is more efficient).

Since it is a combination of the results from Table 2, for some health outcomes and samples, and Table 3 for the others (when the added residuals are statistically significant) we compile the overall set of results that should be used for each outcome and sample and illustrate these in Figure 3. This figure shows that there are significant impacts of grandchild numbers on ADL scores for all five samples, although the direction of the effect varies. For the overall sample, for males, and for rural residents, the effect on the ADL score is negative, which means that these respondents have fewer difficulties in performing daily activities, the more grandchildren they have. However, for females, and for urban residents, having more grandchildren means having more difficulties. In terms of the size of the effect, for males and for rural respondents, one more grandchild reduces the standardized ADL score by 0.2, whereas for females and for urban residents one more grandchildren increase this score by 0.05.

Figure 3: Effect of the Number of Grandchildren on Grandparents' Health

Cross-Sectional



Notes

Estimation is from the OLS/Probit regressions when the added-variable form of the Durbin-Wu-Hausman test suggests no endogeneity, or from IV regressions otherwise, with marginal effects from the number of grandchildren plotted in the graphs. The 95% CI for estimates is shown by the grey bars.

The effect of the number of grandchildren on the probability of being overweight also has offsetting effects for males and females. Specifically, the marginal effect from having one more grandchild is to increase the likelihood of being overweight by 2.6% for males and to decrease it by 2.6% for females. In contrast, when the sample is split by urban and rural location and also in the pooled sample results (where, for all three sets of estimates, men and women are pooled) there are no significant effects of grandchild numbers on risk of being overweight.

For the likelihood of having high blood pressure, the offsetting patterns occur in terms of the place of residence. Specifically, having one more grandchild leads to an 8.6% lower chance of being hypertensive for rural residents, while for the urban elderly an increase by one grandchild raises the risk of hypertension by about 18%. Hypertension may reflect stress, so it is possible that in urban areas more grandchildren mean more family stress.

One consistent pattern shown by the cross-sectional results is that the effects of the number of grandchildren are all tend to make indicators of health worse for urban residents, but better for rural residents. That is, in urban areas, having more grandchildren leads to higher ADL scores, more risk of being hypertensive, and more risk of self-reporting as unhealthy, while the effect of a higher risk of being overweight is imprecisely estimated. In contrast, in rural areas having more grandchildren improves the ability to carry out daily activities and reduces the risk of high blood pressure. One possible reason for the rural-urban difference could be the different burden of child caring and the different resource intensities of urban children compared to rural children. The competition in education for urban children is probably greater than for rural children, given the hierarchy of educational resources available in urban areas and the expectation that children will compete for places in tertiary institutions (which is much less likely for rural children). This focus on the educational needs of urban children could see the grandparents in these areas suffer, either because of resource constraints or because of the direct efforts that they make to assist in the education of the children.

5.2 Panel Analysis

The regression results that consider the panel structure of the data are reported in Table 4. The impacts on the ADL scores are all positive, which means that more grandchildren results in more difficulties in carrying out activities of daily living. This effect is especially apparent in the urban sub-sample, where the coefficient is precisely estimated ($p<0.01$) and is twice as large as for any other sub-sample. For the urban elderly, one more grandchild will increase their ADL score by 0.17, which is large effect compared to the urban average score of 0.02.

Table 4: Effect of the Number of Grandchildren on Grandparents' Health
Panel Analysis

	All	Male	Female	Rural	Urban
ADL score	0.0782*	0.0848	0.0673	0.0585	0.166**
	(0.034)	(0.059)	(0.042)	(0.041)	(0.060)
Overweight	-0.0164	0.0152	-0.0523**	-0.00835	0.0163
	(0.012)	(0.015)	(0.019)	(0.007)	(0.045)
High BP	-0.00587	-0.00323	-0.00924	-0.00352	-0.00744
	(0.007)	(0.009)	(0.010)	(0.006)	(0.020)
	0.00545	-0.00021	0.0118	0.0011	0.0188*
	(0.005)	(0.006)	(0.007)	(0.006)	(0.009)
Observations	4,436	2,089	2,347	2,650	1,786
Individuals	1,444	682	762	852	592

Note
See Table 2.

In line with the cross-sectional results, the effects of changes in grandchild numbers on the likelihood of being overweight run in different directions for different groups. An extra grandchild makes elderly women five percentage points less likely to be overweight (p<0.01), while it has a positive but insignificant effect on the chance of men being overweight. The effects in urban and rural areas also run in the opposite directions but neither is statistically significant.

Unlike the results from the cross-sectional analysis, the change in the number of grandchildren does not seem to have a significant influence on the odds of having high blood pressure, for either the whole sample or for any sub-samples. The likelihood of self-reporting poor health also has weak relationship with the change in the number of grandchildren in general, but it is positive and significant when we restrict the analysis to urban residents, with similar magnitudes for the effect to what is seen from the cross-sectional analysis.

In summary, the panel analysis results indicate that an increase in the number of grandchildren harms the health of grandparents, in terms of weakening their abilities to perform daily activities of living. More grandchildren also makes the senior citizens in urban areas more likely to consider themselves to be unhealthy. On the other hand, extra grandchildren will reduce the chance that their grandmothers are overweight, possibly because the extra physical activities that the grandmother may take on to assist with raising a young grandchild may contribute to a reduction in her body mass index.

5.3 Robustness Analysis

The impacts from the number of grandchildren on health outcomes of their grandparents may take several years to eventuate. As a robustness analysis, we ran all of the models discussed above using the lagged number of grandchildren, where this is defined as the total number of grandchildren of the respondent in the previous survey wave.[8] The coefficients from these models all have the same signs as in the main results, but fewer of them are statistically significant. We interpret this as suggesting that the pattern of the main results is robust.

5.4 Summary of Results

A summary of the statistically significant and consistent results shown in the cross-sectional and panel analysis is that urban grandparents with more grandchildren are more likely to have difficulties in performing ADL and self-report themselves as unhealthy, comparing with those with fewer grandchildren. Grandmothers, who are often the major source of help in looking after young grandchildren, appear to have their body weight lowered when they have more grandchildren.

The statistically significant but inconsistent results from the cross-sectional and panel analysis are the impacts from the number of grandchildren on the ADL scores, where the cross-sectional result (from the IV analysis) suggests that one more grandchild will reduce the ADL score by 0.145, but the panel result suggest an increase of ADL score by 0.0782. Moreover, although not all of the marginal effects are statistically significant, the ADL score is always higher for respondents with more grandchildren for all sub-groups in the panel analysis, whereas the cross-sectional results show different directions of effect for different sub-groups.

A plausible reason for this difference is that the results from cross-sectional analysis show a long-term impact from the number of grandchildren, whereas the results from the panel analysis are more of a short-term effect from a new-born grandchild. Since the physical burden of childcare is heaviest in the first couple of years, it is reasonable that the panel analysis results show that the increase in the number of grandchildren will increase difficulties in performing daily activities. The time horizon needed for effects to unfold may also account for the varying results for hypertension. The effect of grandchildren is significant and positive for the urban elderly, according to the cross-sectional analysis, but is negative and insignificant according to the panel analysis. This difference may reflect the fact that it takes a while for a person to change from normal blood pressure status to hypertensive status, which may not be detected by the panel analysis given the time period covered by the data in this research.

[8] When the information of the previous wave is missing, the number is taken from the closest earlier wave.

6. Conclusions and Discussion

The rapid increase in the elderly population of China, coupled with a very uneven and partial pension system, makes family support crucial for the health and wellbeing of the elderly. However, families also have other financial commitments and calls on their time, particularly when they have to care for children. In these circumstances, it is plausible that competition between the generations could see the health of the elderly suffer when their own children have more children to provide support for. A direct pathway is also possible, particularly for grandmothers, since they are often called upon to assist with the care of young children.

In this paper, we have used exogenous variation in fertility over two generations, due to spatial and temporal variation in the implementation of China's one-child policy, to seek causal evidence on the effect of grandchildren numbers on grandparent health. We also use panel analysis to deal with unobservable factors that may the relationship of interest. We find that the number of grandchildren has strong influences on the health of the grandparents, and having more grandchildren tends to be more of a harm than a benefit for the four health outcomes that we focus on. It is particularly for females, and particularly in urban areas, that health seems to be worse where there are more grandchildren. The sensitivity for these sub-populations may reflect the particular caring duties imposed on grandmothers, and the particular pressures of urban living which may especially result from competitive investment in the human capital of children.

These uneven effects from the number of grandchildren on different sub-groups of old people suggest a need for differentiated health insurance and social support systems for different groups of senior citizens. For example, interventions that pay particular attention to the care of elderly women and urban residents may be needed. To the extent that the new, unconditional two-child policy results in any increase in fertility, it is may have adverse effects on the health of old people if their adult children have a second birth and ask for their help as a caregiver to these extra babies. Consequently, better public child-care facilities might also reduce the burden on grandparents from caring for the young grandchildren, which could help to improve their health status.

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Appendix 1: First-Stage Regressions, OLS, CHNS, 1997-2006
Outcome Equals the Number of Grandchildren

	All	Male	Female	Rural	Urban
Own Eligibility for having 2 children	0.134+	0.156	0.122	0.127	0.103
	(0.072)	(0.143)	(0.087)	(0.112)	(0.094)
# Children eligible to have a 2nd child	0.380**	0.356**	0.405**	0.376**	0.382**
	(0.044)	(0.062)	(0.062)	(0.054)	(0.064)
Community OCP strength	-0.322**	-0.328*	-0.332**	-0.334**	-0.242*
	(0.085)	(0.135)	(0.115)	(0.125)	(0.111)
Female	0.0231			0.019	0.0368
	(0.052)			(0.078)	(0.063)
Urban Residence	-0.184**	-0.226**	-0.150+		
	(0.059)	(0.086)	(0.082)		
Age	-0.0185	0.0401	-0.0559	-0.0893	0.0429
	(0.037)	(0.058)	(0.049)	(0.058)	(0.051)
Age Square	0.0174	-0.0237	0.0431	0.0724+	-0.0308
	(0.026)	(0.041)	(0.034)	(0.042)	(0.036)
Urban Hukou	-0.0145	-0.0698	0.0169	-0.0042	0.065
	(0.057)	(0.083)	(0.078)	(0.075)	(0.083)
Currently Married	-0.290**	-0.293**	-0.296**	-0.257**	-0.268**
	(0.052)	(0.097)	(0.064)	(0.073)	(0.065)
Working as a Farmer, Fisherman or Hunter	-0.0745	-0.149+	-0.0249	-0.0783	0.0657
	(0.051)	(0.077)	(0.066)	(0.057)	(0.159)
Working in other occupations	-0.00447	-0.0652	0.104	-0.039	0.0578
	(0.057)	(0.068)	(0.107)	(0.088)	(0.069)
Primary School Qualification	-0.0123	-0.0364	0.0362	0.00137	-0.0671
	(0.053)	(0.072)	(0.082)	(0.073)	(0.074)
Lower Middle school Qualification	-0.103	-0.116	-0.109	-0.132	-0.0723
	(0.074)	(0.096)	(0.118)	(0.124)	(0.084)
Higher level of qualification	-0.0675	-0.104	0.0267	-0.298+	-0.0158
	(0.062)	(0.084)	(0.091)	(0.152)	(0.075)
Living with Children	0.0167	0.0495	-0.00329	0.0365	0.0409
	(0.051)	(0.072)	(0.072)	(0.072)	(0.067)
Regular Smoker	0.0132	0.0128	-0.0029	-0.00305	0.08
	(0.064)	(0.079)	(0.109)	(0.089)	(0.076)
Daily consumption of Cigarettes	-0.0031	-0.00228	-0.00289	0.000661	-0.0118*
	(0.004)	(0.005)	(0.008)	(0.006)	(0.006)
Regular Tea/Coffee Drinker	0.0278	0.0675	-0.000468	0.0988	-0.059
	(0.047)	(0.066)	(0.069)	(0.070)	(0.056)
Daily consumption of Tea/coffee	0.00397	0.000727	0.00943	0.00736	0.0000795
	(0.011)	(0.014)	(0.017)	(0.018)	(0.012)
Alcohol Drinker	0.0279	0.0193	0.048	0.0145	0.0593
	(0.042)	(0.049)	(0.084)	(0.064)	(0.048)
Annual per-capita real household income (000)	-0.00150*	-0.000859	-0.00312*	-0.0011	-0.00232+
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Owner-occupied Household	0.114**	0.0319	0.178**	-0.0386	0.177**
	(0.038)	(0.060)	(0.051)	(0.081)	(0.045)
Household size	0.286**	0.270**	0.300**	0.304**	0.231**
	(0.017)	(0.024)	(0.024)	(0.023)	(0.021)
Constant	0.318	-1.547	1.536	2.647	-1.835
	(1.299)	(1.984)	(1.708)	(2.004)	(1.796)
Observations	4,436	2,089	2,347	2,650	1,786
R-squared	0.441	0.426	0.456	0.443	0.409
First-stage F-statistics	69.06	30.52	46.8	50.09	32.57

Notes: Robust standard errors are in parentheses. ** p<0.01, * p<0.05, + p<0.1 Fixed effects for survey wave and for Province are included in the models but not reported here.