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Living Arrangements, Offspring Migration, and Health of Older Adults in Rural China: Revelation From Biomarkers and Propensity Score Analysis

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Abstract

Objective: We examine the combined effects of living arrangements and outmigration of adult children on rural older adults' health profiles, measured by biomarker data from the China Health and Retirement Longitudinal Study 2011.

Method: We employ biomarker data and propensity score analysis which allows us to effectively deal with selection issues that are commonly observed in the literature.

Results: We show complex health implications of living arrangements and offspring migration. Living in a traditional multigenerational household has limited health benefits to older adults. However, older parents of migrants who live in a multigenerational household have better fitness in blood pressure. Their advantage over parents of migrants in other living arrangements suggests added benefits of the presence of grandchildren.

Discussion: This study bridges the living arrangement and migration literature on health by showing that health effects of adult children's migration on older adults are contingent upon their living arrangements.

Keywords

living arrangements; migration; left-behind older adults; biomarkers

Introduction

In many developing countries where adult children are an important source of old age support, the outmigration of adult children has been a powerful force in shaping family contexts and health outcomes of older adults (e.g., Adhikari, Jampaklay, & Chamratrithirong, 2011; Antman, 2012; Knodel, Kespichayawattana, Saengtienchai, & Wiwatwanich, 2010). Among them, China is experiencing the largest volume of internal migration in human history. With 221 million so-called "floating population" by 2010

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(China Statistics Press, 2012), internal migration has emerged to be a significant part of the demographic processes that is rapidly changing population distribution and family structure in China.

Coresidence with adult children has been both a cultural expectation and a common practice in rural China, where a formal welfare system for older adults is largely lacking. However, for the past few decades, with a massive number of young rural adults venturing into urban areas, rural older adults who coreside with adult children continue to fall. In the early 2010s, 40% to 45% of rural older Chinese coresided with their adult children, a 10–15% drop from a decade ago (Qu & Sun, 2011; Ren & Treiman, 2015). It is expected that more rural older adults will be living alone, living with their spouses only, or living in skipped-generation households—often taking care of their left-behind grandchildren. For some older adults, even if their family structure does not change, patterns of intergenerational exchanges may shift. For example, when an adult child has migrated away, older adult may continue to live with other adult children. This arrangement may be encouraged by a *time-for-money exchange*, where migrant offspring send remittances to their siblings in exchange for their eldercare by coresiding with their older parents (Cong & Silverstein, 2011).

Undoubtedly, the massive migration of adult children has created new challenges for researchers to examine the family-wellbeing linkage. This study is among the first efforts to go beyond the typical living arrangement model to directly investigate the role of adult children's migration in health of older adults in various living arrangements. Taking all the adult children of older adults into consideration, we examine how migration and living arrangements combined to affect various health outcomes of rural older Chinese. In contemporary societies where migration has been prevalent and family structure has been rapidly changing, exclusively focusing on one or the other could lead to an incomplete picture.

We ask the following research questions. First, how do different types of living arrangements affect the health conditions of older adults in contemporary rural China? Second, within each type of living arrangement, how having adult migrant children affects their health? For example, for an older adult living in a multigenerational household with their adult children, does having a migrant child make a difference in their health?

In addition to the innovative attempt of bridging the migration and living arrangement literature on studies of health effects, we also make a methodological advance in our measurement of health. Instead of the commonly used self-reported or diagnosed physical or mental health or mortality in this literature, we use biomarkers data collected in the China Health and Retirement Longitudinal Study (CHARLS) to evaluate the major health issues of rural older Chinese. With economic development and improvement in public health infrastructure, China is undergoing an epidemiological transition, shifting from a nation with high prevalence of infectious diseases to a nation with a rapidly aging population afflicted with noncommunicable chronic diseases (Shen, Goyal, & Sperling, 2012). These chronic conditions, including risks of diabetes, hypertension, and cardiovascular diseases—sometimes termed “metabolic syndrome”—are usually regarded as “diseases of affluence” in this context (Cook & Dummer, 2004). Due to the spread of unhealthy diet and inactivity,

these diseases of affluence also emerge in rural China (Gao et al., 2013; Yang et al., 2010; Zimmer, Kaneda, & Spess, 2007). At the same time, over 10% of middle-aged and older Chinese are still malnourished, with the diseases associated with malnutrition more prevalent in rural China (He et al., 2005). Our biomarkers include a wide range of indicators that can be used to detect or predict chronic conditions such as diabetes, malnutrition, and cardiovascular diseases. We also examine a composite measure—allostatic load (AL), which is found to be associated with perceived stress or “wear and tear” of the body (McEwen, 2002).

There are two major advantages of using biomarkers in this study. First, the Chinese population are in general experiencing an underdiagnosis in chronic diseases, due to underdevelopment in its public health provisions and low levels and poor quality of routine screenings and disease diagnosis.¹ This underdiagnosis is especially pronounced for rural older adults, who are generally much less educated, have lower socioeconomic status (SES), and are less likely to have medical insurance (Cheng, Tolhurst, Li, Meng, & Tang, 2005). Second, living arrangements and migration are affecting a wide health spectrum of older adults, including those in premorbid dysregulation—stages before the onset of certain diseases. Compared to medical records, the use of biomarkers can capture a wider range of health conditions by using health cutoffs relative to other older adults. In addition, when older adults are diagnosed with diseases or close to mortality, reverse causation can be especially prominent, as adult children may postpone their migration or return from a migration trip (Giles & Mu, 2007). The use of biomarkers can help to reduce such reverse causality to a certain extent.

We have further tackled the endogeneity/selection issue with propensity score analysis. In evaluating roles of living arrangements in the health of older adults, the traditional approach is to assess the associations using regression models controlling for potential confounders. However, estimates could be biased as living arrangements are not random and older adults with certain health profiles and backgrounds are more likely to be selected into certain living arrangements. In propensity score analysis, the conditional probability/propensity of receiving “treatment” (e.g., living alone) given observed covariates (e.g., gender, age, physical impairment) is first calculated (Rosenbaum & Rubin, 1983). Then the treatment cases are matched with comparable, counterfactual control cases based on similar propensity scores, so that it imitates a pseudorandomized experimental research. This way, an improved control for confounding is accomplished (Guo & Fraser, 2014). Details of this method are explained in the Data and Method section.

Literature Review

Living Arrangements and Health

Mixed results are found regarding the health effects of living arrangements for older adults. In settings where living alone is not the norm, and is due to the lack of familial support and

¹A study based on a nationally representative sample has found that 61.3% of the men and 59.8% of the women with diabetes had not previously been diagnosed (Yang et al., 2010). Another study found that only 45.0% of adults in China were aware of their hypertension (Gao et al., 2013)

economic strains, solitary living is found to be negatively associated with self-rated health, psychological health, and mortality of older adults (Silverstein, Cong, & Li, 2006). Compared to living alone, much literature has found that marriage is a “resource” and has a protective effect on both older men and women on a range of health indicators (Koball, Moiduddin, Henderson, Goesling, & Besculides, 2010). However, in rural China, as multigenerational living is the norm, the “empty nest” families are more likely to feel lonely, depressed, and have higher prevalence of chronic diseases than those who live with adult children (Liu & Guo, 2008). Living with adult children is beneficial also because it usually comes with intrafamily support that provides them with economic advantage, better health awareness, healthier lifestyles, and can be served as an effective substitute for physician services (F. Chen & Liu, 2012; Samanta, Chen, & Vanneman, 2015), thus leading to better mental and physical health (Chen & Short, 2008).

However, social ties with adult children may not be assumed to be uniformly supportive (Rook, 1984). Families can also be sources of distress and abuse, and neglect of family members may also take a toll in older adult’s health (Cooper, Selwood, & Livingston, 2008). Case studies in China found that older adults who were living with married sons had limited or no access to their sons’ household income (Goldstein & Ku, 1993). Some also found that older Chinese living in multigenerational households experience a slightly more rapid self-rated health decline than those who live independently (F. Chen & Liu, 2012).

There are also mixed findings regarding the health implications of living in skipped-generation households.² In skipped-generation households, grandparents are usually the primary caregivers of their grandchildren. While day-to-day care of children is physically taxing and may involve sleep loss and exposure to infections, it is associated with chronic stress, which creates a role strain, or overload (Hughes, Waite, LaPierre, & Luo, 2007; Jendrek, 1993; Pearlin, 1989). In China, however, grandparents in this living arrangement may be in line with the “role enhancement” theory, in which older adults have a greater sense of purpose by occupying a culturally sanctioned role, and thus have better mental health and experience a slower health decline as they age (F. Chen & Liu, 2012; Silverstein et al., 2006).

Although the living arrangement-health link is well established when it comes to self-rated mental/physical health and mortality, whether certain type of living arrangements triggers chronic health conditions unknown to individuals, especially in developing country settings, is less discussed. There are at least two pathways through which living arrangements affect the chronic conditions of older adults. First, different living arrangements suggest differentiated distribution of resources and variations in intrafamilial support and daily hassles, thus exacerbating or buffering chronic stress older adults have on a daily basis. Chronic stress may trigger a chronic inflammatory process in the arteries, which eventually leads to coronary heart disease (Black & Garbutt, 2002). Stress may also alter fast glucose and Glycated Hemoglobin (HbA1c) by changing dietary habits and exercising (Peyrot, McMurry, & Kruger, 1999). Second, living arrangements may have direct lifestyle

²-This type of households may or may not have adult migrant children. In the latter case, adult children may normally live in a different household in the same county which allows them to come and visit their children and older parents more often.

implications, such as smoking, drinking, food consumption, or exercising. For example, taking care of grandchildren is associated with increased exercise (Hughes et al., 2007) and a healthier diet (Kicklighter et al., 2007). We expect that consistent with many other health outcomes, by fulfilling the normative ideal of living arrangement, multigenerational living suggests the lowest level of stress and a healthy lifestyle for rural older adults, and thus brought about positive health outcomes in terms of our biomarkers examined:

Hypothesis 1 (H1): Living in a multigenerational household has a positive effect on the health of rural older adults.

Migration of Adult Children and Chronic Conditions

When coresidence takes place, it is typically with one adult child. The locations of other adult children and financial exchanges with other adult children can also be important. Unlike the traditional split households where adult children left parents' household and set up their own households nearby, migrants usually venture into a place far away from the origins, and only pay visits to their older parents several times a year. Therefore, parents of migrants may have more stress due to a loss of perceived instrumental support (Cohen & Wills, 1985; Song, 2017). This might be more prominent for the households without a coresident adult child (Song, 2017).

However, financial remittances are found to be beneficial in relieving chronic stress related to economic strains/insecurity and mobilizing stress-buffering resources, suggesting higher nutritious attainment and lessened health strains (Knodel & Saengtienchai, 2007). This is especially true for older adults living in two-generation or multigenerational households, who receive intrafamily support from coresident children, as well as higher financial resources from their migrant offspring. Prior research also found positive effects of intergenerational transfer on older adults in other living arrangements, especially skipped-generation households, for elevating them from a health deficit in both mental and physical health (F. Chen & Liu, 2012; Cong & Silverstein, 2011; Silverstein et al., 2006), although others did not find sufficient evidence (Antman, 2012; He & Ye, 2014; Song, 2017). Moreover, adult children living nearby may provide limited support when needed, reducing negative impact of adult children's migration (Giles & Mu, 2007). Therefore, we expect that there is a general positive effect of adult children's migration on the health of older adults, in terms of the biomarkers we measured:

Hypothesis 2 (H2): Within each living arrangement, having adult migrant children has a positive effect on the health of rural older adults.

We should also note that while our biomarkers measure a range of aspects of health, effects of living arrangements or adult children's migration may vary by specific biomarkers examined. This is especially plausible in the current period of China's epidemiological transition, in which higher SES is associated with both positive and negative health outcomes. For instance, older adults in multigenerational households with adult migrant children may enjoy both a culturally ideal living arrangement and alleviated financial stress, which can reduce risks of high AL, undernutrition, or hypertension, but they may also increase sugar intake and risks of diabetes (e.g., see Yang et al., 2010). Therefore, instead of

examining a single composite measure of health, our examinations on the range of biomarkers provide a well-rounded picture of how various health indicators are affected.

Data and Method

We use CHARLS 2011—a high-quality nationally representative data set of Chinese residents aged 45 and older for the purpose of this study. This study adopts multistage stratified Probability Proportional to Size (PPS) sampling, and randomly chooses 150 county-level units from 28 provinces. Except for Tibet, the sampling frame contains all county-level units and is stratified by region, urban districts, rural counties, and per capita statistics. Three primary sampling units (PSUs) are chosen within each county-level unit. Within each PSU, households with at least an individual aged 45 or older are randomly chosen. Collective dwellings are excluded in the sampling frame (Zhao, Hu, Smith, Strauss, & Yang, 2012).

In CHARLS 2011, venous blood was collected from each respondent by staff of the Chinese Center for Disease Control and Prevention (China CDC). Among the participants, 66.96% provided samples of fasting blood (Zhao et al., 2012). To correct for nonresponsiveness, a weight is developed specifically for the blood sample (CHARLS 2011–2012 National Baseline Blood Data User's Guide). This probability weight is used in our descriptive analysis. We restrict our analysis to older adults aged at or over 60 years and resided in rural areas. The final sample yields 3,900 rural older adults, of which 1,939 (49.7%) are older parents of migrants.

Biomarkers and AL

Fasting glucose and HbA1c can be both used for diagnosis for diabetes. A low creatinine clearance is strongly correlated with malnutrition, lower muscle mass, and is a risk factor for falls in older adults (Dukas, Schacht, & Stahelin, 2005). A high creatinine is commonly used for detecting kidney failure. C-reactive protein is a protein found in the blood that rises in response to stressors by way of physiological systems such as inflammation. It has been widely found to predict cardiovascular diseases (McEwen, 2002). Similarly, low level of high-density lipoprotein (HDL) cholesterol, high total/HDL cholesterol ratio, high triglycerides, high blood pressure (systolic reading and diastolic reading), and high pulse are all associated with coronary heart diseases. AL is regarded as a preclinical warning sign of deteriorating health and physiological dysregulation, and is found to be associated with perceived stress and poverty (McEwen, 2002). An AL score is computed by linearly summarizing high risks for each biomarker used in the study. For creatinine and body mass index (BMI), both the highest quartile and lowest quartile are obtained to identify high risks. For other biomarkers, the highest quartile is obtained (Juster, McEwen, & Lupien, 2010). To obtain a well-rounded picture of how each health aspect is affected by family and migration contexts, we investigate each individual biomarker as well as the summary AL. Appendix A describes the biomarkers used in this study and criteria used for identifying high risks.

Measurements

We classify living arrangements into five mutually exclusive groups:

1. Living alone: older adults who live on their own;
2. Living with spouse only: Older adults who live only with their spouse;
3. Living in a two-generation household: Older adults who live with adult children or children-in-law, but not grandchildren (may or may not live with spouse);
4. Living in a skipped-generation household: Older adults who live with grandchildren, but not adult children or children-in-law (may or may not live with spouse);
5. Living in a multigeneration household: Older adults who live with grandchildren (and possibly great grandchildren), but not adult children or children-in-law (may or may not live with spouse).

We use a broad definition of migrant children in this article, including (a) children who are not living in the household and are not in the same county; (b) migrant children who are still considered household members but were away for over a month in the past year. The reason we included the second group is to capture the “migration-split households”—migrant offspring who were away from their parents’ household for an extended time but still considered household members.³

Propensity Score Analysis

We use a counterfactual approach—propensity score analysis to identify causal relationships (Becker & Ichino, 2002). In propensity score analysis, a logistic regression is first performed using a series of observed covariates to estimate the probability that an individual would undergo the “treatment” (Rosenbaum & Rubin, 1983). Based on this probability, “treatment” cases are then matched with comparable, counterfactual “control” cases of similar probabilities, and the differences between “treatment” and “control” groups may be attributable to the receipt of “treatment” (Guo & Fraser, 2014). We first introduce our “control” and “treatment” groups, and then use examples to illustrate this method in our study.

We employ two sets of propensity score matching. The first set aims to examine the health effects of living arrangements and contains four matchings. The shared control group is multigenerational living. Each of the other four living arrangements (“treatments”) is compared with multigenerational living (“control”), respectively. For instance, in evaluating the health effects of living alone compared to multigenerational living, we limit our sample to older adults only in these two living arrangements and each individual obtains a propensity score using a set of covariates in a logistic regression. By comparing health of the two groups of similar propensities, we obtain our “treatment effect” of solitary living. Kernel density estimator is used for the matching in which the propensity score distribution is divided by overlapping intervals and a weight is assigned to each value based on the distance

³Approximately 11% of the migrant offspring came from migration-split households in our sample. The past year information is proxy for current migrant children, because they may return in the current year. This is a limitation of the study. However, in the context of massive migration in China, return migration is quite low; X. W.Chen (2009) estimated that return migration is 15% at its highest in 2008 when it was the economic crisis. And even if they return, they usually do not return to the origin households in villages but rather set up new households in nearby towns (Liang, Li, & Ma, 2014). Therefore, we should expect that most of the past year migrants from migration-split households and still considered part of the household in the current year are still migrants.

from the center of the interval. A major advantage of this approach over pairwise matching is that it uses more information so a lower variance is achieved (Smith & Todd, 2005). The same procedure applies to the other three pairs of treatments and controls.

In the second set, we aim to investigate the health effects of offspring's migration on older adult health in each living arrangement. We confine our sample to each living arrangement, and older adults with migrant offspring are the treatment group and those without are the control group. As we have five living arrangements, we have a total of five propensity score matchings in this set of analysis. To illustrate, in the first step, we compare among the categories in the first column of Table 1, and in the second step, we compare the categories within each row. To better understand issues of selectivity, both unmatched results (raw difference) and matched results based on propensity score matching are reported. For matched results, "average treatment effect for the treated" (ATT) is reported. Unmatched results and ATT can be interpreted as logged odds ratios.

The covariates we used to establish matching are as follows. Sociodemographic characteristics include gender, age groups (60–64, 65–69, 70–74, 75+), education (below middle school/middle school or higher), instrumental activities of daily living (IADLs) (mean of 15 items reflecting difficulties in performing IADLs where 0 = *no difficulty* and 4 = *cannot do any of these at all*), current working status (working/not working), and whether or not having pension. Household contexts include the health status of spouse⁴ (spouse absent, spouse in good health, or spouse in fair or bad health), total number of children, number of married children, and household assets (weighted summation score of household belongings using principal component analysis). Village migration prevalence ratio (number of migrants in the village divided by the population of current residents in the village) is assessed by quintiles. We also included regions.⁵ For the analysis, psmatch2 (Leuven & Sianesi, 2003), a user developed program available in STATA is used. All matchings are balanced, and support patterns for each matching are shown in Appendix B.

Results

Results From Descriptive Analysis

Table 1 shows distribution of the weighted sample by older adult living arrangements and offspring's migration status. In terms of living arrangements, those living with spouse only (41.3%) are the largest group, followed by multigenerational households (34.3%). Prominently, 76.1% of those living in skipped-generation households have adult migrant children. This suggests that skipped-generation household is the living arrangement most profoundly influenced by adult children's migration. This is followed by living alone (51.2%) and living with spouse only (47.2%).

⁴.To avoid high collinearity, the category "spouse absent" is not included in the analyses regarding those who live alone and those who live with spouses. Health of spouse is based on spouse's self-reported health status.

⁵.Western region includes Chongqing, Gansu, Guangxi, Guizhou, Inner Mongolia, Qinghai, Shannxi, Sichuan, Xinjiang, and Yunnan. Central region includes Anhui, Henan, Heilongjiang, Hunan, Hubei, Jiangxi, and Jilin. Eastern region includes Beijing, Fujian, Guangdong, Hebei, Jiangsu, Liaoning, Tianjin, and Zhejiang.

Table 2 describes the covariates used to predict the likelihood of being in treatment groups. There are slightly more male older adults than females, and most of the older adults received no education or elementary school education. The typical older adult finds some level of difficulty in managing daily tasks. The majority (64.7%) of older adults has spouses in good health, and, on average, has 3.8 children with 3.6 of them married. The majority of rural older adults reside in the western region, where outmigration is prevalent in its rural areas.

Results From Propensity Score Analysis

Unmatched estimates and ATT for assessing the health of each living arrangement as compared to multigenerational living are reported in Table 3. For older adults living alone, unmatched results show that they have increased risk for low creatinine levels and high blood pressure than those living in multigenerational households. However, after matching, these differences disappeared. This suggests that older adults with these health risks tend to be selected into solitary living. Compared with multigenerational living, ATT results show that living with spouses only would increase their odds of being overweight by 0.11 ($\exp(0.106)-1$), and decrease their odds of being underweight by 0.075 ($1-\exp(-0.077)$). Living in two-generation household may also increase older adult's probability of being overweight, compared to multigenerational living ($p < .1$). For those living in a skipped-generation household, a comparison of unmatched and ATT results suggest that skipped-generation households select older adults with better cardiovascular fit, but they do not benefit or harm the chronic conditions of older adults compared to multigenerational living. Therefore, in terms of our biomarkers measured, we do not observe a general health advantage for those in a multigenerational household, thus rejecting H1.

Table 4 shows the health effects of offspring's migration for older adults within each living arrangement. For older adults living alone, a comparison of the unmatched and ATT results suggests that if older parents are at high risk of cardiovascular diseases (high risks of hypertension or high level of c-reactive protein), individuals tend to refrain from migration to avoid putting their older parents in solitary living. Similar selection is also observed for older adults who live with spouse only.

Adult migration appears to make clear differences in the health of their older parents who live in a two-generation household. In this living arrangement, both positive and negative effects are observed: offspring's migration increases risks of high HbA1c ($p < .1$) and high triglycerides, and reduces risks of low creatinine and underweight, suggesting positive effect on nutritional achievement and negative effects on risks of cardiovascular diseases. By contrast, in multigenerational living, offspring's migration does not have these effects, but only lowers risks of hypertension. Among skipped-generation households, offspring's migration has an adverse effect on their older parent's nutritional achievement (i.e., higher risks of underweight). Overall, our results show that adult children's migration has differentiated effects for rural older adults in different living arrangements. These results suggest more complicated effects of adult children's migration than H2 has proposed. To further explore the role of remittances, financial transfer from nonresident children in the past year is included in the matching schemes for all the models in Table 4 (results not shown). The ATT estimates remain nearly unchanged in most of the models, suggesting that

remittances do not play a significant role in mitigating the health effects of offspring's migration.

We also explored our data by examining different gender and age groups (results not shown). For older adults younger than 70 years old, our results suggest a general health benefit in living in multigeneration households, but such health advantage is not apparent for those who are older (70 + years old). However, we do not observe a consistent and compelling pattern with regard to which age group are more or less likely to benefit/hurt from their adult children's migration in their respective living arrangements. In terms of gender, the "weight plus" observed in two-generation households are similarly affecting older men and women. The migration of adult children seems to have disparate effect on the health of older men and women in two-generation households. However, due to limitation in our sample size in each subgroup, these subgroup analysis results are rather suggestive and explorative. More extensive examination of these subgroups is clearly needed, given that biomarkers collected at a larger scale in rural China become available.

Conclusion and Discussion

The increasing flow of internal and international migration across the world has altered and continues to alter the well-being of families left behind. In societies where adult children are the major source of eldercare, much effort has been devoted to the health effects of changing living arrangements on older adults (F. Chen & Liu, 2012; Samanta et al., 2015). An emerging literature has also isolated the "migration effects" of adult children on health of older adults (Antman, 2012; Knodel et al., 2010). However, these two streams of literature are developed rather independently, usually without referencing one another. Bringing together the role of migrant offspring and living arrangements is especially important in societies like rural China, where older adults face high vulnerability in their health and nearly half of them are affected by the outmigration of their adult children.

Our results shed insight on how migration of adult children affects health of older adults differently in various family circumstances. Moreover, we rely on comprehensive biomarker data addressing a wide range of chronic conditions as well as malnutrition, which are typical conditions experienced by rural Chinese older adults during an epidemiological transition (Gao et al., 2013; Yang et al., 2010). First, our analysis on living arrangements shows that in general, the traditional ideal type of living arrangement, that is, living in a multigenerational household with adult children and grandchildren has only limited health benefits. For example, they are less likely to be overweight, but are more likely to be underweight, compared with those living with spouse only. Second, older adults in two-generation living are more likely to be overweight than their counterparts in multigenerational living, suggesting the health benefits of taking care of grandchildren, such as a more active lifestyle and increased exercises (Hughes et al., 2007). Older adults who live alone or residing in a skipped-generation household do not necessarily suffer from health deficits.

Other than the abovementioned two findings, living arrangements seem to have little effect on different biomarker indicators, after selection is taken into account. However, once we go beyond living arrangements and consider adult children's outmigration, we observe a much-

nuanced picture. In multigenerational households, parents of migrants have lower risks of hypertension than parents without migrants. Parents of migrants in this living arrangement get “the best of both worlds”—an ideal living arrangement and larger financial support from their migrant offspring. Certain adaptive family strategies may contribute to these arrangements. Migrants may pay their siblings to coreside and take care of their older parents (Cong & Silverstein, 2011). With such payment, the coresident adult children may have better relationship with and take better care of their older parents, which reduces the stress of the older adults.

This also highlights the health protections of taking care of grandchildren among migrant-sending families in rural China and joins the stream of literature in support of the “role enhancement” theory. Previous research may provide some possible explanations. Taking care of grandchildren is associated with increased exercise (Hughes et al., 2007). With grandchildren in the households, the food preparers are motivated to cook a healthier diet (Kicklighter et al., 2007). Grandparents’ caregiving for grandchildren could also fulfill a cultural ideal, induce a more active lifestyle, and facilitate family bonding in rural China (Silverstein et al., 2006). Our research further suggests that caregiving for grandchildren may better benefit the health of rural older adults when their living standards are elevated by the resources brought in by their adult migrant children.

Among parents of migrants who are typically called the “left-behind older adults”—those who live alone, live with spouse only, or who live in skipped-generation households, their health is differentially affected by adult children’s outmigration as well. For those in solitary living and living with spouse only, having migrant children does not seem to affect their nutrition status or chronic conditions. For those who live in skipped-generation households, having adult migrant children may increase their risks of being underweight, and remittances may not help to ameliorate such adverse consequences. This result echoes previous research that in skipped-generation households, remittances may not be intended for improving life of older adults, but alternatively for paying for costs of child care (Cong & Silverstein, 2011).

Our analyses of migration selection bear some important policy implications. Although for those who live alone, their chronic conditions are not prominently affected by their adult children’s migration, older adults with higher risks of malnutrition (low creatinine) and hypertension tend to be selected into solitary living. Low creatinine also predicts future fall-related fractures and loss of independence. As living alone is already associated with lower intrafamilial support and other adverse mental and physical health conditions among the rural older Chinese (Li, Zhang, & Liang, 2009), it appears that older adults in solitary living are especially vulnerable. Policies need to direct more resources to serve the health needs of the older adults living alone. Moreover, our results show that migrants postpone their migration or return not only upon older adults’ serious medical conditions, as previous research has suggested (Giles & Mu, 2007), but also due to their chronic conditions. To improve the overall well-being of rural older adults and encourage supplies of laborers in urban China, stake holders need to direct more medical resources to address the chronic conditions of rural older adults.

There are also several limitations to this study. First, it would be ideal to lag health outcomes in propensity score analysis to allow controlling of prior conditions. As CHARLS 2011 is among the first efforts to collect biomarkers for older adults in China, in the long run, it is desirable to utilize longitudinal data that span extended period to evaluate chronic conditions. Second, it would be fruitful for future research to continue exploring family dynamics and negotiations between family members with regard to migration and living arrangements for older adults. For example, what are the family circumstances that trigger a migration-related change in living arrangements? How the genders of migrants and older adults influence such negotiations between family members? The answers to these questions would shed more light on how migration and intergenerational exchanges interplay to affect the well-being of older adults.

Looking ahead, scholars have suggested that with changing norms and elevated living standards, coresidence with adult children may not be the only acceptable way of living arrangement for older Chinese (Whyte, 2003). With nearly half of rural older adults experiencing migration of adult children, the adaptive capacity of older adults to cope with this change is further challenged but may be strengthened (Silverstein et al., 2006). While previous fieldwork found that parents of migrants actively seek ways and negotiate their family roles to maximize their own well-being (He & Ye, 2014), this study suggests the health outcomes of such negotiation. Meanwhile, as rural China continues to move away from the “disease of poverty” toward “diseases of affluence” (Cook & Dummer, 2004), the outmigration of adult children also directly pushes forward this epidemiological transformation in rural China.

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Appendix A:

Description of Biomarkers and Criteria for “High Risk.”

Biomarkers	1 percentile	25 percentile	50 percentile	75 percentile	99 percentile	Criteria for “high risk”
Glucose (mg/dl)	69.84	95.04	102.78	115.38	286.56	>115.38 mg/dL
Glycated Hemoglobin (HbA1c)	4.10	4.90	5.20	5.50	9.30	>5.50%
Creatinine	0.43	0.67	0.78	0.92	1.47	<.67 or > .92 mg/dL
C-reactive protein	0.20	0.60	1.14	2.51	45.00	>2.51 mg/L
HDL cholesterol	22.81	41.75	50.64	61.86	100.52	<41.75 mg/dL
Total/HDL cholesterol	1.96	3.00	3.70	4.65	8.64	>4.65
Triglycerides	38.06	72.57	100.89	144.26	453.12	> 144.26 mg/dL
Systolic blood pressure	95.33	118.00	132.33	148.00	193.33	> 148.00 mmHg

Biomarkers	1 percentile	25 percentile	50 percentile	75 percentile	99 percentile	Criteria for "high risk"
Diastolic blood pressure	50.67	66.67	74.33	82.33	105.67	>82.33 mmHg
Pulse (heart rate)	50.33	64.67	71.33	78.67	101.00	>78.67 bpm
BMI	15.32	20.00	22.14	24.78	32.05	<20.00 or >24.78

Note. HDL = high-density lipoprotein; BMI = body mass index.

Appendix B:

Support Information for Propensity Score Matchings.

	Off support	On support
"Treatment 1": Living alone		
Untreated	0	1,326
Treated	0	273
"Treatment 2": Only with spouse		
Untreated	0	1,326
Treated	0	1,610
"Treatment 3": Two-generation household		
Untreated	0	1,326
Treated	0	259
"Treatment 4": Skipped-generation household		
Untreated	0	1,273
Treated	2	415
One gen, No spouse: Migrant vs. Nonmigrant		
Untreated	0	133
Treated	1	130
One gen, Spouse: Migrant vs. Nonmigrant		
Untreated	0	760
Treated	4	846
Two gen: Migrant vs. Nonmigrant		
Untreated	0	149
Treated	3	107
Three gen: Migrant vs. Nonmigrant		
Untreated	0	717
Treated	1	608
Skipped gen: Migrant vs. Nonmigrant		
Untreated	0	99
Treated	0	313

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Table 1.

Tabulations on Older Adult Living Arrangements and Children's Migration Status.

	With migrant children		Without migrant children		Sum	
Living alone	141	7.3%	134	6.8%	275	7.1%
Only with spouse	761	39.2%	850	43.3%	1,611	41.3%
Two-generation household	110	5.7%	150	7.6%	260	6.7%
Multigeneration household	611	31.5%	728	37.1%	1,339	34.3%
Skipped-generation household	316	16.3%	99	5.0%	415	10.6%
Sum	1,939	100.0%	1,961	100.0%	3,900	100.0%

Table 2.

Covariates Used to Predict the Likelihood of Being in Treatment Groups.

	% or <i>M</i>	<i>SD</i>
Sociodemographic characteristics		
Male	53.0%	
Female	47.0%	
Aged 60–64	40.2%	
Aged 65–69	23.5%	
Aged 70–74	17.4%	
Aged 75 +	18.9%	
No education or elementary school education	97.6%	
Middle school education or higher	2.4%	
Instrumental activities of daily living	1.4	0.5
Any work	4.2%	
Receive pension	5.4%	
Household contexts		
Spouse absent ^a	21.5%	
Spouse in good health ^a	64.7%	
Spouse in fair or bad health ^a	13.8%	
Total number of children	3.8	1.6
Number of married children	3.6	1.7
Household assets	1.4	0.7
Village migration prevalence ratio (Upper limit)		
First quintile	0.06	
Second quintile	0.15	
Third quintile	0.28	
Fourth quintile	0.47	
Fifth quintile	2.20	
Regions		
West	62.9%	
Central	19.6%	
East	17.5%	

Note. Weighted by the inversed probability that blood sample is drawn from individuals.

^aVariables not included for one generation households.

Table 3.

Propensity Score Estimates of Unmatched Results and Average Treatment Effects, by Older Adult Living Arrangements.

	“Treatment 1”: Living alone		“Treatment 2”: Only with spouse		“Treatment 3”: Two-generation household		“Treatment 4”: Skipped-generation household	
	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.
Allostatic load score ≥ 4								
Unmatched	0.033		0.007		0.021		−0.050	†
ATT	0.000		−0.001		0.021		−0.048	
Glucose (mg/dl)								
Unmatched	0.022		0.012		−0.029		−0.033	
ATT	0.060		0.035		−0.021		−0.027	
Glycated Hemoglobin (HbA1c)								
Unmatched	0.01 1		−0.011		−0.047	+	0.016	
ATT	0.027		−0.009		0.031		−0.004	
Low creatinine								
Unmatched	0.068	*	−0.007		0.012		0.011	
ATT	0.046		−0.015		0.010		0.008	
High creatinine								
Unmatched	−0.015		−0.006		0.018		0.017	
ATT	−0.015		−0.018		0.005		0.015	
C-reactive protein								
Unmatched	0.025		−0.009		−0.010		−0.010	
ATT	−0.042		−0.030		−0.050		0.002	
HDL cholesterol								
Unmatched	−0.023		0.012		0.078	**	−0.014	†
ATT	−0.023		0.034		0.041		0.004	
Total/HDL cholesterol								
Unmatched	0.022		0.025		0.044		−0.043	
ATT	−0.024		0.037		0.006		−0.038	
Triglycerides								
Unmatched	0.006		0.013		0.007		−0.035	
ATT	−0.001		0.014		−0.066		−0.036	
Systolic reading								
Unmatched	0.114	***	0.000		0.024		−0.034	
ATT	0.077		−0.008		0.046		−0.017	
Diastolic reading								
Unmatched	−0.01 1		−0.001		−0.030		−0.055	*
ATT	−0.044		0.002		0.022		−0.029	
Pulse (heart rate)								
Unmatched	−0.007		−0.050		0.011		−0.050	*
ATT	0.046		−0.021		0.009		−0.043	
Underweight								

	“Treatment 1”: Living alone		“Treatment 2”: Only with spouse		“Treatment 3”: Two-generation household		“Treatment 4”: Skipped-generation household	
	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.
Unmatched	−0.025		−0.033	*	−0.037		0.019	
ATT	−0.051		−0.077	***	−0.038		−0.011	
Overweight								
Unmatched	−0.005		0.060	***	0.007		−0.021	
ATT	0.001		0.106	***	0.075	†	0.015	

Note. The models in this table define multigenerational households as the “control” group.

ATT = Average Treatment Effect on Treated; HDL = high-density lipoprotein,

† $p < .1$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4.

Propensity Score Estimates of Unmatched Results and Average Treatment Effects, by Adult Children's Migration Status.

	Living alone: Migrant offspring vs. No migrant offspring		With only spouse: Migrant offspring vs. No migrant offspring		Two-generation: Migrant offspring vs. No migrant offspring		Three-generation: Migrant offspring vs. No migrant offspring		Skipped generation: Migrant offspring vs. No migrant offspring	
	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.
Allostatic load score ≥ 4										
Unmatched	-0.069		-0.038		0.022		0.391		-0.031	
ATT	-0.007		-0.011		0.032		0.383		-0.047	
Glucose (mg/dl)										
Unmatched	-0.034		-0.001		0.051		0.241		0.055	
ATT	0.006		-0.013		-0.047		0.245		0.035	
Glycated Hemoglobin (HbA1c)										
Unmatched	0.071		0.038		0.111	*	0.192		0.072	
ATT	0.050		0.023		0.103	†	0.205		0.029	
Low creatinine										
Unmatched	-0.071		0.002		-0.102	†	0.257		-0.046	
ATT	-0.027		0.019		-0.191	*	0.238		-0.046	
High creatinine										
Unmatched	-0.012		0.038	†	0.070		0.252		-0.026	
ATT	-0.058		0.022		0.049		0.275		-0.029	
C-reactive protein										
Unmatched	-0.094	†	-0.069	†	0.001		0.237		-0.002	
ATT	-0.005		-0.079		0.033		0.214		-0.039	
HDL cholesterol										
Unmatched	-0.065		-0.029		0.030		0.254		-0.002	
ATT	-0.083		0.007		0.040		0.263		0.042	
Total/HDL cholesterol										
Unmatched	-0.042		-0.052		0.063		0.237		0.076	†
ATT	-0.063		-0.027		0.084		0.244		0.069	
Triglycerides										
Unmatched	-0.080		-0.035		0.124	*	0.251		0.049	
ATT	-0.082		0.001		0.152	*	0.244		0.015	
Systolic reading										
Unmatched	-0.124	*	-0.025	*	-0.025		0.244		-0.038	
ATT	-0.109		-0.026		0.004		0.232		-0.024	
Diastolic reading										
Unmatched	0.004		0.010		-0.012		0.285		-0.001	
ATT	-0.071		0.014		0.008		0.257	*	0.023	
Pulse (heart rate)										
Unmatched	-0.011		0.008		-0.104	†	0.261		0.062	

	Living alone: Migrant offspring vs. No migrant offspring		With only spouse: Migrant offspring vs. No migrant offspring		Two-generation: Migrant offspring vs. No migrant offspring		Three-generation: Migrant offspring vs. No migrant offspring		Skipped generation: Migrant offspring vs. No migrant offspring	
	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.	<i>b</i>	Sig.
ATT	0.017		0.014		−0.106		0.255		0.033	
Underweight										
Unmatched	0.019		0.026		−0.069		0.230	[†]	0.061	
ATT	0.005		0.014		−0.171	*	0.237		0.120	
Overweight										
Unmatched	−0.034		−0.026		−0.019		0.251		−0.005	
ATT	−0.035		0.007		0.002		0.236		−0.025	

Note. The models in the table define the older adults with no migrant children in each living arrangement as the “control” group. ATT = Average Treatment Effect on Treated; HDL = high-density lipoprotein.

[†]
 $p < .1$.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.