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Tess Stafford, Xiaoyun Zhang and Katja Hanewald

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Tess Stafford[1], Xiaoyun Zhang*[2] and Katja Hanewald[3]

[1]School of Economics, UNSW Sydney, Australia
[2]School of Economics, Zhejiang Gongshang University, China
[3]School of Risk & Actuarial Studies, UNSW Sydney, Australia and ARC Centre of Excellence in Population Aging Research (CEPAR), Australia

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Abstract

We study the effect of rural-urban migration on the well-being of older adults that remain in rural communities in China, a country that is experiencing extensive rural-urban migration and rapid population aging. We exploit China's historic "sent-down youth" program which temporarily relocated millions of urban youth to rural villages and created lasting social ties between sending cities and receiving villages. These ties, coupled with present-day variation in urban growth, create exogenous variation in present-day rural-urban migration rates, allowing us to uncover causal effects of migration. Results suggest that migration negatively affects the physical, cognitive, and emotional health of older adults that remain behind. (JEL I12, I15, J24, J61, O15, O18, R23)

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1 Introduction

In the developing world, the urban-rural gap can explain almost half of within-country inequality (Young, 2013; Lagakos, 2020), and value added per worker is much higher in the nonagricultural sector than in agriculture (Gollin et al., 2014). These facts suggest that rural agricultural workers may gain substantially by migrating to urban areas and that rural-urban migration may be a key way to reduce rural poverty and increase aggregate productivity. On the other hand, these facts may simply reflect geographic sorting of people by human capital and skill level (Young, 2013), which would suggest little gain from migration. A large literature studies whether these theoretical benefits materialize for migrants and for regions and countries in the aggregate (Hao et al., 2020; Lagakos et al., 2020; Beegle et al., 2011; Bryan et al., 2014) and how migration affects those already living in destination communities (Card, 2001). Less studied is the well-being of those remaining in origin communities, who are perhaps the most vulnerable and least likely to benefit from rural-urban migration.

We study the effect of migration on the well-being of older adults who remain in rural communities in China, a country that, like many other developing countries, is experiencing extensive rural-urban migration and rapid population aging. By the end of 2022, the number of migrant workers in China reached 292.5 million, approximately 20.9% of the total population (NBS, 2023). At the same time, the percentage of the population aged 65 and older was 13.7% and is estimated to more than double in the next thirty years, reaching 30.2% by 2050 (United Nations, 2023). In the past few years, the Chinese government has introduced basic pension and health insurance programs in rural areas, but the benefits of these programs are limited, and older people in rural areas still frequently rely on family for support. Whether older adults benefit from the migration of working-age family members depends on the degree to which the gains from migration are shared within the family, the extent to which the absence of adult children and those accompanying them affects the well-being of older adults, and the extent to which inputs to health and well-being, like wealth and time, are substitutes.

Identifying a causal effect of migration on health poses significant empirical challenges. This is primarily because migrants self-select, and many of the factors that drive migration decisions likely also influence parents' health. For example, a lack of resources and infrastructure may drive individuals to migrate in search of better opportunities while simultaneously hindering older individuals' access to quality health care. Migrants may also explicitly take parents' health into consideration when deciding whether to migrate, leading to reverse causality.

To address concerns of self-selection, we use an instrumental variables strategy that combines new and detailed information on rural-urban networks and employment prospects in urban destinations. Rural-urban networks have been shown to lower migration costs (Bryan et al., 2014) and improve employment outcomes in destinations (Munshi, 2003), making them an important factor in the decision to migrate. Similar to Kinnan et al. (2018), we make use of a historical cultural experiment that served to create lasting connections between certain rural villages and urban cities in China. As part of the Chinese Cultural Revolution of the 1960s and 1970s, the government mandated the temporary relocation of approximately 16.5 million urban youth to the countryside with the supposed objective to cultivate communist ethics in the bourgeois urban youth. These urban youth became known as the "sent-down youth" or *zhiqing*. On average, the sent-down youth spent five to six years in the countryside, typically working in agriculture, before returning to urban areas after the government terminated the program in the late 1970s. Although forced relocation was temporary, Kinnan et al. (2018) found that the connections formed between sending cities and receiving villages endured for decades after the sent-down youth program ended.

To construct our instrument, we interact historical village-level urban-rural sent-down youth flows with present-day economic growth in sent-down youth origin cities. Specifically, we use the annual growth rate in the average wage in manufacturing and construction, the two sectors responsible for employing more than half of all migrants during our sample period. The idea is that employment opportunities in potential migrant destinations are especially relevant when individuals also have access to a network at the destination.

In our empirical specification, we separately include sent-down youth flows and a set of province fixed effects. Thus, we do not require that the rural-urban networks that were formed are independent of present-day health. Rather, our key identifying assumption is that, conditional on having received sent-down youth and conditional on own-province effects, older adults' health and well-being is affected by short-term growth in potential migrant destinations only through rural-urban migration.

To investigate the relationship between rural-urban migration and health at older ages, we use the national baseline of the China Health and Retirement Longitudinal Study (CHARLS), which offers several advantages. First, it is a nationally representative sample of the population aged 45 years and older, living in private households in China. Second, CHARLS collects rich health-related information on respondents and their spouses, which allows us to conduct an unusually comprehensive assessment of migration on physical, cognitive, and emotional health. Third, CHARLS collects village-level information on sent-down youth flows, which allows us to construct a spatially granular instrument for migration.

Our first stage results strongly support our hypothesis that growth in sending provinces leads to an increase in village-level migration rates. Estimates are largely insensitive to the inclusion of additional covariates and are highly statistically significant, with Kleibergen-Paap F-statistics above 40 in all specifications. Our second stage results suggest that migration negatively affects the health and well-being of left-behind older adults. Specifically, we find that a one standard deviation increase in the village-level migration rate leads to a statistically and economically significant decrease in lung function, the ability to perform simple daily activities like dressing and eating, the ability to perform more complex daily activities like cooking and shopping, and mental health.

Next, we explore whether the effects of migration differ by age and by gender. Overall, our results show a general pattern of deteriorating health for all subpopulations. However, differences in estimates across subpopulations suggest that the negative health effects associated with migration are more concentrated among physical measures of health for older individuals (60+ years of age) and among emotional and cognitive measures for younger individuals (50-60 years of age). Differences between females and males are less distinct, though the estimates suggest that females may be more likely to suffer when it comes to self-reported measures of physical health.

To provide some evidence on the potential channels through which labor migration might affect the health of older individuals remaining in villages, we replace our dependent variable with a series of channel variables and perform otherwise similar two-stage least squares regressions. These secondary results are consistent with our main results on health. We find no evidence of positive channels in operation. The average value of remittances does not appear to increase, and we document statistically and economically significant decreases in annual per capita household expenditures on utilities, medical services, and communication. On the other hand, we do find evidence of negative channels in operation. Migration increases the need for physical assistance for the full sample and for each age and gender subsample. While older individuals and females report that much of this increase in need is met, largely by spouses, younger individuals and males report a significant level of unmet need. Individuals report less in-person and remote contact with children and fewer social interactions. Older individuals and males are more likely to engage in farm work for themselves and to work more hours. To the extent there are gains from rural-urban migration, our results strongly suggest that older individuals are not the beneficiaries of these gains.

Our paper contributes to the growing literature on the relationship between labor migration and the well-being of older adults that remain behind in rural villages. The studies in this literature vary in methods and focus and, perhaps as a result, also vary in their conclusions. Key studies include Kuhn et al. (2011), who use a propensity score matching approach to study the effect of internal migration in Indonesia and find positive effects, Gibson et al. (2011), who exploit a migration lottery program to study the effect of international migration in Tonga and find marginally negative to no significant effects, Böhme et al. (2015), who use an instrumental variables strategy to study the effect of international migration in Moldova and find positive effects, and Antman (2016), who uses fixed effects estimation and an instrumental variables strategy to study the effect of international migration in Mexico and finds negative effects. We compare and contrast our setting, methods, and findings with these studies.

The remainder of the paper is organized as follows. Section 2 introduces a conceptual framework that relates migration and health. Section 3 describes our empirical strategy and the historic sent-down youth program. Section 4 describes the data, including our measures of health and migration. Section 5 presents and discusses the results, and Section 6 concludes.

2 Conceptual Framework

Rural-urban labor migration may affect the health of older adults that remain behind for a number of reasons. Foremost, migration may benefit older parents through an increase in wealth. In many cases, it is the promise of higher earnings that drives migration, and migrants commonly report sending considerable shares of their income to family members that remain in origin communities (Du et al., 2005; Yang, 2008; Zhao et al., 2018). An increase in wealth may increase food consumption, reduce consumption volatility, and increase expenditures on and investments in health (Kinnan et al., 2018; Clemens and Tiongson, 2017; Démurger and Wang, 2016). It may also allow older parents to reduce their labor supply and devote more time to leisure or health (Antman, 2013, p. 298-299) or alleviate credit constraints and allow parents to pursue more lucrative or satisfying self-employment opportunities (Yang, 2008).

However, migration may also result in negligible increases or even decreases in wealth (Antman, 2012). Many migrants leave not only their parents behind, but also their spouses and children, who are likely the primary recipients of migrants' surplus earnings (Akay et al., 2014). The distance generated by migration may also weaken the financial responsibility felt by migrants for their aging parents or make it easier for migrants to hide their true income, causing a reduction in overall financial support (Rapoport and Docquier, 2006; Baseler, 2023). Migration may also result in decreases in in-kind support, primarily through farm work (Lee and Xiao, 1998). To compensate for a decrease in wealth or for the loss of a laborer, parents may engage in more work, which could be detrimental to health if this leads to a reduction in time devoted to healthy activities or if the work is strenuous, as farm work often is (Chang et al., 2011).

The absence of adult children may also have other adverse effects. Many older individuals in developing countries require assistance to access sufficient nutrition and medical services and to perform daily activities like bathing (World Health Organization, 2015), which is often provided by family members, adult children in particular (Lee and Xiao, 1998). Given their distance, migrants are less able to provide this type of assistance (Bian et al., 1998). Whether overall assistance decreases depends on whether other family and community members can compensate for any loss in assistance (Antman, 2012). It also depends on the extent to which money and time are substitutable and sufficient care can be financed from an increase in remittances (Pan and Dong, 2020).

The absence of adult children may also harm parents' mental health (Gibson et al., 2011; Antman, 2016). The loss of physical contact with children may produce feelings of isolation and loneliness and erode relationships. Migration may also lead to stress and anxiety if parents are concerned about the well-being of their migrant children or left-behind grandchildren (Connelly and Maurer-Fazio, 2016; Ivlevs et al., 2019).

In addition to the direct effects of a child migrating, there may be indirect effects that stem from community-level changes in demographics and resources. For example, if skilled individuals are more likely to migrate, outmigration may result in "brain drain" and hinder rural growth and development (Lucas, 2005; Mendola, 2012). Rural wages may increase with outmigration as rural workers become scarcer (Lagakos, 2020). If elderly parents are more likely to demand labor (e.g., require domestic assistance) than to supply labor, higher rates of migration may harm parents. On the other hand, migrants may facilitate the transmission of knowledge and attitudes from urban to rural communities, which may increase human capital and healthy behaviors in origin communities (Dinkelman and Mariotti, 2016) and decrease rural-urban inequality (McKenzie and Rapoport, 2007). However, much of the evidence in support of such positive spillovers stems from long-term rather than short-term effects of migration.

The relationship between rural-urban migration and the health and well-being of older adults that remain behind is far from theoretically clear. In this paper, we attempt to uncover the composite causal effect of migration and to explore which of these possible channels are in operation.

3 Empirical strategy

Identifying a causal effect of migration on health is challenging because many factors likely affect both the migration decisions of adult children and the health of older parents that remain in origin communities. For example, genetic traits, such as predispositions to certain health conditions or personality traits, may affect both parental health and children's migration decisions. Environmental factors, such as air pollution, may prompt individuals to migrate out of their village and affect the health of those that remain behind. Negative idiosyncratic shocks to parents' health may induce children to migrate in search of higher-paying work that will help cover health expenses (Wagstaff and Lindelow, 2008) or may induce children to remain in rural villages so that they can care for their parents (Giles and Mu, 2007). While it may be possible to directly control for many of these factors, it is still likely that remaining unobserved factors jointly affect migration and health. In such cases, regressing health on migration will produce a biased estimate of the effect of migration, and the sign of the bias will depend on the overall correlation between migration and unobserved factors that affect health, which is difficult to theoretically predict.

To address these endogeneity concerns, we use an instrumental variables strategy. Like Böhme et al. (2015) and Kinnan et al. (2018), our instrument combines information on the historical migration flows between rural villages and urban cities and the present-day economic growth of these urban cities, which we discuss next.

3.1 The Sent-down Youth Movement

The Sent-down Youth Movement, also known as the "Up to the Mountains and Down to the Countryside Movement", was a political program that temporarily relocated millions of urban youth to the rural countryside (Bernstein, 1977). The program began in the mid-1950s and was initially voluntary, encouraging around 1.3 million urban youth to relocate in the first ten years. With the launch of the Chinese Cultural Revolution, the program underwent a significant shift, becoming compulsory and growing exponentially. Between 1966 and 1976, the government mandated the relocation of approximately 16.5 million urban youth, roughly 10% of the entire urban population (Gu, 2009). The majority of the sent-down youth, or *zhiqing*, were junior and senior high school graduates, between the ages of 16 and 20.[1] The program's official objective was to cultivate communist ethics in urban youth and reeducate them through participation in agricultural production (Rene, 2013, p. 94). However, the disruptions and social unrest caused by the Cultural Revolution are often cited as underlying motivations (Xie et al., 2008). For example, many urban secondary schools, colleges, and universities were closed by the government for years, leaving a large youth population without school or job prospects.[2] The sent-down youth movement reached peak relocation numbers of 2.6 million in 1969 (Gu, 2009). The government terminated new relocations in 1978 and allowed those already relocated to return home in 1979. By the end of 1980, the vast majority of sent-down youth had returned to urban areas (Zhou and Hou, 1999).

The temporary resettlement pattern of urban youth to rural areas was determined by the central government and was organized in a top-down manner.[3] The urban youth had no control over whether and when they were selected to relocate nor where they were sent. The government revoked the urban *hukou* status of those selected, which rendered them ineligible for jobs and food stamps in urban locations (Rene, 2013). This, combined with the consequences of opposing the government, ensured high compliance rates. According to Gu (2009), 92% of resettlement occurred within the same province, with the remaining 1.4 million urban youth relocated to rural areas in other provinces. Inter-provincial resettlement was typically conducted between large cities and remote and poor provinces: Beijing, Tianjin, and Shanghai were the main sending cities, and Heilongjiang, Anhui, Xinjiang and Hebei were the main receiving provinces [4].

The sent-down youth engaged in a number of activities while living in rural communities. Most worked in agriculture alongside local farmers (Gu, 2009; Bernstein, 1977, p. 124). Because they were better educated than rural residents, some were assigned non-agricultural jobs, such as village school teachers, agricultural technicians, "barefoot" doctors who received minimal medical training to provide basic healthcare to rural villagers, and local leaders and cadres who were responsible for the management of the Chinese Communist Party's local affairs (Chen et al., 2020). On average, the sent-down youth stayed five to six years in the countryside, and 95% of them eventually returned to urban areas. Those that stayed married local farmers or were employed in local nonagricultural jobs (Zhou and Hou, 1999).

Although forced relocation was temporary, the sent-down youth and rural villagers formed significant

[1] According to calculations in Chen et al. (2020), 73.3% of sent-down youth had completed junior high education and 28.3% had completed senior high education by the time they were relocated.

[2] Giles et al. (2019) estimates that the Cultural Revolution reduced high school and college completion rates at age 25 by 7.1% and 6.3%.

[3] See Rene (2013) for details on the administration and allocation of sent-down youth.

[4] According to Gu (2009), 1.24 million out of the 1.4 million inter-provincial sent-down youth were sent from large cities of Beijing, Tianjin, and Shanghai; 1.15 million of them were received by Heilongjiang, Anhui, Xinjiang, Hebei, Jiangxi, Yunnan, and Inner Mongolia.

connections. For example, some married and some had children when they were living in the countryside. And although many eventually returned to cities, leaving behind their rural partners and children who were not legally allowed to accompany them, anecdotal evidence suggests that the left-behind partners and children often visited the returned sent-down youth years later.

Kinnan et al. (2018) posits that these personal ties led to lasting connections between sending cities and receiving villages and that these lasting connections may facilitate present day migration from receiving villages to sending cities by lowering cultural barriers, providing kinship, and facilitating the transmission of information on labor markets in urban sending cities.[5] Using province-level data on sent-down youth flows, Kinnan et al. (2018) demonstrates that, decades after the sent-down youth program ended, increased access to and benefits of migration in sending cities leads to higher rates of migration from receiving provinces. We build on this insight to construct an instrument for present-day village-level migration.

3.2 Identifying Exogenous Variation in Migration Rates

In CHARLS, community respondents are asked to report the number of sent-down youth that the community received in the 1960s and 1970s and to report the province from which the majority of sent-down youth came.[6] Table 1 summarizes these responses and illustrates the variation in sent-down youth flows both across- and within-province. For example, of the twelve rural communities in Hebei that are surveyed in CHARLS, six did not receive any sent-down youth, three received sent-down youth from elsewhere in Hebei, and three received sent-down youth from either Beijing or Tianjin. While the majority of sent-down youth were relocated to rural communities within the same province, approximately 11% of rural communities that received sent-down youth received them from other provinces. We hypothesize that these communities developed lasting social ties with sending provinces that facilitate present-day inter-provincial migration.

Based on this, we construct the following instrument for labor migration:

$$IV_{vp} = SDY_{vp}^{s \neq p} \cdot growth_{s(v)}. \tag{1}$$

The first term, $SDY^{s \neq p}$, is an indicator variable that equals 1 if the community respondent for village v in province p reports that the village received sent-down youth and reports a sending province, s, that differs from p. We interpret this variable as an indicator of whether the village has inter-provincial social ties. We interact this variable with a measure of economic growth in the sending province to capture employment prospects for migrants. Specifically, $growth$ is the rate of growth between 2009 and 2010 in sending province s in the average wage in manufacturing and construction, the two sectors responsible for employing more than half of all migrants in 2010.[7] See

[5] For example, in a field experiment in Kenya, Baseler (2023) shows that providing information on employment prospects in Nairobi increases migration rates to Nairobi by about 40% over two years.

[6] See questions JH009 and JH013.

[7] See the 2011 Statistical Report on Chinese Migrant Workers published by the National Bureau of Statistics China, available at `http://www.stats.gov.cn`.

Table 1: Distribution of Rural Communities by Province and SDY-Recipient Status

Province	Total number of communities	Did not receive SDY	Received SDY within province	Received SDY across province	Origin of across-province SDY
Anhui	17	0	6	11	Shanghai
Chongqing	5	0	5	0	
Fujian	12	3	8	1	Yunnan
Gansu	8	0	8	0	
Guangdong	22	6	16	0	
Guangxi	9	5	4	0	
Guizhou	5	0	4	1	Hunan
Henan	23	6	17	0	
Hebei	12	6	3	3	Beijing, Tianjin
Heilongjiang	2	1	1	0	
Hunan	12	2	10	0	
Hubei	8	2	6	0	
Inner Mongolia	7	3	2	2	Anhui, Heilongjiang
Jiangsu	11	0	11	0	
Jiangxi	13	3	10	0	
Jilin	4	1	3	0	
Liaoning	8	0	8	0	
Qinghai	3	2	1	0	
Shandong	22	6	15	1	Shanghai
Shannxi	9	3	6	0	
Shanxi	11	4	6	1	Beijing
Sichuan	31	2	25	4	Chongqing
Tianjin	2	0	2	0	
Yunnan	19	10	8	1	Shanghai
Zhejiang	11	1	10	0	
All	286	66	195	25	

Notes: Statistics include all rural communities surveyed in CHARLS for which there is at least one individual with complete information on health. Communities' SDY-recipient status and SDY origin province are determined using answers to survey questions JH009 and JH013, which ask "How many [sent-down] youth did your village accept during the 1960s and 1970s?" and "Where are the youth rusticated to your village mostly from?".

Appendix C for more detail on how we construct *growth* and how it varies across sending provinces. Thus, IV takes the value of growth in the sending province for those communities that received sent-down youth from other provinces and equals 0 for all other communities. We consider and discuss alternative specifications in Section 5.3.

3.3 The Causal Effect of Migration on Health

Given the nature of our instrument, IV, we cannot isolate the effect of migration of specific individuals or groups of individuals, such as an older person's children, because we cannot hold constant the migration decisions and outcomes of other individuals in the village, such as other family members, neighbors, and the children of other older individuals, which may also affect an older person's health. Such an interpretation is common among studies that use labor demand shocks to identify exogenous variation in migration rates, such as in Böhme et al. (2015) and Kinnan et al. (2018), who use instruments that vary at the village- and province-levels. Thus, we estimate variations of the following relationship between village-level labor migration, M, and the health of an older person who remains behind, H:

$$H_{ivp} = \beta_1 M_{ivp} + \beta_2 SDY_{vp}^{s\neq p} + \beta_3 SDY_{vp}^{s=p} + \theta_p + \epsilon_{ivp}, \tag{2}$$

where i, v, and p denote individuals, villages, and provinces, θ denotes province fixed effects, and ϵ is an unobserved component. We consider a number of measures of health, H, which are discussed in detail in Section 4. As in equation (1), $SDY^{s\neq p}$ is an indicator variable that equals 1 if the village received sent-down youth from another province and equals 0 otherwise. Similarly, $SDY^{s=p}$ is an indicator variable that equals 1 if the village received sent-down youth from within the same province and equals 0 otherwise. Thus, β_2 and β_3 capture any systematic differences in health associated with communities that received sent-down youth from across and within provinces.

To address endogeneity concerns, we instrument M, and our first stage equation is given by

$$M_{ivp} = \alpha_1 IV_{vp} + \alpha_2 SDY_{vp}^{s\neq p} + \alpha_3 SDY_{vp}^{s=p} + \phi_p + u_{ivp}, \tag{3}$$

where IV is defined in equation (1), ϕ denotes province fixed effects, and u is an unobserved component. We construct village-level labor migration rates by dividing the number of working-aged migrants by the total population of working-aged individuals in the village.[8] We discuss this process in detail, including issues with measurement, below and in Section 4.3 and Appendix B. The interpretation of the 2SLS estimate of β_1 is the effect of a 100-percentage point change in village-level labor migration, driven by short-term interprovincial labor demand shocks, on health. To the extent different types of migrants, for example females and males, have different effects on the health of older adults, β_1 is a weighted average of these effects, where the weights are determined by the relative effect of IV on each type's propensity to migrate and by the relative size of each population.

Our instrument, IV, is a valid instrument for M if $cov(IV, \epsilon) = 0$. By including the SDY terms, we allow for correlation between health and the allocation of sent-down youth to rural communities. For example, we allow for the possibility that community characteristics that affect both the likelihood of receiving sent-down youth and the likelihood of migrating, such as poor infrastructure or geographical features like mountains, independently affect present-day health. By including the SDY terms, we also allow for the possibility that sent-down youth affect present-day health through channels other than migration. For example, we allow for the possibility that exposure to educated urban youth encouraged rural inhabitants to acquire more schooling, which, in turn, promoted better health (Chen et al., 2020). By including province fixed effects, we allow for correlation between health and the spatial patterns of urban growth experienced by all communities within the same province. This is important if, for example, inter-provincial sent-down youth were primarily

[8]Despite measuring migration at the village-level, we index M by i for two reasons. First, we prefer to estimate models at the individual-level as a way of weighting villages by sample size. Second, in some specifications, we include covariates that vary at the individual-level. Constructing migration rates at the village-level also has the added benefit of reducing measurement error in our migration variable.

relocated within the same broader geographic or economic region and economic opportunities in sending provinces partially capture economic opportunities in home provinces, which, in turn, are correlated with present-day health for reasons other than migration.

Given these control variables, our validity condition is satisfied provided that, among communities that received sent-down youth from other provinces and after conditioning on own-province effects, differential annual wage growth in manufacturing and construction in sending provinces affects health only through migration. This assumption could be violated if relatively "healthier" communities were more (or less) likely to receive sent-down youth from provinces that, forty years later, would have high wage growth in manufacturing and construction between 2009 and 2010. Province-level wage growth in manufacturing and construction varies quite a bit from year to year, and we find it unlikely that such short term variation could be forecastable some forty years in the future.

Our validity condition could also fail if we mis-measure migration rates and the measurement error is correlated with IV. This could happen if, for example, IV induces other individuals that are not considered in our migration rate measure, such as young children, to migrate, and either their rate of migration or the effect that they have on the health of older adults differs from those that we measure. If these unmeasured individuals are "passive" migrants who accompany working-aged migrants, then the interpretation of β_1 is the composite effect of labor migration, including any secondary effects from passive migration. However, if these unmeasured individuals are "active" migrants who directly respond to changes in IV, then the estimate of β_1 may be biased if the unmeasured population is non-negligible. Provided the effect of IV on unmeasured individuals is smaller than the effect of IV on measured individuals, which seems plausible in the case of young children, such measurement error will attenuate our estimate of β_1, which means we provide a conservative estimate of the effect of migration on health. Nevertheless, in Section 5.3 and Appendices B and H, we consider alternative measures of migration to explore the sensitivity of our results.

Related, our validity condition could fail if IV has anticipatory effects not captured in our measure of migration that affect health (Kinnan et al., 2018). This could happen if, for example, IV causes changes in a family's asset ownership in anticipation of sending a migrant and these changes affect the health of oler adults. If anticipatory effects and migration effects work in the same direction, then our estimate of β_1 will be inflated (in magnitude). In Appendix G, we show reduced-form estimates, which capture both anticipatory effects and the direct effects of migration, and we discuss these results in Section 5.3.

While we are not aware of a theoretical reason to believe that IV is correlated with individual- or village-level characteristics, given the other covariates in equations (2) and (3), to address the possibility of spurious correlation, we also estimate models that include additional covariates. Individual covariates include gender, age, marital status, number of children, and educational attainment. Village covariates include weather conditions, road quality, hospital accessibility, and participation in other historical social programs that occurred around the time as the sent-down youth program. We describe these variables and how they are constructed in Appendix D, and we provide and discuss descriptive statistics in Section 4.

4 Data

In this section, we describe our regression sample, the health and well-being measures that we focus on, how we identify migrants and construct village-level migration rates, and individual- and village-level characteristics of our sample.

4.1 Our Sample

The China Health and Retirement Longitudinal Study (CHARLS) is a longitudinal survey of a nationally representative sample of persons in China aged 45 years and older and their spouses.[9] The survey design is based on the Health and Retirement Study (HRS) and other related aging surveys, such as the English Longitudinal Study of Ageing (ELSA) and the Survey of Health, Ageing and Retirement in Europe (SHARE). We use data from the national baseline survey, which was collected between May 2011 and March 2012, with 90% completed by September 2011, using face-to-face computer-assisted personal interviews. The baseline survey involved 17,708 individuals from 10,257 households living in 450 communities across 28 provinces.

To focus on the relationship between labor migration and the health of older individuals that remain behind, we limit our sample to individuals aged 50 and older and living in rural villages.[10] To better ensure comparability across health measures, we further limit our sample to include only individuals with non-missing values for all measures of health that we study so that all regressions are based on the same sample. After imposing these criteria, our primary regression sample consists of 6,274 individuals, for whom all relevant information is available.

Table 2 provides summary statistics on the health, village-level migration rates, and individual- and village-level characteristics of the elderly individuals in our regression sample. The first four columns provide statistics for the full sample, and the remaining columns provide statistics for sub-populations based on village-level migration rates, age, and gender. We use the median village-level migration rate to split the sample into those living in villages with low and high migration rates, and we use 60 years of age to split the sample into "younger" and "older" individuals. We discuss these summary statistics, including differences across sub-populations, below.

4.2 Measures of Health

We study thirteen measures of health and well-being that capture key aspects of physical health, mental health, and cognitive health. We provide brief descriptions of each measure below and

[9] More information on CHARLS is available at `http://charls.pku.edu.cn/en`.

[10] We classify a community as a rural village if the community respondent answers either "village committee office" or "both village committee office and community office" to question JA001: "Is this office a community office or a village committee office?"

Table 2: Summary statistics

Variable	Full Sample				Sub-populations					
	Mean	Standard Deviation	Minimum	Maximum	Migration rate low	Migration rate high	Younger $(50-59)$	Older $(60+)$	Females	Males
Health										
Self-reported health $(1-4)$	2.0	0.8	1	4	2.1	2.0	2.1	2.0	2.0	2.1
ADL ability $(0-6)$	5.6	0.9	0	6	5.7	5.6	5.8	5.5	5.6	5.7
IADL ability $(0-5)$	4.5	1.0	0	5	4.6	4.5	4.7	4.4	4.4	4.6
Systolic blood pressure $(mmHg)$	127.2	21.2	89	187	128.8	125.7	123.4	130.7	127.9	126.6
Diastolic blood pressure $(mmHg)$	73.0	11.6	48	105	74.2	71.9	73.5	72.5	72.8	73.2
Pulse (bpm)	70.0	10.1	49	99	69.8	70.3	69.9	70.1	70.4	69.7
Lung Function (l/min)	285.7	121.5	60	610	289.8	281.8	318.6	256.2	240.8	327.7
Grip strength (kg)	32.1	9.8	10	58	32.2	32.1	34.5	30.0	26.0	37.8
BMI (kg/m^2)	23.0	3.9	11.8	57.4	23.5	22.6	23.5	22.6	23.6	22.5
Mental health $(0-30)$	20.8	6.5	0	30	21.3	20.3	21.3	20.4	19.7	21.9
Life satisfaction $(1-5)$	3.1	0.7	1	5	3.1	3.0	3.0	3.1	3.1	3.1
Memory $(0-20)$	6.4	3.3	0	19	6.7	6.2	7.0	5.9	6.2	6.6
Cognitive ability $(0-11)$	6.8	3.1	0	11	7.0	6.5	7.2	6.4	5.8	7.7
Migration										
Migration rate	0.49	0.19	0	1	0.33	0.64	0.49	0.49	0.48	0.50
Individual characteristics										
Female	0.48		0	1	0.50	0.47	0.50	0.46	1	0
Age	61.9	7.8	50.0	95.7	61.6	62.2	55.5	67.7	61.6	62.2
Married	0.87		0	1	0.87	0.87	0.94	0.81	0.84	0.90
Number of children	3.0	1.4	0	10	3.0	3.0	2.4	3.5	3.1	2.9
Primary school	0.46		0	1	0.45	0.46	0.41	0.50	0.37	0.53
Middle school	0.15		0	1	0.16	0.14	0.20	0.10	0.08	0.21
High school and above	0.06		0	1	0.06	0.06	0.11	0.02	0.03	0.10
Village characteristics										
Number of rainy days	52.3	39.5	0	182	46.3	58.1	50.0	54.4	52.2	52.4
Number of snowy days	6.9	13.5	0	150	6.9	6.9	7.0	6.8	7.1	6.7
Condition of roads	2.3	0.9	1	3	2.4	2.3	2.3	2.3	2.3	2.3
Hospital	0.54		0	1	0.60	0.48	0.54	0.54	0.53	0.54
Distance to hospital (km)	12.4	18.5	0	130	12.4	12.5	13.0	11.9	12.0	12.8
Number of barefoot doctors	3.0	3.6	0	45	2.7	3.3	3.0	3.0	3.0	3.0
Sample size	6,274				3,086	3,188	2,970	3,304	3,031	3,243

Notes: The first four columns present summary statistics for the full sample of individuals aged 50 and older, living in rural communities with an agricultural *hukou*. The remaining columns provide statistics for sub-populations based on village-level migration rates, age, and gender. We use the median migration rate to split the sample into those living in villages with low and high migration rates, and we use 60 years of age to split the sample into younger and older individuals.

detailed descriptions, including how each is constructed, in Appendix A.

Self-reported health: Self-reported health is a commonly used measure of overall health and has been shown to be a strong predictor of mortality and changes in functional ability (Idler and Kasl, 1995; Idler and Benyamini, 1997). During the CHARLS interview, individuals are asked twice to rate their health using five-point Likert scales that range from either "very poor" to "very good" or "poor" to "excellent". We use individuals' second responses to create an index that equals 1 if the individual reports "poor" or "very poor" health, 2 if the individual reports "fair" health, 3 if the individual reports "good" health, or 4 if the individual reports "excellent" or "very good" health. On average, individuals in our sample report being in "fair" health.

ADL ability: We include a measure of individuals' ability to perform basic activities of daily living (or ADLs) to gauge their physical functioning and assess the extent to which they need assistance with basic self-care tasks. Respondents rate their ability to perform ADLs, including dressing, bathing and showering, eating, getting into and out of bed, using the toilet, and controlling urination and defecation. We combine responses on these six activities to create a composite ability index that ranges from 0 (difficulties with all six ADLs) to 6 (no difficulties with any ADL). The mean ADL ability is 5.6, which indicates that few individuals have ADL limitations.

IADL ability: Respondents also report their ability to perform more complex daily activities (known as instrumental activities of daily living or IADLs) that allow an individual to live independently, including doing household chores, preparing hot meals, shopping for groceries, managing money, and taking medications. We combine responses on these five activities to create a composite IADL ability index that ranges from 0 (difficulties with all five IADLs) to 5 (no difficulties with any IADL). The mean IADL ability is 4.5, which, like ADL limitations, indicates that few individuals have IADL limitations.

Systolic and diastolic blood pressure: We include systolic and diastolic blood pressure separately to assess whether an individual has high blood pressure, which can cause health conditions, such as heart disease and stroke. Both values are measured in $mmHg$. Blood pressure numbers of more than 120 $mmHg$ systolic or more than 80 $mmHg$ diastolic typically indicate high blood pressure. Though the mean diastolic measure is 73, the mean systolic measure is 127. This imbalance, called isolated systolic hypertension, is typically due to age-related stiffening of large arteries and long-term build-up of plaque and is the most common form of high blood pressure in older individuals.

Pulse: A high pulse or heart rate is associated with a higher risk of all-cause mortality and cardiovascular diseases (e.g., Perret-Guillaume et al., 2009). Pulse is measured in heart beats per minute (*bpm*). A resting heart rate between 60 and 100 bpm is considered normal for adults, including older adults. In our sample, the mean heart rate is 70.

Lung function: The lungs mature by age 20 to 25, and thereafter lung function declines with age (e.g., Sharma and Goodwin, 2006). We include individuals' forced expiratory rate in liters per minute, measured by the CHARLS surveyors with a peak flow meter. The mean lung function in our sample is 285 l/min.

Grip strength: Handgrip strength is an indicator of upper body strength and has been found to be a strong predictor of mortality in middle-aged and elderly persons (Sasaki et al., 2007). We include grip strength, measured in kilograms by the CHARLS surveyors with a dynamometer. The mean grip strength is 32 kg.

BMI: We calculate body mass index (BMI) by dividing an individual's weight in kilograms by height in meters squared (kg/m^2). A BMI between 18.5 and 24.9 kg/m^2 is within a healthy weight range. BMI values below and above this range are associated with increased mortality (Flegal et al., 2005). Although overweight and obesity are increasing in China, the CHARLS data suggest that overweight and obesity are rare in the 50+ age group and that underweight is more prevalent. In our sample, the mean BMI is 23, which is well within the healthy range.

Mental health: In CHARLS, mental health is assessed using the ten-item Center for Epidemiological Studies-Depression (CES-D-10) scale. Surveyors present individuals with ten statements about their feelings and behaviors during the previous week, such as "I felt depressed". We convert the responses to a numeric scale and sum across statements to construct a mental health index that ranges from 0 (poor mental health) to 30 (excellent mental health). On average, individuals have a mental health index of 20.8.

Life satisfaction: Surveyors ask individuals how satisfied they are with their lives. We convert responses to a numeric scale that ranges from 1 ("not at all satisfied") to 5 ("completely satisfied"). The mean life satisfaction rating is 3.1, which roughly corresponds to individuals being "somewhat satisfied" with their lives as a whole.

Memory: During the interview, surveyors read a list of ten simple words, like rice, foot, and mountain. Individuals are asked to recall as many words as possible immediately after the list is read and again several minutes later. We sum the number of words that the individual can recall on each attempt, constructing a measure of memory that ranges from 0 (no words recalled on either attempt) to 20 (all words recalled on both attempts). The mean memory score is 6.4.

Cognitive ability: To measure cognitive ability, surveyors ask individuals several sets of questions based on the Telephone Interview for Cognitive Status (TICS). In the first set, surveyors ask individuals to state the current date, day of the week, and season. In the second set, surveyors ask individuals to subtract 7 from 100 (up to five times). In the third set, individuals are shown a picture of two overlapping pentagons and are asked to replicate it. We sum all correct answers to create a composite measure of cognitive ability that ranges from 0 to 11. The mean cognition score is 6.8.

Table 2 reports that those living in villages with lower migration rates, those aged between 50 and 59, and males are in better health.

4.3 Measures of Migration

We use information collected from CHARLS respondents about their children to construct our measure of labor migration. CHARLS collects information on the age, school enrollment status, and residence of each child. For those children considered to be household members, respondents report whether the child spent any time away from the household during the past year and the length of time spent away. We classify a resident child as a migrant if the respondent reports that the child spent any time away from the household and reports that the child is not enrolled in school. For those children considered to live outside the household, respondents report where the child normally lives and the type of location in which the child resides. We classify a non-resident child as a migrant if the respondent reports that the child lives in a city or lives 20 or more kilometers away and reports that the child is not enrolled in school. To focus on labor migration, we drop from our calculations children under the age of 18 or over the age of 40 and children for whom we cannot determine an age. We construct village-level migration rates by dividing the sum of all migrants by the sum of all migrants, all non-migrants, and all those in school. Appendix B provides more detail on how we construct migration rates, including a discussion of alternative measures. Section 5.3 and Appendix H present and discuss results based on these alternative measures.

Table 2 reports that the mean village-level migration rate is 49%, and the standard deviation of 19% suggests that there is sizable variation in migration rates across villages.

4.4 Individual- and Village-Level Characteristics

The second half of Table 2 provides summary statistics on individual- and village-level characteristics of the older individuals in our regression sample. Appendix D provides detail on how each variable is constructed.

Our final regression sample consists of 48% females. Individuals' ages range from 50 to almost 96 years of age, with an average of 62. 87% of the sample were married at the time of the survey. On average, individuals have three children. Education levels are low in our sample. A third have not completed primary school, and only 6% have completed high school. There is considerable variation in weather across villages, and about half of villages have access to a hospital.

5 Results

To determine the effect of labor migration on the health and well-being of the rural elderly population, we estimate several versions of equation (2). We begin with OLS in Section 5.1. Though OLS does not provide a causal interpretation, it allows us to gain some intuition for the ways in which migration and health my be correlated due to unobserved heterogeneity. In Section 5.2, we address endogeneity concerns and estimate equation (2) via 2SLS, where our first stage is given by equation (3). We interpret these results as providing a causal effect of migration on health. To better ensure that our results are not driven by spurious correlation, we augment equations (2) and

(3) to include additional individual- and village-level covariates. In Section 5.3, we investigate the sensitivity of our results to the manner in which we construct key variables. We also estimate a reduced form to capture any anticipatory effects of migration. In Section 5.4, we estimate models separately for sub-populations to explore potential heterogeneous effects of migration on health by age and gender.

At each stage in Sections 5.1 - 5.4, we estimate separate regressions for each of the thirteen health measures described in Section 4. To better ensure comparability across health measures, we base regressions on a common sample that includes only individuals with non-missing values for all thirteen health measures. To aid interpretation, we use the negative of systolic and diastolic blood pressure and pulse so that, for all thirteen measures of health, a larger value is associated with better health.[11] We also normalize each measure of health to be mean 0 with standard deviation 1. We cluster standard errors at the community-level to allow for arbitrary correlation among individuals living within the same community.

In Section 5.5, we explore potential channels through which migration may affect health. We do this by replacing the dependent variable in equation (2) with a series of variables that aim to capture changes in wealth, nutrition, assistance, and time use.

In all regressions discussed in Section 5, the interpretation of the coefficient on migration, β_1 in equation (2), is the effect of going from 0% to 100% village-level labor migration. When discussing magnitudes below, we typically rescale estimates in terms of a one standard deviation change in the migration rate, which is approximately a 19 percentage point change (See Table 2).

5.1 Ordinary Least Squares

The first three columns of Panel A of Table 3 report OLS estimates of the effect of migration on health (β_1 in equation (2)). Each estimate corresponds to a separate regression. We vary the measure of health (the dependent variable) along the rows, and we vary the measure of migration along the columns. Panel C reports the regression specification and sample details.

In the first column, we use the migration rate of one's own children. Most of the estimated coefficients are positive and statistically significant, suggesting that, at the individual level, migration and parents' health are positively correlated. These results are consistent with genetic traits playing a role. They are also consistent with a story of reverse causality where children choose to remain in rural villages to care for ill and frail parents. In the second column, we use village-level migration rates that are constructed using only information from those included in the regression sample. Most estimates change signs and several are negative and statistically significant. The key distinction between the results in the first and second column is that most of the idiosyncratic variation in migration rates has been removed, suggesting that, at the village level, migration and health are

[11] Although the relationship between BMI and health is non-linear, approximately 75% of the elderly in our regression sample are classified as underweight or normal, and only 4% are classified as obese, so we think it is reasonable to interpret larger values as indicative of better health for this group.

Table 3: OLS and 2SLS Estimates of the Effect of Migration on Health

	OLS			2SLS			
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A: Second Stage Estimates						
Self-reported health	0.021	−0.110	−0.158	−0.466	−0.462	−0.442	−0.452
	(0.037)	(0.098)	(0.104)	(0.415)	(0.428)	(0.431)	(0.443)
ADL ability	0.099**	−0.057	−0.140	−1.867***	−1.866***	−1.877***	−1.890***
	(0.038)	(0.112)	(0.108)	(0.489)	(0.483)	(0.503)	(0.492)
IADL ability	0.152***	−0.082	−0.205*	−0.912*	−0.891*	−0.902*	−0.904*
	(0.039)	(0.120)	(0.120)	(0.504)	(0.514)	(0.516)	(0.521)
Systolic blood pressure	0.273***	0.440***	0.342***	−0.535	−0.563	−0.589	−0.639
	(0.038)	(0.114)	(0.122)	(0.412)	(0.407)	(0.423)	(0.415)
Diastolic blood pressure	0.068*	0.381***	0.385***	−0.519	−0.536	−0.545	−0.558
	(0.037)	(0.121)	(0.124)	(0.474)	(0.472)	(0.486)	(0.482)
Pulse	0.089**	0.187*	0.189*	0.319	0.366	0.356	0.333
	(0.036)	(0.109)	(0.111)	(0.464)	(0.485)	(0.489)	(0.490)
Lung function	0.296***	0.044	−0.105	−2.117***	−2.114***	−1.993**	−2.023***
	(0.044)	(0.164)	(0.169)	(0.727)	(0.642)	(0.776)	(0.691)
Grip strength	0.218***	−0.101	−0.097	0.123	0.077	0.166	0.091
	(0.034)	(0.139)	(0.146)	(0.569)	(0.532)	(0.574)	(0.535)
BMI	0.032	−0.429***	−0.461***	−0.190	−0.084	0.125	0.144
	(0.038)	(0.099)	(0.107)	(0.445)	(0.447)	(0.437)	(0.440)
Mental health	0.038	−0.300**	−0.376***	−1.086*	−1.059*	−0.958	−0.954
	(0.041)	(0.132)	(0.134)	(0.575)	(0.579)	(0.584)	(0.588)
Life satisfaction	−0.059*	−0.170*	−0.270**	−0.420	−0.399	−0.538	−0.512
	(0.036)	(0.100)	(0.105)	(0.586)	(0.585)	(0.564)	(0.566)
Memory	0.189***	−0.206	−0.358***	−0.255	−0.106	−0.247	−0.162
	(0.038)	(0.138)	(0.136)	(0.484)	(0.448)	(0.482)	(0.452)
Cognitive ability	0.180***	−0.484***	−0.521***	−0.182	0.006	−0.076	0.034
	(0.040)	(0.121)	(0.124)	(0.514)	(0.480)	(0.519)	(0.484)
	Panel B: First Stage Estimates						
Migration				4.996***	4.984***	4.907***	4.904***
				(0.739)	(0.732)	(0.771)	(0.765)
Kleibergen-Paap F-statistic				45.66	46.35	40.45	41.09
	Panel C: Specifcation and Sample Details						
Province fixed effects	✓	✓	✓	✓	✓	✓	✓
SDY indicators	✓	✓	✓	✓	✓	✓	✓
Individual covariates					✓		✓
Community covariates						✓	✓
Migration measure	Alt 1	Alt 2	Main	Main	Main	Main	Main
Number of clusters	279	279	279	279	279	275	275
Number of observations	6,274	6,274	6,274	6,274	6,274	6,160	6,160

Notes: Panel A presents OLS and 2SLS estimates of the effect of migration on health (β_1 in equation (2)). Each estimate in Panel A corresponds to a separate regression in which the measure of health (the dependent variable) varies. Standard errors are clustered at the community level and shown in parentheses below point estimates. Panel B presents estimates of the effect of our instrument on migration (α_1 in equation (3)). Because we use a common sample across all measures of health, all 2SLS regressions in each column share the same first-stage regression and the same number of observations. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

largely negatively correlated. These results are consistent with a world in which negative spatial shocks, such air pollution and poor infrastructure, simultaneously induce working aged individuals to migrate in search of better opportunities and deteriorate the health of those that remain behind. In the third column, we use village-level migration rates that are constructed using information from all individuals included in the survey. This is the measure that we use in subsequent 2SLS analyses. Compared with Column 2, estimates generally become larger in magnitude and more statistically significant, which is consistent with measurement error attenuating the estimates in Column 2 and supports our use of this measure in subsequent analyses.

5.2 Two-Stage Least Squares

The last four columns of Table 3 report 2SLS results. Panel B presents first stage estimates of the effect of our instrument on migration rates (α_1 in equation (3)). Complete regression results are shown in Appendix F. Column 4 reports estimates from our primary specification. Columns 5, 6, and 7 report estimates from specifications that include additional individual- and community-level covariates, which are described in Section 4.4. The estimates suggest that a one percentage point increase in growth in the sending province produces around a five percentage point increase in the village-level migration rate. This result is largely insensitive to the inclusion of additional covariates and is highly statistically significant, with a Kleibergen-Paap F-statistic above 40 in all specifications.

Panel A presents second-stage estimates of the effect of instrumented migration on health (β_1 equation in (2)). In our primary specification (Column 4), estimates of the effect of migration are negative for eleven of thirteen measures of health and are statistically significant at conventional levels for four measures. More specifically, a one standard deviation (or 19 percentage point) increase in the migration rate leads to a 0.35 standard deviation decrease in ADL ability, a 0.17 standard deviation decrease in IADL ability, a 0.40 standard deviation decrease in lung function, and a 0.21 standard deviation decrease in mental health.[12] The addition of covariates slightly decreases sample sizes and slightly increases standard errors. However, the general pattern of results and statistical significance remains largely unchanged. A notable difference is that the estimated effect of migration on mental health becomes noisier when community covariates are added.

Overall, 2SLS results suggest that the migration of adult children negatively affects several dimensions of physical and mental health of the elderly that remain behind.

5.3 Robustness Exercises

To investigate whether our results are sensitive to the way in which we construct key variables, we consider alternative methods of constructing sent-down youth flows (SDY in (1), (2), and (3)) and

[12] Estimates in Table 3 reflect the effect of going from 0% to 100% village-level labor migration. To aid interpretation in our discussion, we rescale estimates in terms of a one standard deviation change in the migration rate, which is approximately a 19 percentage point change. So, for example, a 19 percentage point increase in the migration rate leads to a $1.867 * 0.19 = 0.35$ standard deviation decrease in ADL ability.

village-level migration rates (M in (2) and (3)).

In our main specification, we convert the number of sent-down youth reported by the CHARLS community respondents into a binary measure for two reasons. First, poor recall may introduce measurement error. Second, the functional form of the relationship between historical sent-down youth numbers and present-day migration networks is unclear. For example, it is not clear whether sent-down youth numbers should be adjusted by village population, and it is not clear whether adjustments should be made with historic (unobserved) or current population numbers. Further, some villages have split, and others have combined over time, further complicating the relationship between historic sent-down youth numbers and current population.

Nevertheless, we consider several alternative measures of sent-down youth flows that make use of the variation in the number received by each village. We use the same empirical specification given by equations (1), (2), and (3). However, we vary our construction of the variable SDY in the following ways. First, we take the natural logarithm of the number of sent-down youth received. Second, we construct a per capita measure by dividing the number of sent-down youth received by the 2011 village-level population, as reported by the community respondent in CHARLS. This is the only population measure that we have, and it is not clear how well it correlates with historical levels. Third, we use the unadjusted number of sent-down youth received, which we refer to below as "levels".

Results based on these alternative measures of sent-down youth are shown in Table H.1 in Appendix H. Results based on the log of sent-down youth are rather similar to our main results. The first-stage F-statistic remains reasonably large at 31. The second-stage estimates of the effect of migration are negative for ten of thirteen measures of health, and these estimates are statistically significant at conventional levels for the same four measures as before and also for self-reported health. Results based on per capita and level measures, on the other hand, are much weaker. First-stage F-statistics fall to 3 and 4, suggesting that the variation in these measures is not particularly useful for predicting present-day migration. When using levels, second-stage estimates of the effect of migration are negative and statistically significant for ADL ability and mental health, only. When using the per capita measure, second stage estimates are statistically insignificant for all measures.

In our main specification, we base our calculation of village-level migration rates on the children of respondents that are between the ages of 18 and 40, and we count those enrolled in school – either locally or distantly – as non-migrants. The reason for these choices is that we exploit labor demand shocks in manufacturing and construction to identify exogenous variation in migration rates, and preliminary analyses and other statistics suggested that children in this age range and children not in school are far more responsive to these shocks than their counterparts. Nevertheless, we do observe migrants that are below the age of 18, above the age of 40, and classified as in school, and these individuals may be at least partially influenced by labor demand shocks.

In Appendix B, we detail five alternative construction methods that vary our treatment of age and school enrollment status. In each case, we think it's likely that we are adding individuals that are less responsive to labor demand shocks, so we anticipate that first stage estimates of α_1 will be smaller and second stage estimates of β_1 will be larger. For this reason, we think of our main method as providing conservative estimates of the effect of migration on health.

Results based on these alternative measures are shown in Table H.2 of Appendix H. First stage estimates of α_1 are smaller $(4.0-4.6)$ as are first-stage F-statistics $(23-34)$. Second-stage estimates of β_1 are qualitatively very similar to our main results in that coefficient signs and statistical significance are virtually identical. However, coefficient magnitudes grow by $8-24\%$ depending on the specification.

For transparency, we also estimate reduced-form versions of (3), in which M is replaced with IV for each measure of health. Results are shown in Appendix G. The signs and levels of statistical significance of the reduced form estimates are very similar to the comparable 2SLS estimates in Table 3.

5.4 Heterogeneity

To explore whether the effects of migration differ by age and by gender, we estimate equations (2) and (3) separately for those aged 50-60 and those aged 60+ and separately for females and males. Estimates of β_1 are shown in Columns 2, 3, 5, and 6 of Table 4. For parsimony, we only show results based on our primary specification, which corresponds to that shown in Column 4 of Table 3. For ease of comparison, these results are replicated in Column 1 of Table 4. As in Table 3, each estimate corresponds to a separate regression, and we vary the measure of health (the dependent variable) along the rows. For each measure of health, we test whether the coefficient estimates for younger and older populations are statistically different from one another and whether coefficient estimates for females and males are statistically different from one another. The differences in coefficient estimates are shown in Columns 4 and 7, with standard errors below each difference in parentheses. Negative values in Column 4 indicate more negative (or less positive) effects of migration on health for older individuals. Similarly, negative values in Column 7 indicate more negative (or less positive) effects of migration on health for males.

Overall, Table 4 suggests a general pattern of deteriorating health for all subpopulations. As in the full sample, most of the coefficients are negative, and several are also statistically significant for all subpopulations. The one exception is the positive and statistically significant effect of migration on the pulse for younger individuals.

Examining the differences across subpopulations, we find that the negative health effects associated with migration are more concentrated among physical measures for older individuals and among emotional and cognitive measures for younger individuals. This is demonstrated by the predominantly negative differences in physical health measures in Column 4, with several being statistically significant, and the exclusively positive differences in emotional and cognitive measures in Column

4, two of which are statistically significant. Differences between females and males are less distinct, though the estimates suggest that females may be more likely to suffer when it comes to self-reported measures of physical health and ability.

Table 4: Effects of Migration on Health by Age and Gender

		By Age			By Gender		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	All	Younger	Older	Difference	Female	Male	Difference
Self-reported health	−0.466	−0.409	−0.480	−0.071	−0.964**	−0.052	0.912
	(0.415)	(0.510)	(0.473)	(0.490)	(0.413)	(0.583)	(0.564)
ADL ability	−1.867***	−0.677	−3.043***	−2.365**	−2.221***	−1.621***	0.601
	(0.489)	(0.464)	(0.904)	(1.022)	(0.689)	(0.556)	(0.746)
IADL ability	−0.912*	−0.623	−1.138*	−0.515	−1.640**	−0.352	1.288**
	(0.504)	(0.520)	(0.632)	(0.574)	(0.688)	(0.507)	(0.595)
Systolic blood pressure	−0.535	−0.462	−0.633	−0.171	−0.299	−0.791	−0.491
	(0.412)	(0.663)	(0.503)	(0.846)	(0.462)	(0.627)	(0.758)
Diastolic blood pressure	−0.519	−0.429	−0.672	−0.243	−0.186	−0.863	−0.677
	(0.474)	(0.721)	(0.502)	(0.750)	(0.529)	(0.666)	(0.747)
Pulse	0.319	0.941**	−0.195	−1.136*	0.287	0.337	0.050
	(0.464)	(0.371)	(0.724)	(0.663)	(0.662)	(0.370)	(0.499)
Lung function	−2.117***	−1.929**	−2.291***	−0.363	−1.894***	−2.400***	−0.506
	(0.727)	(0.899)	(0.637)	(0.580)	(0.602)	(0.828)	(0.479)
Grip strength	0.123	0.870	−0.449	−1.319**	0.203	−0.061	−0.264
	(0.569)	(0.649)	(0.617)	(0.600)	(0.526)	(0.614)	(0.426)
BMI	−0.190	−0.400	0.065	0.465	−0.114	−0.232	−0.118
	(0.445)	(0.483)	(0.601)	(0.587)	(0.505)	(0.612)	(0.694)
Mental health	−1.086*	−1.404**	−0.770	0.634	−1.040*	−1.186*	−0.147
	(0.575)	(0.642)	(0.599)	(0.479)	(0.569)	(0.713)	(0.613)
Life satisfaction	−0.420	−0.456	−0.378	0.078	−0.429	−0.414	0.015
	(0.586)	(0.588)	(0.706)	(0.505)	(0.664)	(0.616)	(0.480)
Memory	−0.255	−1.195**	0.714	1.909**	0.049	−0.509	−0.558
	(0.484)	(0.561)	(0.669)	(0.773)	(0.685)	(0.540)	(0.752)
Cognitive ability	−0.182	−0.811	0.526	1.337**	0.244	−0.656	−0.900
	(0.514)	(0.529)	(0.670)	(0.622)	(0.702)	(0.498)	(0.654)
K-P F-statistic	45.66	45.77	36.64		45.47	44.30	
Number of clusters	279	275	278		277	276	
Number of observations	6,274	2,970	3,304		3,031	3,243	

Notes: See Table 3. Coefficients are 2SLS estimates of the effect of migration on health (β_1 in equation (2)). All regressions include SDY indicator variables and province fixed effects. Columns 4 and 7 show differences in point estimates between younger and older individuals and between females and males, with standard errors shown in parentheses below each difference.

5.5 Channels

In Section 2, we discussed a number of potential channels through which labor migration might affect the health of the elderly remaining in villages. Here, we provide some evidence on these channels. Determining the effect of intermediate variables on health is challenging for the same reasons that make determining the effect of migration on health challenging. While we argue that our instrumental variables strategy can overcome these challenges, we do not have secondary instruments that allow us to separately identify the effect of intermediate variables. Instead, we provide suggestive evidence by replacing our measure of health, H, in (2) with a series of channel variables and performing otherwise similar two-stage least squares regressions. Conditional on the same identifying assumptions discussed in Section 3, we can interpret β_1 in (2) as the causal effect of migration on the channel variable of interest. However, we cannot determine whether the channel variable, in turn, affects health nor whether, conversely, health affects the channel variable. Nevertheless, we find these exercises informative.

Tables 5 – 9 present the results. Each row of results corresponds to a separate regression in which the channel (dependent variable) varies. Details on how each channel variable is constructed are provided in Appendix E. For each channel variable, we provide the point estimate of the effect of migration and the associated standard error, the number of observations in the regression sample, the first stage F-statistic, and the sample mean. The number of observations and the first stage F-statistic vary across regressions because we do not restrict the sample to include only the set of individuals with non-missing responses for all channel variables.

We present results for the full sample and for subpopulations. For channel variables that are recorded at the individual level, we perform heterogeneity analyses by age and by gender. For channel variables that are recorded at the household level, we are precluded from performing heterogeneity analyses by gender because there is essentially no variation in households' gender composition. To perform heterogeneity analyses by age, we classify households as "younger" or "older" households depending on whether the average age of the main respondent and their spouse (if alive) is below or above 60 years of age. For channel variables that are recorded at the household-level, we keep one observation per household.

Table 5 reports on remittances received from non-cohabitating children in the last year, both monetary and in kind. Though the effect of migration on both the probability of receiving remittances and the value of remittances received is imprecisely estimated, the estimates do not provide evidence of a positive wealth channel in operation. Since an increase in wealth is perhaps the most plausible channel through which migration might improve the well-being of the elderly, these non-positive results may provide a key explanation for our findings on health.

Table 6 reports on annual per capita household expenditures on food, utilities, medical needs, and communication. While estimates on food expenditures are quite noisy, estimates on utilities, medical needs, and communication for the full sample are negative, statistically significant, and economically meaningful. A one standard deviation increase in the migration rate leads to 73, 307, and 60 yuan decreases in annual expenditures on utilities, medical needs, and communication, which are roughly 30%, 31%, and 23% of the annual averages.[13] Decreases in expenditures on medical needs and

[13]For comparison, according to the National Bureau of Statistics of China, per capita income from wages of rural residents was 2,963 yuan in 2011. See `http://www.stats.gov.cn/english/NewsEvents/201201/t20120130_26566.html`.

Table 5: Remittances Received From Non-cohabitating Children

		By Age		
	(1)	(2)	(3)	(4)
Dependent variable	Full Sample	Younger	Older	Difference
Received remittances last year				
Coef.	0.08	-0.21	0.35	0.56
Std. Err.	(0.21)	(0.33)	(0.33)	(0.47)
Obs.	3,658	1,590	2,068	
F-stat.	43.68	46.38	32.30	
Mean	0.52	0.43	0.60	
Total yuan received last year				
Coef.	$-3,583.15$	$-1,953.58$	$-4,175.68$	$-2,222.10$
Std. Err.	(2,279.72)	(2,210.87)	(3,375.75)	(3,339.14)
Obs.	3,631	1,578	2,053	
F-stat.	43.76	46.86	32.41	
Mean	1,866.60	1,719.30	1,981.48	

Notes: Coefficients are 2SLS estimates of β_1 in equation (2), where the dependent variable, H, is replaced with a channel variable. Each row of results corresponds to a separate regression in which the channel varies. Conventional IV-standard errors are clustered at the community level and are shown in parentheses below point estimates. The number of observations in the sample, the first-stage Kleibergen-Paap F-statistic, and the mean of the dependent variable are shown below standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

communication are not statistically distinguishable for younger and older households. However, the drop in expenditures on utilities is much larger for younger households.

Table 7 reports on average daily meal consumption. While the effect of migration on meal consumption is not statistically significant for the full sample, there is stark heterogeneity by both age and gender. A one standard deviation increase in the migration rate reduces average meal consumption by roughly 3% for both younger individuals and males. Meanwhile, point estimates are extremely small for older individuals and females.

Table 8 reports on assistance received in the past month with ADLs and IADLs. The first measure equals 1 if the individual reports that they needed assistance, but did not receive it. The second measure equals 1 if the individual reports that they needed assistance and received it. The sum of these two measures captures the overall need for assistance. Focusing on the sum first, migration increases the need for assistance for the full sample and for each age and gender subsample. Separating need by whether it is met reveals considerable heterogeneity by age and gender. Older individuals and females see larger increases in overall need, and nearly all of the increase in need is met. For younger individuals and males, however, a considerable portion of the increase in need is unmet.

When individuals are asked about their ADL and IADL needs, they also report who most often helps with these activities. The most common responses are a spouse, a child, a child's spouse, or a grandchild. The increase in need that is met is almost entirely driven by help from a spouse, which suggests that elderly individuals provide more assistance to other elderly individuals as a consequence of migration (results are shown in Appendix I). Hours of assistance decrease for all

Table 6: Annual Per Capita Household Expenditures (yuan)

		By Age		
	(1)	(2)	(3)	(4)
Dependent variable	Full Sample	Younger	Older	Difference
Food				
Coef.	−396.18	−739.30	411.53	1,150.83
Std. Err.	(1,439.75)	(1,564.67)	(1,844.37)	(1,881.75)
Obs.	4,092	1,942	2,150	
F-stat.	49.25	53.69	36.02	
Mean	2,610.40	2,684.90	2,542.84	
Utilities				
Coef.	−383.00***	−559.51***	−159.32	400.19**
Std. Err.	(137.77)	(204.54)	(99.80)	(189.11)
Obs.	4,179	1,991	2,188	
F-stat.	45.76	45.80	33.87	
Mean	246.65	275.10	220.68	
Medical				
Coef.	−1,616.43*	−1,516.26	−1,474.39	41.87
Std. Err.	(886.58)	(1,098.50)	(1,050.18)	(1,166.65)
Obs.	4,101	1,944	2,157	
F-stat.	47.86	49.97	34.69	
Mean	984.14	956.59	1,009.13	
Communication				
Coef.	−313.22***	−248.28*	−385.40***	−137.12
Std. Err.	(115.83)	(142.73)	(117.75)	(136.72)
Obs.	4,151	1,977	2,174	
F-stat.	45.29	46.59	32.85	
Mean	255.61	314.00	202.35	

Notes: See Table 5.

Table 7: Daily Meals

		By Age			By Gender		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Full Sample	Younger	Older	Difference	Female	Male	Difference
Average number of meals per day							
Coef.	−0.23	−0.44*	0.03	0.47**	0.01	−0.46**	−0.48***
Std. Err.	(0.16)	(0.23)	(0.15)	(0.21)	(0.16)	(0.20)	(0.18)
Obs.	6,270	2,969	3,301		3,030	3,240	
F-stat.	45.57	45.74	36.54		45.45	44.16	
Mean	2.88	2.91	2.86		2.87	2.89	

Notes: See Table 5.

groups, but is only statistically significant for females, for whom the drop in hours is rather large. Estimates suggest that a one standard deviation increase in the migration rate reduces hours of assistance received in the last month by 17 hours for females, which is more than 100% of the sample mean.

Table 9 reports on social engagements and time use. The first two rows concern contact with

Table 8: Assistance with ADLs and IADLs

		By Age			By Gender		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Full Sample	Younger	Older	Difference	Female	Male	Difference
Needed assistance last month but did not receive it							
Coef.	0.10	0.20**	−0.00	−0.20**	0.08	0.13**	0.05
Std. Err.	(0.07)	(0.10)	(0.07)	(0.10)	(0.13)	(0.05)	(0.13)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.03	0.02	0.04		0.04	0.02	
Needed assistance last month and received it							
Coef.	0.36**	0.21	0.52*	0.31	0.46**	0.27	−0.20
Std. Err.	(0.17)	(0.13)	(0.30)	(0.31)	(0.22)	(0.24)	(0.30)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.13	0.09	0.16		0.15	0.11	
Hours of assistance received last month							
Coef.	−60.54	−50.23	−68.79	−18.56	−89.78*	−38.00	51.77
Std. Err.	(37.45)	(36.43)	(53.40)	(59.25)	(50.42)	(37.09)	(43.25)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	12.49	8.05	16.48		12.85	12.16	

Notes: See Table 5.

non-cohabitating children.[14] This information is reported at the household level, so heterogeneity analyses are only performed by age. In-person contact with children decreases for both younger and older households, which may be a mechanical result of migration. The estimate for the full sample suggests that a one standard deviation increase in the migration rate leads to about 28 fewer instances of in-person contact over a year, which is almost half the annual average. Remote contact – which includes phone, text, mail, and email contact – with children also decreases, though the effect is driven entirely by older households. A one standard deviation increase in the migration rate leads to about 39 fewer instances of remote contact, which is almost 100% of the sample mean.

The third row of Table 9 reports on social interactions in the past month. Estimates are quite similar across all subpopulations and are statistically significant in all cases. A one standard deviation increase in the migration rate leads to almost two fewer social interactions per month, which is a 30-40% decrease relative to sample means.

The fourth and fifth rows of Table 9 report on farm work. Older individuals and men are more likely to work for themselves and to work more hours. A one standard deviation increase in the migration rate leads to an increase of 68 hours per year (38% relative to the average) for older individuals and an increase of 84 hours per year (39% relative to the average) for males.

[14] Respondents are asked to report how often they see and how often they have phone, text, mail, or email contact with each non-cohabitating child, with responses ranging from "almost every day" to "once a year" and "almost never". We convert responses to annual frequencies and average across all non-cohabitating children, separately for "in person" and "remote" contact.

Table 9: Social Engagements and Time Use

		By Age			By Gender		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Full Sample	Younger	Older	Difference	Female	Male	Difference
Average instances of in-person contact with non-cohabitating children last year							
Coef.	−146.65***	−166.76***	−120.59***	46.18			
Std. Err.	(24.77)	(37.68)	(30.51)	(46.85)			
Obs.	3,669	1,593	2,076				
F-stat.	43.86	46.85	32.42				
Mean	59.63	51.36	66.06				
Average instances of remote contact with non-cohabitating children last year							
Coef.	−109.17***	−23.08	−186.13***	−163.05**			
Std. Err.	(25.48)	(44.04)	(42.23)	(65.63)			
Obs.	3,666	1,592	2,074				
F-stat.	43.63	46.63	32.17				
Mean	50.25	62.17	40.99				
Number of social interactions last month							
Coef.	−9.90***	−8.22**	−11.19***	−2.96	−10.04**	−10.01***	0.02
Std. Err.	(3.38)	(3.99)	(4.09)	(4.20)	(4.50)	(3.72)	(4.69)
Obs.	6,274	2,970	3,304		3,031	3,243	
F-stat.	45.66	45.77	36.64		45.47	44.30	
Mean	5.19	4.97	5.38		5.57	4.83	
Engaged in 10 or more days of farm work for self last year							
Coef.	0.33*	0.22	0.43*	0.21	0.06	0.57***	0.51*
Std. Err.	(0.20)	(0.23)	(0.22)	(0.26)	(0.28)	(0.19)	(0.26)
Obs.	6,241	2,957	3,284		3,012	3,229	
F-stat.	45.61	44.71	37.49		46.40	43.51	
Mean	0.63	0.70	0.57		0.59	0.67	
Total hours of farm work for self last year							
Coef.	336.74*	286.37	356.84**	70.47	230.22	440.89**	210.67**
Std. Err.	(180.94)	(258.31)	(139.66)	(211.69)	(207.73)	(174.75)	(102.79)
Obs.	6,163	2,920	3,243		2,973	3,190	
F-stat.	47.12	46.45	38.58		48.46	44.81	
Mean	200.82	227.92	176.42		184.05	216.45	
Average minutes of nightly sleep							
Coef.	−34.92	−36.87	−35.09	1.78	−37.50	−35.50	2.00
Std. Err.	(40.58)	(61.87)	(46.42)	(73.18)	(63.23)	(42.17)	(66.45)
Obs.	6,241	2,961	3,280		3,007	3,234	
F-stat.	46.11	47.01	36.71		46.72	44.27	
Mean	375.68	383.12	368.96		367.68	383.11	
Average minutes of daily nap							
Coef.	−25.31	−39.39*	−11.08	28.31	−10.10	−40.69	−30.59
Std. Err.	(23.58)	(22.99)	(32.65)	(29.26)	(20.00)	(31.25)	(27.11)
Obs.	6,265	2,968	3,297		3,025	3,240	
F-stat.	45.59	45.77	36.57		45.47	44.19	
Mean	33.32	30.95	35.44		26.89	39.31	

Notes: See Table 5.

The final two rows of Table 9 report on daily sleep. Although all coefficients are negative, standard errors are quite large. For younger individuals, only, do we see a statistically significant decrease in sleep through naps, though the magnitude is rather small. A one standard deviation increase in the migration rate leads to a 7.5 minute decrease in nap time for younger individuals.

Overall, the results on potential channels are consistent with our main finding that labor migration leads to poorer health of elderly individuals that remain behind. We find no evidence of positive wealth channels in operation while we do find evidence of negative wealth, time use, assistance, and mental health channels in operation.

6 Discussion and Conclusion

We exploit China's historic "sent-down youth" program, which involved the relocation of young urban residents to rural areas and resulted in lasting ties between rural villages and urban cities, to identify exogenous variation in present-day rural-urban migration rates and study the causal effect of labor migration on the health of the left-behind older rural population. The richness of the nationally-representative CHARLS data allows us to study a number of aspects of health and wellbeing, including physical, emotional, and cognitive health.

Our two-stage least squares results suggest that the migration of working-age adults negatively affects several dimensions of physical and mental health of older adults that remain behind. We find this general pattern of deteriorating health for both younger and older and male and female individuals. However, the negative health effects of migration are more concentrated among physical measures of health for older individuals and among emotional and cognitive measures for younger individuals. Though differences between females and males are less distinct, the negative health effects of migration are more pronounced among self-reported measures of physical health for females.

To explore the potential channels through which migration may affect health, we perform a series of two-stage least squares regressions in which we replace our measure of health with a number of channel variables. The results are consistent with our main findings on health. We find no evidence of positive wealth channels in operation: remittances do not increase. On the other hand, we do find evidence of negative wealth, assistance, time use, and mental health channels in operation: household expenditures decrease, the need for physical assistance increases, in-person and remote contact with children and social interactions decrease, and farm work increases.

The studies most similar to ours methodologically are Kinnan et al. (2018) and Böhme et al. (2015). However, in contrast to our findings, both papers find positive effects of labor migration. Kinnan et al. (2018) also exploit China's historic sent-down youth program to identify exogenous variation in present-day access to rural-urban migration and find that, on net, increased access and returns to rural-urban labor migration are beneficial for rural households. There are, however, two key differences in our studies. Foremost, we study outcomes for older individuals, while Kinnan et al. (2018) study outcomes for household members who are, on average, much younger than the individuals in our sample and include spouses and children who benefit from migration differently than aging parents. Second, we exploit village-level variation in sent-down youth, while Kinnan et al. (2018) exploit province-level variation to identify exogenous variation in migration rates. Thus, the interpretation of our coefficient of interest is the effect of village-level migration, holding constant the migration rates of other villages within the same province, while the interpretation in Kinnan et al. (2018) is the effect of province-level migration. Any positive spillover effects of migration could account for some of the difference in our findings.

Böhme et al. (2015) use an instrumental variables strategy similar to ours to study the effects of international labor migration on the health of older adults that remain behind in Moldova and find a positive effect of migration on health. Importantly, Böhme et al. (2015) also find evidence of positive channels, namely wealth, in effect. It is possible that international labor migration is more lucrative than internal migration or that Moldovian migrants share a larger part of their income with their parents. Baseler (2023) studies whether migrants attempt to hide or under-report incomes from their parents as a way to reduce remittances and finds that parents that remain in rural Kenyan villages under-estimate their migrant children's incomes by 45% on average. Such behavior may be prevalent in our setting.

Our OLS results suggest that there may be positive selection in migration at the individual level and negative selection at the village level. This finding may help explain why studies that use varying methods – particularly those that assume selection on observables or use propensity-score matching, but also those that use questionable instrumental variables – find varying results. Similarly, Gibson et al. (2011) find strong evidence of positive selection among households that migrate from Tonga to New Zealand, suggesting that non-experimental estimates of the effect of migration may overstate the benefits to those that remain behind.

There is growing evidence that the urban-rural wage gap cannot be due solely to sorting of individuals by ability (Lagakos, 2020). Between 2000 and 2015, China's aggregate income increased dramatically while provincial income inequality and the share of employment in agriculture decreased dramatically, and internal rural-urban migration is central to explaining this transformation (Hao et al., 2020). These aggregate facts, coupled with the results in Kinnan et al. (2018) demonstrate that there are likely large gains from reducing the barriers to internal migration. Nevertheless, our study highlights potential drawbacks. And given the growing size of aging populations in China and other developing countries, these drawbacks may be quite large.

One solution to address the negative health effects that we document could be to expand access to health care and health insurance in rural communities. However, China has already experienced unprecedented progress in this direction during the years leading up to our sample period. Following a long period in which health insurance for rural households was almost non-existent, in 2003, the Chinese government initiated the New Cooperative Medical Scheme (NCMS), which provides comprehensive coverage of hospital expenditures for rural households. By 2010, 88% of China's rural population was enrolled in the program, more than 800 million people, making it the largest health insurance program in the world (Gruber et al., 2023). Gruber et al. (2023) estimate that the program has had sizable benefits: aggregate mortality significantly declined, and the reduction was even larger for older individuals. It is quite possible that the negative effects of migration that we find would have been much larger in the absence of the NCMS. Whether additional coverage or higher benefits could further mitigate the negative effects of migration in China is an open question.

Another possible solution is to expand pension and cash transfer programs. A growing body of evidence suggests that alleviating financial hardship improves mental health (Banerjee et al., 2023). In China, specifically, Chen et al. (2019) exploit exogenous geographic variation in access to China's recently established New Rural Pension Scheme and find that enrollment reduces depressive symptoms. A key finding in Banerjee et al. (2023) is that mental and physical health are positively correlated and likely affect one another, which suggests that improving mental health may in turn improve physical health. Expanding pension and cash transfer programs may also directly improve physical health if it allows older adults to cover co-payments for health services that they could not otherwise afford.

Finally, given the existing evidence on the benefits of migration to migrants (Lagakos et al., 2020), another possible solution is to relax the constraints that hinder migrants from bringing their aging parents along with them. Gibson et al. (2011) draw a similar conclusion. A key constraint is China's *hukou* or household registration system, which (similar to a 'local passport') determines where Chinese citizens can receive public benefits and services such as healthcare and pensions, with large disparities between urban and rural areas. *Hukou* status is inherited from one's parents and, until recently, it was nearly impossible to convert a rural *hukou* to an urban *hukou*. Since the 1990s, a number of *hukou* reforms were implemented to gradually allow rural-urban migration. However, these reforms enabled rural workers, and not their dependents, to migrate. In 2018, further reforms allowed children with rural *hukou* status to migrate to urban areas to attend urban schools. Reforms that allow migrants to take aging parents with them may alleviate some of the negative effects of migration that we find.

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Appendix A: Measures of Health

Self-Reported Health: Survey respondents are asked to rate their general health at the beginning of the health status sub-section of the "health status and function" section and again at the end of the health status sub-section after having answered a number of detailed health-related questions. See questions DA001, DA002, DA079, and DA080. Two scales are used to measure self-reported health: scale A includes "excellent", "very good", "good", "fair", and "poor" as possible answers, and scale B includes "very good", "good", "fair", "poor", and "very poor" as possible answers. The first time they are asked, respondents are randomly assigned either scale A or scale B. Those assigned scale A the first time they are asked are assigned scale B the second time they are asked. Approximately 56% of those assigned scale B the first time they are asked are again assigned scale B, with the remainder assigned scale A the second time they are asked.

Figure A.1 illustrates the distribution of responses to each question on self-reported health. It is clear that individuals are more responsive to descriptions of health status as opposed to the rank of health status within a given scale. For example, approximately 46% of respondents report "fair" health the first time they are asked, regardless of whether "fair" is the third (DA002) or fourth (DA001) option provided by the surveyor. For this reason, we classify individuals' health status based on descriptions and not rank.

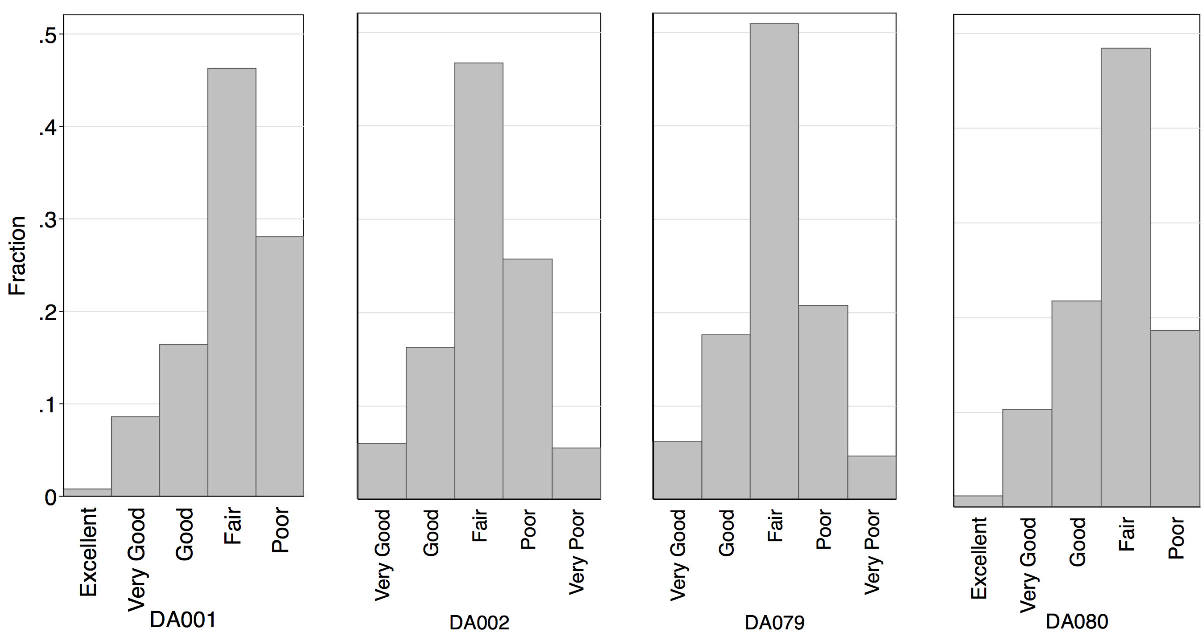

Figure A.1: Distributions of Self-Report Health Status

Notes: Items DA001 and DA002 record individuals' self-reported health the first time they are asked, and items DA079 an DA080 record individuals' self-reported health the second time they are asked.

Because the descriptions of health vary across scales A and B, we combine responses "excellent" and "very good" into one category, and we combine responses "poor" and "very poor" into another category, so that, for each scale, there are four possible responses. Using second responses only, we create an index that equals 1 if the individual reports "poor" or "very poor" health, 2 if the individual reports "fair" health, 3 if the individual reports "good" health, or 4 if the individual reports "excellent" or "very good" health.

Activities of Daily Living: Individuals are asked six questions regarding their ability to perform basic daily activities, including dressing, bathing and showering, eating, getting into and out of bed, using the toilet, and controlling urination and defecation. See questions DB010–DB015. Responses to these questions include "No, I don't have any difficulty", "I have difficulty but can still do it", "Yes, I have difficulty and need help", and "I cannot do it." We combine responses to these six questions to create a composite measure that captures the number of Activities of Daily Living (ADLs) with which the individual has no difficulty executing. Specifically, for each question, we assign a value of 1 if the individual reports "No, I don't have any difficulty" and a value of 0 otherwise. We then sum across all six questions, creating an index that varies from 0 to 6, where a value of 6 indicates no difficulty with any ADL.

Instrumental Activities of Daily Living: Individuals are asked five questions regarding their ability to perform more complicated daily activities that help them to live independently, including doing household chores, preparing hot meals, shopping for groceries, managing money, and taking medications. See questions DB016–DB020. As with ADLs, responses to these questions include "No, I don't have any difficulty", "I have difficulty but can still do it", "Yes, I have difficulty and need help", and "I cannot do it." We combine responses to these five questions using the same procedures used for ADLs to create a composite measure that captures the number of Instrumental Activities of Daily Living (ADLs) with which the individual has no difficulty executing. Specifically, for each question, we assign a value of 1 if the individual reports "No, I don't have any difficulty" and a value of 0 otherwise. We then sum across all five questions, creating an index that varies from 0 to 5, where a value of 5 indicates no difficulty with any IADL.

Blood Pressure and Pulse: Surveyors used an Omron HEM-7200 monitor to measure individuals' blood pressure and pulse. Three systolic, diastolic, and pulse readings were recorded for each individual, taken 45 seconds apart. See questions QA003–QA005, QA007– QA009, and QA011–QA013. For each measure, we use the lowest of the three readings.

Lung Function: Surveyors used a peak flow meter to measure individuals' forced expiratory volume (FEV). See questions QB002, QB003, and QB004. Individuals were asked to stand up, take a deep breath, and blow as hard and as fast as possible into the mouthpiece of the meter. This process was repeated three times with 30-second breaks in between. We use the highest of the three readings.

Grip Strength: Surveyors used a dynamometer to measure individuals' hand grip strength. See questions QC003–QC006. Individuals were asked to stand up, hold their arm at their side at a 90-degree angle, and squeeze the meter as hard as possible for a couple of seconds. This process was repeated twice for each hand, alternating between hands. We use the highest of the four readings.

Body Mass Index: Surveyors measure individuals' height and weight. See questions QI002 and QL002. We convert these measures to body mass index (BMI) by dividing weight in kilograms by height in meters squared (kg/m^2).

Mental Health: In CHARLS, mental health is assessed using the ten-item Center for Epidemiological Studies-Depression (CES-D) scale. Surveyors present individuals with ten statements about their feelings and behaviors during the previous week, such as "I felt depressed". See questions DC009–DC018. For each statement, individuals may respond that they felt or behaved this way "Rarely or none of the time (<1 day)", "Some or a little of the time (1-2 days)", "Occasionally or a moderate amount of the time (3-4 days)", or "Most or all of the time (5-7 days)". Following Lei et al. (2012)

and Radloff (1977), we construct a mental health index based on the Center for Epidemiologic Studies Depression Scale (CES-D). For negative statements like “I felt depressed”, we assign a value of 3 to the first response, 2 to the second, 1 to the third, and 0 to fourth. For positive statements like “I was happy”, we reverse the scale and assign a value of 0 to the first response, 1 to the second, 2 to the third, and 3 to the fourth. We sum values across all ten statements to create a composite mental health index that ranges from 0 to 30.

Life Satisfaction: Individuals are asked how satisfied they are with their life, as a whole. See question DC028. We assign a value of 5 to the response “Completely satisfied”, 4 to “Very satisfied”, 3 to “Somewhat satisfied”, 2 to “Not very satisfied”, and 1 to “Not at all satisfied”.

Memory: Towards the beginning of the cognition and depression section of the health module, surveyors conduct a memory test. See questions DC006 and DC027. They inform individuals that they will next read a list of ten words, that they will not repeat the list, and that when they are finished reading they will ask individuals to recall as many words as possible in any order. Surveyors randomly select one of four lists that include simple words like rice, foot, and mountain. Surveyors are instructed to pause for approximately two seconds between words and to give individuals approximately two minutes to recall words. Once the test is finished, surveyors inform individuals that they will ask them to recall these words again at a later time, which occurs at the end of the cognition and depression section.[1] We sum the number of words that the individual is able to recall on each attempt, constructing a measure of memory that ranges from 0 to 20.

Cognition: Surveyors ask individuals several sets of questions to measure cognitive ability. In the first set, surveyors ask individuals to state the current date, including the year, month, and day, the current day of the week, and the current season. See questions DC001–DC003. In the second set, surveyors ask individuals to subtract 7 from 100 and then to subtract 7 from the ensuing answer four more times. See questions DC019–DC023. We consider the first response correct if the value given is 93. We consider each subsequent response correct if the difference between the individual's previous response and current response is 7, regardless of whether the previous response was correct. Occasionally, surveyors record answers corresponding to “don't know” or “refuse”. We consider each of these responses as incorrect. In the third set, individuals are shown a picture of two overlapping pentagons and are asked to replicate it. See question DC025. Surveyors report whether the individual drew the picture or failed to draw the picture. We consider the response ‘correct” if the individual drew the picture. We sum all correct answers to create a composite measure of cognitive ability that varies from 0 to 11.

Appendix B: Measures of Migration

CHARLS collects information on the age, school enrollment status, and residence of each of respondents' children. We use this information to construct village-level migration rates. We document this process below.

Migration Status

Respondents are asked different questions about children that are considered household members and children that are considered not living with the respondent. We determine the migration status of resident children using responses to questions A016 and A017 of the “household roster” section

[1] According to Lei et al. (2012), the second test occurs approximately four minutes after the first.

of the CHARLS questionnaire:

A016: Did child spend one or more months away from the household in the past year?
  A1: Yes
  A2: No
A017: How many months in the past year did child live away from home?
  A1: 0
  A2: 1
  ...
  A13: 12

We determine the migration status of non-resident children using responses to questions CB053 and CB054 of the "family information" section:

CB053: Where does child normally live now?
  A1: This household, but economically independent
  A2: The same or adjacent dwelling/courtyard with me
  A3: Another household in this village/neighborhood
  A4: Another village/neighborhood in this county/city
  Distance from here: _____ km
  A5: Another county/city in this province
  A6: Another province
  A7: Abroad
CB054: In what type of location does child live?
  A1: City
  A2: County
  A3: Town
  A4: Village

Migrants: We classify a resident child as a migrant if the respondent reports "Yes" to question A016 and anything other than "0" to question A017, including no response. We classify a non-resident child as a migrant if the respondent reports A1 for question CB054 or if the respondent reports A4 with a distance $> 20km$, A5, A6, or A7 for question CB053.

Non-migrants: We classify a resident child as a non-migrant if the respondent reports "No" to question A016. We classify a non-resident child as a non-migrant if the respondent reports A1, A2, A3, or A4 with a distance $\leq 20km$ for question CB053 and reports A2, A3, or A4 for question CB054.

Unknown: A small number of children do not meet any of the above migrant or non-migrant criteria. For the most part, these are children with missing answers to the questions used to determine migration status. We classify these children's migration status as unknown.

School Enrollment Status

We use responses to questions A013 and CB058 ("Is child still in school now") to classify children as in school ("Yes"), not in school ("No"), or unknown (no response).[2]

Migration Rate

[2]XXX There is one exception here. Need to check do file.

Children can be grouped into nine categories based on their migration and school enrollment statuses, which are illustrated in Table B.1. To best capture labor migration, we drop from our calculations children under the age of 18 or over the age of 40 and children for whom we cannot determine an age, and we construct village-level migration rates by dividing the sum of all migrants-not-in-school by the sum of all migrants-not-in-school, all non-migrants, and all those in school. Formally, this is (4) / (1 + 2 + 3 + 4 + 5 + 8), and children in cells 6, 7, and 9 are not included in the calculation.

	Migrant	Non-migrant	Unknown
In school	1	2	3
Not in school	4	5	6
Unknown	7	8	9

Table B.1: Child classifications by migration and school enrollment statuses

Table B.2 reports the number of children in each cell when the sample is restricted to those communities included in our regression analysis. More than 95% of all children belong to cells 4 and 5, which suggests that migration rates should not be too sensitive to how we treat the remaining cells in our calculation. Nevertheless, we consider alternative methods of constructing migration rates, including methods that vary our migration status criteria (which changes the treatment of each cell) and methods that vary child age ranges (which changes the populations in each cell), which we discuss next.

	Migrant	Non-migrant	Unknown
In school	373	85	0
Not in school	6,209	6,008	80
Uknown	19	18	17

Table B.2: Number of children in each migrant-by-school category (18-40 years old)

Alternative Methods

To determine how sensitive results are to our method of constructing migration rates, we construct several alternative measures.

First, we consider two measures that vary the manner in which we calculate the numerator and the denominator. Both are based on the sample of children described by Table B.2. The first can be thought to relax our migrant criteria and the second to strengthen it.

Alternative A: We ignore school enrollment status, and we construct village-level migration rates by diving the sum of all migrants by the sum of all non-migrants. Formally, this is (1 + 4 + 7) / (1 + 2 + 4 + 5 + 7 + 8), and children in cells 3, 6, and 9 are not included in the calculation.

Alternative B: We focus solely on those not in school, and we construct village-level migration rates by dividing the sum of migrants-not-in-school by the sum of non-migrants-not-in-school. Formally, this is (4) / (4 + 5), and children in cells 1, 2, 3, 6, 7, 8, and 9 are not included in the calculation.

Second, we consider two measures that relax the age criteria of children included in the calculation. In our primary specification, we include only children between the ages of 18 and 40. The reason for this choice is that we exploit labor demand shocks in manufacturing and construction to identify exogenous variation in migration rates, and preliminary analyses and other statistics suggest that children in this age range are far more responsive to these shocks than are younger and older children. Nevertheless, we do observe migrants below the age of 18 and above the age of 40, and these individuals may be at least partially influenced by labor demand shocks.

Figure B.1 plots the distribution of the ages of all children in white and the distribution of the ages of those classified as migrants-not-in school (cell 4 of Table B.1) in gray. We include only children from communities that are included in our regression analysis. Two-thirds of all children are between the ages of 18 and 40 and just over 50% of these children are classified as migrants. Although migration rates are largest for this group, rates are non-trivial for those between 15 and 20 and those between 40 and 50 and remain positive for other groups as well, and it is possible that labor demand shocks are an important driver of migration for these individuals. To address this possibility, we consider the following two alternative measures of migration.

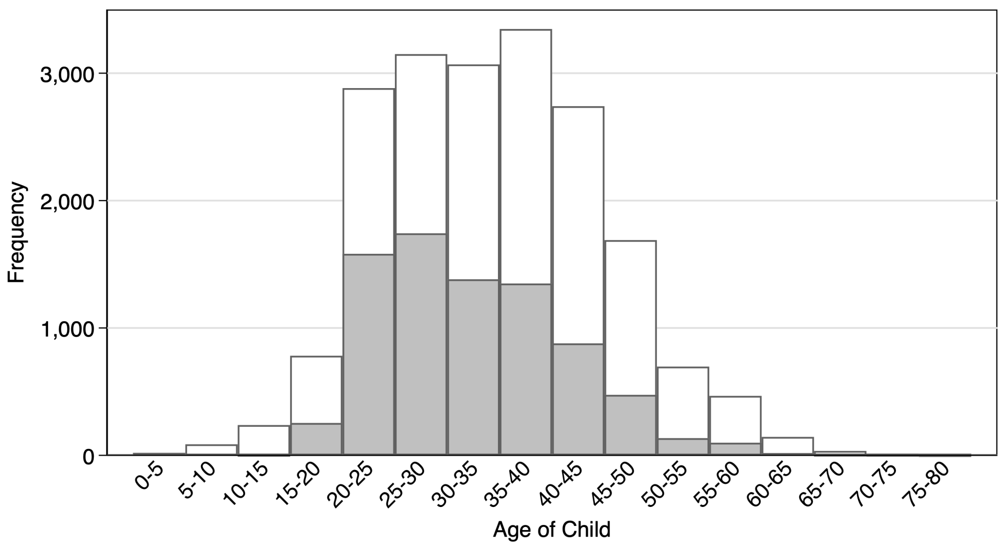

Figure B.1: Distribution of the ages of the children of those surveyed in CHARLS

Notes: The distribution of the ages of all children is plotted in white and the distribution of the ages of those classified as migrants-not-in school (cell 4 of Table B.1) is plotted in gray.

<u>Alternative C</u>: We calculate migration rates according to our main method – that is, (4) / (1 + 2 + 3 + 4 + 5 + 8) – but include children between the ages of 16 and 50 in the calculation. Table B.3 reports the number of children in each cell when the age range is expanded.

<u>Alternative D</u>: We calculate migration rates according to our main method – that is, (4) / (1 + 2 + 3 + 4 + 5 + 8) – but include all children, regardless of age, in the calculation. Table B.4 reports the number of children in each cell when the age criteria is fully relaxed.

	Migrant	Non-migrant	Unknown
In school	445	161	0
Not in school	7,649	9,140	104
Uknown	19	18	19

Table B.3: Number of children in each migrant-by-school category (16-50 years old)

	Migrant	Non-migrant	Unknown
In school	472	193	294
Not in school	8,143	10,851	168
Uknown	21	24	69

Table B.4: Number of children in each migrant-by-school category (all ages)

Third, we consider an alternative distance threshold to split children for whom respondents report A4 to question CB053 into migrants and non-migrants.

Alternative E: We classify a non-resident child as a migrant if the respondent reports A4 with a distance $> 50km$ to question CB053, and we classify a non-resident child as a non-migrant if the respondent reports A4 with a distance $\leq 50km$ for question CB053 and reports A2, A3, or A4 for question CB054. Table B.5 reports the number of children in each cell when the distance threshold is increased. Again, we calculate migration rates according to our main method – that is, (4) / (1 + 2 + 3 + 4 + 5 + 8).

	Migrant	Non-migrant	Unknown
In school	368	90	0
Not in school	5,764	6,453	80
Uknown	19	18	17

Table B.5: Number of Children in Each Migrant-by-School Category (increased distance threshold)

In each alternative, we believe that the additional individuals that are considered are less likely to respond to labor demand shocks. As a result, we anticipate that first stage estimates of the effect of IV on M will be smaller and second stage estimates of the effect of M on H will be larger. For this reason, we think of our main results as providing a conservative estimate of the effect of migration on health.

Results based on these five alternative measures are shown in Appendix H.

Appendix C: Urban Growth

For each province, we average annual wages in manufacturing and construction and then calculate the growth rate in wages between 2009 and 2010. Table 4-16 of the 2010 and 2011 editions of the China Statistical Yearbook provide data on the 2009 and 2010 average wage of employed persons in urban units by sector. These tables are provided by the National Bureau of Statistics China and can be downloaded at `http://www.stats.gov.cn/english/Statisticaldata/AnnualData`.

Figure C.1 illustrates the variation in wage growth across the 27 provinces that sent urban youth both within- and across-province. The eight provinces shaded in dark gray are those that sent urban youth across provinces. Wage growth in these eight provinces ranges from 11.2% in Shanghai to 20.1% in Yunnan, with a mean of 15.3% and a standard deviation of 3.3%.

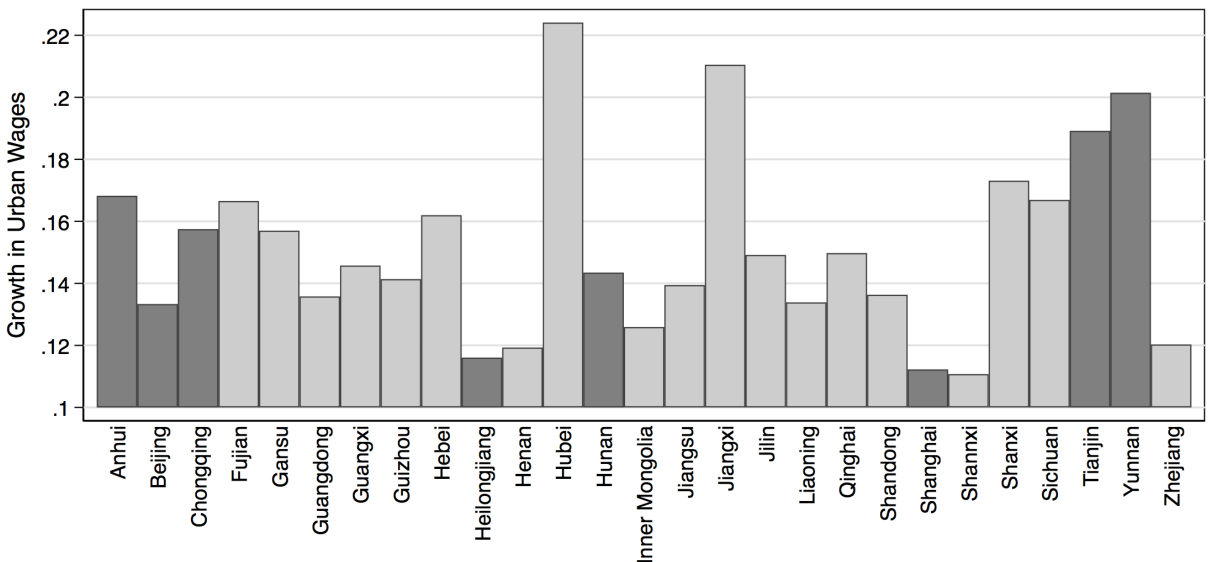

Figure C.1: Provincial-level growth in urban wages in manufacturing and construction between 2009 and 2010

Notes: The set of provinces shown above includes all provinces that sent urban youth in the 1960s and 1970s to communities surveyed in CHARLS. Provinces shaded in dark grey are those that sent urban youth to other provinces.

Appendix D: Other Covariates

To address the possibility that our results are driven by spurious correlation between our instrument and some factor that affects health, we consider alternative specifications of equations (3) and (4) in which we include individual- and village-level covariates. Below, we list the set of covariates that we include and describe how each variable is constructed.

Female: Interviewers record each surveyed individual's gender in the "demographic background" section of the questionnaire under the variable "rgender". Using this variable, we create an indicator variable that equals 1 if the individual is female.

Age: Interviewers record the year and month of birth of main respondents and their spouses – including separated, divorced, and deceased spouses – as well as the year and month that the interview took place. See questions BA002 and BF002. We calculate age at the time of interview by taking the difference in years between year and month of interview and year and month of birth. Respondents may report birth dates in either solar or lunar calendar format. See questions BA003 and BF003. Prior to calculating age, we convert all lunar dates to solar dates using the "lunar2solar" Stata command created by the CHARLS team.[3] We also construct and include age squared.

Married: Question BE001 asks individuals to identify their marital status, where "common-law" marriage is considered marriage. We classify individuals as married if they respond that they are "married with spouse present" or "married but not living with spouse temporarily for reasons such as work", and we classify individuals as not married if they respond that they are "separated", "divorced", "widowed", or "never married". Question BE002 asks individuals whether they are unmarried, but living with a partner. We also classify as married individuals that respond "yes" to this question.

Number of children: We combine information from the "household roster" and "family information" sections of the questionnaire to determine each household's total number of living children. Question A006 of the household roster describes the type of relationship between the respondent and each household member. We classify household members as children if the respondent reports "child" as the type of relationship. Questions CB0049, CB051, and CB052 of the family information section provide information on the gender and age of children residing outside the household. We use responses to these questions to identify the total number of non-resident children. For each household, we sum the number of resident and non-resident children to arrive at the total number of living children. We consider children of all ages and we do not distinguish between biological and adopted children, but we do distinguish between children (included) and the spouses of children (not included).

Educational attainment: Question BD001 asks individuals to identify the highest level of education that they have attained by selecting among eleven possible categories. We combine responses to form four education categories: The first includes "no formal education (illiterate)". The second includes "did not finish primary school but capable of reading and/or writing", "sishu/home school", and "elementary school". The third includes "middle school". The fourth includes "high school" and beyond. The first category serves as the omitted category in our regression analysis.

Number of rainy days: Question JA040 of the community questionnaire asks community respondents to report the number of rainy days in the community during the 2010 calendar year. We use this variable exactly as recorded.

Number of snowy days: Question JA041 of the community questionnaire asks community respondents to report the number of snowy days in the community during the 2010 calendar year. We use this variable exactly as recorded.

Condition of roads: As part of the "infrastructure and public facilities" section of the community questionnaire, community respondents are asked to report the main type of road within the community. See question JB001. Possible responses include 'pathway/dirt/unpaved", "sand-stone", "paved", "highway", and "other". No rural communities report "highway" and only one reports "other". We create a categorical variable that equals 1 if the respondent reports "pathway/dirt/unpaved road",

[3] See http://forum.charls.org/viewtopic.php?t=12.

equals 2 if the respondent reports "sand-stone road", and equals 3 if the respondent reports "paved road".

Hospital accessibility: As part of the "health and insurance" section of the community questionnaire, community respondents are asked about the types of medical facilities frequented by residents in need of health care . See question JF001. Possible responses include "general hospitals, "specialized hospitals", "Chinese medicine hospitals", "nearby pharmacy store", "community health care center", "community health care medical post", "township health clinic (hospital)", and "village medical post". Respondents are asked to circle all facilities that apply. We create an indicator variable that equals 1 if the respondent reports that residents frequent "general hospitals", "specialized hospitals", or "Chinese medicine hospitals". In question JF006, respondents are asked to report the distance, in kilometers, from the community to each type of frequented medical facility, where a response of 0 indicates that the facility is within the community. We create a second variable that equals the minimum distance residents must travel to reach any of "general hospitals", "specialized hospitals", or "Chinese medicine hospitals".

Number of "barefoot doctors": As part of the "community history" section of the community questionnaire, respondents are asked to report the number of barefoot doctors present in the community during the 1970s. See question JH014. Barefoot doctors typically had a secondary education and received minimal medical training so that they could provide rural villages with basic healthcare. The program was introduced in 1968 and became much more prevalent in the 1970s. Sent-down youth were one of the main sources of barefoot doctors. We use this variable exactly as recorded.

Appendix E: Channel Variables

Remittances: We construct two measures of remittances received by the household. The first measures the annual value of remittances received from all non-resident children. Question CE007 asks "In the past year, did you or your spouse receive any economics supports [sic] from your non-coresident children?". If the respondent reports "yes", the surveyor asks the respondent to identify all children that provided support and then asks question CE009, "How much of the following did you receive [from each identified child] in the past year?", where responses are recorded for regular monetary support, regular in-kind support, non-regular monetary support, and non-regular in-kind support. For each of these categories, either a numerical value is recorded or a range of values is recorded, for example 400-800 yuan. For regular support, the surveyor also records the frequency of support received as monthly, quarterly, half-yearly, or yearly.

We sum all types of support using the following procedure. First, we convert ranges to a single number using the mid-point of the range. For example, a reported range of 400-800 yuan would be converted to 600 yuan. Second, we annualize all regular support using the reported frequency. For example, we multiply by 12 regular support that is received monthly. Third, we sum all regular and non-regular monetary and in-kind support that is received from all non-resident children to arrive at total annual remittances.

We construct a second measure that simply captures whether any remittances are received. This measure takes the value of 1 if respondent reports "yes" to question CE007 and the value of reported remittances is positive, and it takes the value of 0 if the respondent reports "no" to question CE007 and the value of reported remittances is either zero or missing. We drop from the sample inconsistent responses, which include situations in which the respondent reports "yes" to question CE007 but reports zero annual remittances and situations in which the respondent reports "no" to question

CE007 but reports positive annual remittances.

Expenditures: The household living expenditure section of the survey asks a number of questions about weekly, monthly, and annual household expenditures. We study weekly expenditures on food (see GE006), monthly expenditures on utilities and communication (see GE009), and annual expenditures on medical needs (see GE010). We multiply weekly expenditures by 52 and monthly expenditures by 12 so that all expenditure categories are in terms of annual household expenditures.

Because household size may change with migration, we convert annual household expenditures to per capita expenditures. Household members are identified by coverscreen question CV002, and their ages are determined using household roster question A003. This section of the survey also identifies whether a household member is considered a migrant. See questions A016 and A017 and Appendix B for details on how determine the migration status of household members. We construct a weighted household size that weights members under 18 by 0.5, and we omit migrants from our measure. We divide each category of annual household expenditures by this weighted measure to arrive at per capita expenditures. To reduce the influence of outliers, we censor the top 1% of each expenditure variable by replacing it with the 99th percentile value.

Meals: Question DA058 in the health status and functioning section of the survey asks the respondent to report the number of meals normally eaten each day. Responses include (i) more than 4 meals per day, (ii) 4 meals per day, (iii) 3 meals per day, (iv) 2 meals per day, (v) 1 meal per day, and (vi) <1 meal per day. We code the first response as "5", the last response as "0", and all others as the number of meals reported.

Assistance: Following the questions regarding one's ability to perform Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) (see questions DB010 - DB020 in the health status and functioning section of the survey and Appendix A), respondents are asked to identify up to three individuals that most often help with these activities and to identify the number of days in the last month and average hours on these days that each individual provided assistance (see questions DB022, DB023, and DB024). Using these responses, we construct two measures of assistance.

When asked about their ability to perform ADLs and IADLs, individuals choose rom the following answers: "No, I don't have any difficulty", "I have difficulty but can still do it", "Yes, I have difficulty and need help", and "I cannot do it". If the individual answers either "Yes, I have difficulty and need help" or "I cannot do it" to *any* ADL or IADL question, we consider the individual in need of assistance. For this population only, we construct a measure of whether any assistance is received that equals 1 if the individual reports that one or more individuals provided assistance in response to question DB022 and equals 0 if the individual reports "no one helped" or provides no response to question DB022. We next create a measure of intensity that sums the number of hours of assistance in the last month provided by all identified individuals (see questions DB023 and DB024).

Contact with children: In the family section of the survey, individuals are asked about contact with their children. For each non-cohabitating child, they are asked how often they see the child (question CD003) and how often they communicate via phone, text, mail, or email (question CD004). We convert responses into annual frequencies using the following assignment of values:

- "Almost every day" = 260 times per year
- "2-3 times a week" = 130 times per year
- "Once a week" = 52 times per year
- "Every two weeks" = 26 times per year

- "Once a month" = 12 times per year
- "Once every three months" = 4 times per year
- "Once ever six months" = 2 times per year
- "Once a year" = 1 time per year
- "Almost never" = 0.5 times per year
- "Other" = 1 time per year

So that our measure does not simply reflect family size, we average responses across all non-cohabitating children. We do this separately for in-person and remote contact.

Daily sleep: The health status and functioning section of the survey asks two questions about sleep. Question DA049 asks "During the past month, how many hours or actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed.)" and question DA050 asks "During the past month, how long did you take a nap after lunch". We use answers as given, but convert hours sleeping at night to minutes for easier comparison with naps.

Social interaction: Question DA056 in the health status and functioning section of the survey asks respondents about participation in a number of activities. Two of these activities – "interacted with friends" and "played Ma-jong, played chess, played cards, or went to community club" – capture, in our view, positive social interaction. Question DA057 asks about the frequency that respondents engaged in each activity during the previous month. Answers include almost daily, almost every week, and not regularly. We combine this information to create a composite "social interaction" variable using the following procedure. For each activity, we assign a value of 20 times per month if the respondent reports "almost daily", we assign a value of 4 times per month if the respondent reports "almost every week", we assign a value of 1 time per month if the respondent reports "not regularly", we assign a value of 0 times a month if the respondent does not report engaging the activity, and we assign a value of 1 time per month if the respondent reports that they engage in the activity, but does not report a frequency. Next, we sum frequencies across the two activities, producing a variable that varies from 0 to 40.

Farm work: In the work, retirement, and pension section of the survey, individuals are asked about time spent doing agricultural work for themselves and for others. First, we construct indicator variables, separately for work for others (question FC001) and work for self (question FC008), that capture whether the individual did 10 or more hours of agricultural work in the past year. Next, we construct corresponding intensive variables by multiplying months per year (questions FC004 and FC009) by average days per month (questions FC005 and FC010) by average hours per day (questions FC006 and FC001) to arrive at hours worked in the last year. These variables are set to 0 for individuals that report that they did not work 10 or more hours (questions FC001 and FC008), and they are set to missing if months, days, or hours are missing or if days or hours are reported as 0. In addition, we drop the sample individuals with inconsistent responses, which includes situations in which no work is reported but positive hours are reported and situations in which work is reported but zero hours are reported. Finally, we set all extensive and intensive measures to 0 if the individual reports that they did not engage in agricultural work, for themselves or others, for 10 or more hours in the past year (questions FA001) and these variables have not otherwise been assigned a value.

Appendix F: First Stage Regression Results

Table F.1: First Stage Estimates

Covariate	(4)	(5)	(6)	(7)
IV	4.996***	4.984***	4.907***	4.904***
	(0.739)	(0.732)	(0.771)	(0.765)
$SDY^{s \neq p}$	−0.058***	−0.058**	−0.049**	−0.048**
	(0.022)	(0.022)	(0.023)	(0.023)
$SDY^{s=p}$	−0.614***	−0.613***	−0.589***	−0.589***
	(0.125)	(0.124)	(0.123)	(0.122)
Female		−0.018***		−0.015***
		(0.005)		(0.004)
Married		−0.001		0.001
		(0.006)		(0.006)
Age		−0.008**		−0.008**
		(0.004)		(0.004)
Age sqaured		0.000**		0.000*
		(0.000)		(0.000)
Primary school		−0.017**		−0.013*
		(0.008)		(0.007)
Middle school		−0.018*		−0.012
		(0.011)		(0.010)
High school and above		−0.020*		−0.016
		(0.012)		(0.012)
Number of children		0.004		0.004
		(0.003)		(0.003)
Number of rainy days			0.001	0.001
			(0.000)	(0.000)
Number of snowy days			−0.002*	−0.002*
			(0.001)	(0.001)
Hospital			−0.022*	−0.022*
			(0.012)	(0.012)
Distance to hospital (km)			−0.040*	−0.039*
			(0.024)	(0.024)
Roads in good condition			0.002**	0.002**
			(0.001)	(0.001)
Number of barefoot doctors			0.002	0.002
			(0.002)	(0.002)
Province fixed effects	✓	✓	✓	✓
Individual Covariates		✓		✓
Community Covariates			✓	✓
Kleibergen-Paap F-statistic	45.66	46.35	40.45	41.09
Number of observations	6,274	6,274	6,160	6,160

Notes: Shown above are OLS estimates of the parameters in the first stage equation (4). Column numbers correspond to those given in Table 3 of the main text. Standard errors are clustered at the community level and shown in parentheses below point estimates. ***, **, and * denote statistical significance at the 1%, 5%, and 10% percent-levels.

Appendix G: Reduced Form Results

For transparency, we also estimate a reduced-form version of equation (3), in which M is replaced with IV. Specifically, we estimate the following model:

$$H_{ivp} = \tilde{\beta}_1 IV_{vp} + \tilde{\beta}_2 SDY_{vp}^{s \neq p} + \tilde{\beta}_3 SDY_{vp}^{s=p} + \tilde{\theta}_p + \tilde{\epsilon}_{ivp}. \qquad (\tilde{3})$$

Estimates of $\tilde{\beta}_1$ are reported in Table G.1. A one-unit change in IV represents a 100-percentage point increase in the growth rate in the sending province. So, for example, a one-percentage point increase in growth leads to a 0.093 standard deviation decrease in ADL ability.

Table G.1: Reduced Form Estimates

Dependent variable	(4)	(5)	(6)	(7)
Self-reported health	−2.327	−2.303	−2.168	−2.216
	(2.151)	(2.215)	(2.186)	(2.248)
ADL ability	−9.328***	−9.302***	−9.208***	−9.268***
	(2.107)	(2.072)	(2.021)	(1.969)
IADL ability	−4.556*	−4.438*	−4.428*	−4.435*
	(2.487)	(2.534)	(2.503)	(2.530)
Systolic blood pressure	−2.675	−2.805	−2.889	−3.132
	(1.960)	(1.936)	(1.979)	(1.951)
Diastolic blood pressure	−2.594	−2.674	−2.673	−2.738
	(2.285)	(2.273)	(2.312)	(2.299)
Pulse	1.595	1.444	1.419	1.286
	(2.296)	(2.298)	(2.330)	(2.319)
Lung function	−10.575***	−10.537***	−9.778***	−9.919***
	(3.544)	(3.161)	(3.528)	(3.183)
Grip strength	0.617	0.384	0.816	0.447
	(2.860)	(2.663)	(2.846)	(2.639)
BMI	−0.949	−0.716	0.306	0.415
	(2.272)	(2.261)	(2.118)	(2.140)
Mental health	−5.424**	−5.279*	−4.700*	−4.680
	(2.765)	(2.799)	(2.821)	(2.867)
Life satisfaction	−2.099	−1.988	−2.642	−2.511
	(2.969)	(2.956)	(2.890)	(2.888)
Memory	−1.275	−0.529	−1.213	−0.797
	(2.450)	(2.253)	(2.390)	(2.237)
Cognitive ability	−0.911	0.029	−0.373	0.166
	(2.622)	(2.401)	(2.574)	(2.376)
Individual Covariates		✓		✓
Community Covariates			✓	✓
Number of Observations	6,274	6,274	6,160	6,160

Notes: Shown above are OLS estimates of $\tilde{\beta}_1$ in equation $\tilde{3}$. Column numbers correspond to those given in Table 3 of the main text. Standard errors are clustered at the community level and shown in parentheses below point estimates. ***, **, and * denote statistical significance at the 1%, 5%, and 10% percent-levels.

Appendix H: Alternative Specifications

Table H.1 presents results based on alternative measures of sent-down youth flows, which are described in Section 5.3 of the main text.

Table H.1: Instrumental Variables Estimates of the Effect of Migration on Health Using Alternative Measures of Sent-Down Youth Flows

	Main Method	Alternative Methods		
Dependent variable	Binary	Log	Per Capita	Levels
Self-reported health	−0.466	−0.810**	−0.628	−1.111
	(0.415)	(0.354)	(0.929)	(0.776)
ADL ability	−1.867***	−2.112***	0.181	−2.865*
	(0.489)	(0.549)	(1.690)	(1.666)
IADL ability	−0.912*	−1.156**	−0.560	−1.426
	(0.504)	(0.491)	(1.453)	(1.075)
Systolic blood pressure	−0.535	−0.321	−0.135	0.143
	(0.412)	(0.366)	(0.986)	(0.622)
Diastolic blood pressure	−0.519	−0.128	−0.795	0.372
	(0.474)	(0.439)	(1.302)	(0.630)
Pulse	0.319	0.187	−1.197	−0.168
	(0.464)	(0.477)	(1.324)	(0.693)
Lung function	−2.117***	−1.589**	0.547	−0.652
	(0.727)	(0.697)	(2.255)	(0.454)
Grip strength	0.123	−0.004	0.309	−0.249
	(0.569)	(0.575)	(1.530)	(0.616)
BMI	−0.190	0.196	0.716	1.206
	(0.445)	(0.399)	(1.101)	(0.779)
Mental health	−1.086*	−1.137**	−1.112	−1.453**
	(0.575)	(0.574)	(1.475)	(0.670)
Life satisfaction	−0.420	−0.652	−0.899	−0.154
	(0.586)	(0.603)	(1.166)	(0.855)
Memory	−0.255	0.248	1.421	1.294
	(0.484)	(0.518)	(1.957)	(1.271)
Cognitive ability	−0.182	−0.145	0.358	0.241
	(0.514)	(0.534)	(1.589)	(0.719)
Kleibergen-Paap F-statistic	45.66	31.33	2.63	3.90
Number of observations	6,274	6,127	6,127	6,127

Notes: Shown above are 2SLS estimates of β_1 in equation (3). See Table 3 of the main text.

Table H.2 presents results based on alternative measures of village-level migration rates, which are described in Appendix B.

Table H.2: Instrumental Variables Estimates of the Effect of Migration on Health Using Alternative Methods to Construct Migration Rates

	Main	Alternative Methods				
Dependent variable	Method	(A)	(B)	(C)	(D)	(E)
Self-reported health	−0.466	−0.529	−0.503	−0.515	−0.572	−0.578
	(0.415)	(0.465)	(0.445)	(0.451)	(0.506)	(0.528)
ADL ability	−1.867***	−2.119***	−2.017***	−2.066***	−2.292***	−2.317***
	(0.489)	(0.582)	(0.555)	(0.568)	(0.663)	(0.702)
IADL ability	−0.912*	−1.035*	−0.985*	−1.009*	−1.120*	−1.132*
	(0.504)	(0.567)	(0.550)	(0.542)	(0.626)	(0.678)
Systolic blood pressure	−0.535	−0.608	−0.578	−0.592	−0.657	−0.665
	(0.412)	(0.467)	(0.449)	(0.458)	(0.515)	(0.530)
Diastolic blood pressure	−0.519	−0.589	−0.561	−0.575	−0.638	−0.645
	(0.474)	(0.536)	(0.514)	(0.531)	(0.590)	(0.593)
Pulse	0.319	0.362	0.345	0.353	0.392	0.396
	(0.464)	(0.534)	(0.508)	(0.503)	(0.559)	(0.608)
Lung function	−2.117***	−2.402***	−2.286***	−2.342***	−2.599***	−2.627***
	(0.727)	(0.842)	(0.789)	(0.884)	(0.957)	(0.801)
Grip strength	0.123	0.140	0.133	0.137	0.152	0.153
	(0.569)	(0.647)	(0.615)	(0.627)	(0.696)	(0.711)
BMI	−0.190	−0.216	−0.205	−0.210	−0.233	−0.236
	(0.445)	(0.503)	(0.478)	(0.493)	(0.547)	(0.542)
Mental health	−1.086*	−1.232*	−1.173*	−1.201**	−1.333*	−1.348*
	(0.575)	(0.676)	(0.640)	(0.611)	(0.686)	(0.803)
Life satisfaction	−0.420	−0.477	−0.454	−0.465	−0.516	−0.521
	(0.586)	(0.666)	(0.637)	(0.632)	(0.715)	(0.770)
Memory	−0.255	−0.290	−0.276	−0.282	−0.313	−0.317
	(0.484)	(0.546)	(0.520)	(0.536)	(0.594)	(0.591)
Cognitive ability	−0.182	−0.207	−0.197	−0.202	−0.224	−0.226
	(0.514)	(0.579)	(0.553)	(0.566)	(0.630)	(0.635)
	Panel B: First Stage Estimates					
Migration	4.996***	4.402***	4.626***	4.516***	4.069***	4.025***
	(0.739)	(0.803)	(0.798)	(0.769)	(0.718)	(0.845)
Kleibergen-Paap F-statistic	45.66	30.05	33.62	34.45	32.12	22.68
	Panel C: Sample Details					
Mean Migration Rate	0.489	0.518	0.507	0.436	0.411	0.484
Number of Observations	6,274	6,274	6,274	6,274	6,274	6,274

Notes: Shown above are 2SLS estimates of β_1 in equation (3). See Table 3 of the main text.

Appendix I: Additional Channels

When individuals are asked about their ADL and IADL needs, they also report who most often helps with these activities. The most common responses are a spouse, a child, a child's spouse, or a grandchild. Tables I.1 and I.2 below provide additional regression results based on these questions.

Table I.1: Any Assistance Received with ADLs and IADLs

		By Age			By Gender		
Dependent variable	(1) Full Sample	(2) Younger	(3) Older	(4) Difference	(5) Female	(6) Male	(7) Difference
Needed assistance last month and received it							
Coef.	0.36**	0.21	0.52*	0.31	0.46**	0.27	−0.20
Std. Err.	(0.17)	(0.13)	(0.30)	(0.31)	(0.22)	(0.24)	(0.30)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.13	0.09	0.16		0.15	0.11	
Received assistance from spouse last month							
Coef.	0.35**	0.27**	0.44*	0.17	0.50***	0.21	−0.29
Std. Err.	(0.15)	(0.12)	(0.24)	(0.25)	(0.19)	(0.20)	(0.25)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.09	0.08	0.11		0.10	0.09	
Received assistance from children last month							
Coef.	0.00	−0.05	0.06	0.10	−0.02	0.03	0.05
Std. Err.	(0.05)	(0.04)	(0.08)	(0.08)	(0.11)	(0.03)	(0.12)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.03	0.02	0.03		0.04	0.01	
Received assistance from children's spouse(s) last month							
Coef.	−0.03	−0.08	−0.00	0.08	−0.03	−0.03	0.00
Std. Err.	(0.04)	(0.06)	(0.07)	(0.08)	(0.07)	(0.03)	(0.07)
Obs.	6,274	2,970	3,304		3,031	3,243	
F-stat.	45.66	45.77	36.64		45.47	44.30	
Mean	0.01	0.01	0.02		0.02	0.01	
Received assistance from grandchildren last month							
Coef.	−0.00	0.02	−0.02	−0.04	−0.02	0.02	0.04
Std. Err.	(0.03)	(0.02)	(0.05)	(0.04)	(0.07)	(0.02)	(0.07)
Obs.	6,274	2,970	3,304		3,031	3,243	
F-stat.	45.66	45.77	36.64		45.47	44.30	
Mean	0.01	0.00	0.01		0.01	0.00	

Notes: See Table 8 of the main text.

Table I.2: Hours of Assistance Received with ADLs and IADLs

		By Age			By Gender		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Full Sample	Younger	Older	Difference	Female	Male	Difference
Total hours of assistance received last month							
Coef.	−60.54	−50.23	−68.79	−18.56	−89.78*	−38.00	51.77
Std. Err.	(37.45)	(36.43)	(53.40)	(59.25)	(50.42)	(37.09)	(43.25)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	12.49	8.05	16.48		12.85	12.16	
Hours of assistance received from spouse last month							
Coef.	−29.27	−20.15	−37.35	−17.20	−16.46	−42.22	−25.76
Std. Err.	(24.55)	(25.71)	(33.45)	(36.55)	(24.50)	(30.52)	(26.49)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	9.35	6.66	11.77		8.67	9.99	
Hours of assistance received from children last month							
Coef.	−22.28	−17.18	−24.59	−7.41	−51.02	1.80	52.82
Std. Err.	(13.91)	(14.95)	(19.67)	(25.36)	(32.37)	(2.91)	(32.95)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	1.63	0.68	2.48		2.19	1.11	
Hours of assistance received from children's spouse(s) last month							
Coef.	−7.09	−11.90	−4.84	7.06	−10.32	−4.54	5.79
Std. Err.	(5.77)	(10.95)	(5.49)	(11.95)	(6.60)	(6.45)	(5.98)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.92	0.36	1.43		1.28	0.59	
Hours of assistance received from grandchildren last month							
Coef.	−5.62	−1.16	−9.71	−8.55	−12.16	0.54	12.70
Std. Err.	(5.04)	(1.34)	(9.59)	(9.70)	(10.74)	(0.55)	(10.78)
Obs.	6,272	2,969	3,303		3,029	3,243	
F-stat.	45.66	45.77	36.65		45.47	44.30	
Mean	0.27	0.07	0.45		0.51	0.04	

Notes: See Table 8 of the main text.

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