

ABSTRACT

Objective: This study investigates the impacts of receiving informal care on the progression of functional limitations among older people aged 60 and over in China.

Method: The data come from three waves of the China Health and Retirement Longitudinal Survey (CHARLS), which collected health and ageing-related information on a nationally representative sample of Chinese older people from 2011 to 2015. Multilevel regression models were used to analyse the data.

Results: The protective effect of receiving informal care is stronger for the first two years after the baseline survey and tends to fade away or be reversed four years later. The protective effect is stronger among older people receiving low-intensity informal care and is gradually weakened with an increase in care intensity.

Discussion: Trajectories of function capabilities are deeply embedded in social relationships. In the context of rapid population ageing and increasing demand for informal care, government support for caregivers is needed to sustain the protective effects of informal care.

Keywords: Informal care, functional limitations, Older People, China

Introduction

Long-term care is essential to older people who become physically frail and consequently have difficulty with, or are unable to, perform daily activities by themselves such as eating, dressing, cooking and shopping. In many countries, care responsibilities are mainly assumed by informal or unpaid care providers who are the relatives or friends of the care recipients (Montgomery, 1999; Morse, 2014). In the US, 34.2 million people provide unpaid care to older people on a yearly basis (Gibson & Reinhard, 2015). In China, the long-term care system relies almost exclusively upon informal care providers (National Survey Research Centre of China, 2014).

Numerous studies have shown that functional capability is the most important determinant of utilisation of informal care. Older people with a higher level of functional limitations usually receive more hours of informal care (Bonsang, 2009; Hu & Ma, 2018; Suanet et al., 2012; Wolf, 2014). In comparison, much less is known about the long-term consequences of receiving informal care. In particular, there is a paucity of evidence on the impacts of receiving informal care on older people's future functional capability. An investigation into this issue is vitally important, as it looks beyond the immediate function of informal care to meet older people's needs, and sheds light on the extent to which informal care alters functional limitation trajectories in the long run.

Verbrugge and Jette (1994) argued that informal social care can help to reduce the negative impacts of functional limitations and slow down the process of disablement. However, Uchino et al. (2016) pointed out that informal care is not always beneficial since in some cases care recipients may feel a sense of dependence or experience evasion of privacy. So far, most of the empirical research on this topic comes from the US, and research findings seem to vary according to the timing and the groups of people under investigation (Lin & Wu, 2011; Mendes de Leon et al., 2001; Wilcox et al., 1994).

Moreover, informal care receipt is a social exchange process influenced and shaped by its social and cultural context, which means that the research findings reported in one country may not be generalised to another with a different context. This is especially the case for East Asian countries, where the value systems, social norms and collective beliefs are markedly different from those in the US or European countries. For example, the discourse of ‘independence’, which is closely related to the well-being of older people in western countries, has not been recognised by Chinese older people as an important issue (Li et al., 2012). Indeed, influenced by the Confucius values and the discourse of ‘filial piety’, Chinese older people take great pride in their dependence on adult children and feel blessed if they have access to family care in later life (Qi, 2015).

Against this backdrop, this study uses longitudinal information from a nationally representative sample to investigate the dynamics of informal care receipt and functional capability among older people in China. The research question of the study is: does the receipt of informal care have a significant impact on people’s progression of functional limitations?

Informal care and trajectories of functional limitations

Although older people's trajectories of physical functioning vary markedly according to their demographic characteristics, socioeconomic status and lifestyle, on the whole people’s functional limitations increase with age (Chakravarty et al., 2012; Chen et al., 2016; Kelley-Moore & Ferraro, 2004; Matthews et al., 2005; Zimmer et al., 2014; Zimmer et al., 2012). A gradual decline in the ability to perform daily activities is a striking feature of the ageing process (Kingston et al., 2012).

Unlike healthcare services which aim to cure a patient’s ill health condition or slow down the progression of a particular disease, informal long-term care intends to make an old person’s disabled state of life more bearable (Maisonneuve & Martins, 2013) by reducing the gap

between the person's functional capabilities and the requirements imposed by the physical and social environment (Lawton, 1983; Lawton & Nahemow, 1973; Scheidt & Windley, 2006). In practice, informal care is provided to older people with functional limitations to meet their daily living needs. Rarely has the slowdown of progression of functional limitations been the first order consideration.

However, the absence of intention does not imply the absence of impact. Theoretically, receiving informal care can have a protective effect against future progression of limitations. The absence of care leads to unmet needs. Older people who need help with feeding or preparing meals may lack nutrition and those who experience difficulties in moving around may have restricted opportunities to take exercise or participate in social activities (Allen & Mor, 1997; Allen et al., 2014; Freedman & Spillman, 2014). These negative consequences of unmet needs will have a feedback effect on people's health conditions which may result in a further decline in physical functioning among older people. Receiving adequate and high-quality family care and support, therefore, can protect them against a downward spiral in their functional capabilities.

Meanwhile, the receipt of informal care is not without its downside. Provision of informal care may have a series of negative consequences on caregivers' health (Kaschowitz & Brandt, 2017; Vlachantoni et al., 2013) and employment (Van Houtven et al., 2013), and care recipients may develop a sense of burden or suffer from psychological distress when they feel that they are heavily reliant on other people in their lives (Bai et al., 2016; Morris, 2004). These negative consequences may impair the relationships between caregivers and care recipients, reduce the quality of support and care, and ultimately contribute to an increase in functional limitations.

Empirical studies have been conducted in the US to investigate the disability-related outcomes of social support which includes emotional support, financial support, and informal care

(Everard et al., 2000; Greenglass et al., 2006; Lachman & Agrigoroaei, 2010; Taylor & Lynch, 2004). In general, the evidence supports the argument of protective effects. However, since these studies treat social support as a single measure, the role of informal care remains unclear. Only three studies have investigated the long-term effects of informal care separately. They are all based on a longitudinal research design. There is evidence that the receipt of informal care is associated with a decline in future functional capabilities (Lin & Wu, 2011; Mendes de Leon et al., 2001), but it has also been reported that the impacts may depend upon the adequacy of support, the particular groups, and the timeframe under investigation (Wilcox et al., 1994).

The difficulty in reaching a consensus in this area of research is partly attributed to the complex nature of informal care receipt, which is both a social exchange process (Mavandadi et al., 2007) and a manifestation of the social relationships embedded in the wider social and cultural contexts (Fine & Glendinning, 2005; Mendes de Leon et al., 2001). People in different social or cultural groups interpret the meaning of informal care provision and receipt differently, and the balance between the protective effects and the negative consequences is likely to vary.

Confucianism, the dominant value system in Chinese society, emphasises the importance of family cohesion and filial piety (Canda, 2012). Through a system of moral principles, Confucianism defines the fundamental relationships in society (e.g. wife and husband, and parents and children) and sets out the roles and responsibilities within these relationships. Under such a value system, older people in China with care needs expect to receive help from family members rather than regarding themselves as a burden on their caregivers. Meanwhile, people provide care to their parents or spouse, not only due to their emotional attachment but also because they feel a strong sense of obligation to do so as a member of the family (Lee & Smith, 2012). Caregivers believe that it is their duty to care for older people in the family with respect and diligence. Caregiving may have various negative impacts on their lives, but meanwhile, caregivers may consider their life meaningful since caregiving enables them to

fulfil their obligations and find a purpose in life (Lai, 2010). In comparison to western societies, these social values in Chinese society provide an additional buffer in regard to the negative consequences of informal care and make the protective effects more salient. Following this argument, we formulate the first hypothesis in this study as follows:

H1: All other things being equal, Chinese older people who receive informal care will have a slower increase in functional limitations than those who do not receive informal care.

It should be recognised that the buffering effects of the social values are neither homogenous nor unlimited. In China, 94% of informal care recipients receive care from a spouse or their children (Hu & Ma, 2018). Children and spouse caregivers have different characteristics. A meta-analysis of 168 studies on the characteristics of informal care providers reported that spouse caregivers provide more hours of care than children caregivers and are more likely to have physical and mental health difficulties due to their old age (Pinquart & Sorensen, 2011). Heightened caring responsibilities will exacerbate a spouse's health difficulties. This is not to say that children do not face the challenges associated with caregiving. However, it is a viable option for some adult children to take turns providing care or sharing the caring tasks. In comparison, a spouse is usually the main caregiver, if not the sole caregiver, and thus is fully exposed to the health risks of caregiving (Gruijters, 2017). Therefore, our second hypothesis can be summarised as follows:

H2: The protective effects are stronger among older people receiving informal care from their children.

The hours of informal care provided to older people vary greatly. An increase in the hours of care crowds out caregivers' time to fulfil other responsibilities in life, making them feel overstretched (Cook & Dong, 2012). In some cases, around-the-clock caregiving is needed,

which seriously disrupts caregivers' daily routines (e.g. sleep) and continuously challenges the boundary of the buffering effects of social values (Chiu et al., 2014). A decline in health conditions among care recipients is associated with an increase in time demands for care providers and decreased capacity to provide high-quality care. Meanwhile, it can be argued that care recipients receiving more hours of care are more likely to develop a sense of dependence on their care providers. All of this will tip the balance towards the negative consequences of informal care. This leads to our third hypothesis:

H3: The protective effects of informal care are expected to be weakened with an increase in the hours of care.

Research methods

Data

The data in this study come from three waves of the China Health and Retirement Longitudinal Survey (CHARLS), which collects health and ageing-related information on people aged 45 and over in private households in China. The baseline interviews collected information from 17,708 respondents across China in 2011, which represents a response rate of 80%. The same respondents were followed up in 2013 and 2015. Following a four-stage cluster sampling procedure, the survey provided a nationally representative sample (Zhao et al., 2013).

In this study, we investigate the effects of informal care receipt and other characteristics of older people in one wave on the functional limitations in the next wave. 7,687 older people aged 60 and over participated in the baseline survey in 2011. Our analysis focuses on 5,791 older people who participated in all three waves of the survey (Figure 1). These older people come from 443 urban communities or rural villages in 28 provinces in China.

(Figure 1 about here)

Key Measurements

The dependent variables are older people's functional limitations in waves 2 and 3 (i.e. CHARLS 2013 and 2015). The survey asked respondents whether they could perform six activities of daily living (ADLs, eating, dressing, bathing, using the toilet, controlling urination and defecation, and getting in and out of bed) and five instrumental activities of daily living (IADLs, cooking, shopping, taking medication, managing money, and doing housework). For each ADL item, a respondent could choose from one of the four choices: 'I do not have difficulty', 'I have difficulty but can do it', 'I need help', or 'I cannot do it', and we scored the answer from 1 to 4 accordingly. We added up the scores and divided the total scores by the total number of ADL tasks. This gives us a variable that ranges from 1 (no ADL limitations) to 4 (inability to perform any ADL tasks). The Cronbach's reliability coefficient of the ADL limitation variable is 0.852 in wave 2, and 0.853 in wave 3. Similarly, we coded respondents' answers to each IADL question from 1 to 4, added up the scores, and divided the total scores by 5. This gives us an IADL limitation variable, which ranges from 1 (no IADL limitations) to 4 (inability to perform any IADL tasks). The Cronbach's reliability coefficient of the IADL limitation variable is 0.843 in wave 2, and 0.840 in wave 3.

The receipt of informal care in waves 1 and 2 is the key independent variable of interest in this study. The CHARLS asked respondents whether they had received informal care in regard to ADLs or IADLs, and, if so, who had provided the care and how many hours of care they had received. Based on the information obtained from these questions, we created two informal care receipt variables. First, following Hu (2018), we created a source of informal care variable, which has four mutually exclusive categories: no informal care, informal care from a spouse (including care from a spouse only and care from both a spouse and other caregivers), informal care from children (including care from children only and care from both children and other people, but not from a spouse), and informal care from relatives, friends or neighbours only.

Second, following Van Houtven et al. (2013) and Robards et al. (2015), we measured informal care intensity by the total hours of care older people received each week from different caregivers. The variable has four categories: no informal care, less than 10 hours, 10-20 hours and more than 20 hours per week. Compared to a continuous variable, a categorical variable can better differentiate the impacts of different levels of care. The CHARLS 2013 dataset only contains information on the hours of informal care from a spouse. The total hours of informal care receipt in 2013 are unknown. Therefore, we only investigated informal care intensity in 2011.

Control variables

The control variables are the characteristics of older people in waves 1 and 2 that may affect their functional limitations in waves 2 and 3, respectively. Based on the discussion in the previous section, we controlled for four groups of variables in the analysis, including health conditions, demographic factors, lifestyle factors and socioeconomic status. There are five health-related control variables in the analysis: ADL limitations, IADL limitations, number of chronic diseases, self-reported health, and severity of depressive symptoms. The CHARLS collected information on 14 chronic diseases. The self-reported health variable had three categories: good, fair and bad health. The severity of depressive symptoms was measured using the 10-item Centre for Epidemiologic Studies Depression Scale (CES-D Scale). The variable ranges from 10 (no depressive symptoms) to 40 (severe depressive symptoms).

There are five demographic factors, age, gender, rural-urban residence, marital status and living arrangements, and two lifestyle factors, drinking and smoking, in the analysis. We divided the older people into two categories according to their marital status: those who were single and had never been married, divorced, widowed or separated (single people), and those who were married or cohabiting with their partners (married couples). We divided the older people into

two categories according to their living arrangements: those who lived alone and those who lived with other people in the same household.

We also controlled for three socioeconomic status variables: level of education, household income per capita and housing tenure. The education variable has two categories: those who were illiterate or did not finish primary school (no formal education) and those who had at least finished primary education (receipt of formal education). The housing tenure variable has two categories: living in rented housing and living in owned or mortgaged housing. Gender, rural-urban residence and level of education are time-invariant variables. All of the other control variables are time-variant variables.

Multilevel dynamic regression modelling

The theoretical framework discussed in the previous section indicates that functional limitations are a developmental process. The impacts of informal care on limitation progression are cumulative over time and become increasingly discernible in the longer terms. Therefore, we built dynamic regression models to capture such an intertemporal effect. Furthermore, a dynamic model is less vulnerable to reverse causation (Croezen et al., 2015). Multilevel regression models were used to capture unobserved heterogeneity (Rabe-Hesketh & Skrondal, 2012). Following the recent mutual assimilation between multilevel regression (panel data) modelling and generalised structural equation modelling (Allison et al., 2017; Bollen & Brand, 2010; Skrondal & Rabe-Hesketh, 2004), our model takes the following form:

$$\text{Log}(y_{tik}) = \beta_0 + \beta_{t-1}c_{(t-1)ik} + \gamma_1z_{1(t-1)ik} + \dots + \gamma_{15}z_{15(t-1)ik} + \zeta_{ik}^{(2)} + \zeta_k^{(3)} + \varepsilon_{tik}, t = 2, 3$$

y_{tik} denotes the ADL or IADL status for an older person i at time point t ($t=2, 3$) in community k . Following Ormel *et al.* (2002), we logarithmically transformed this variable to reduce the dispersion and account for the non-normality of the sample distribution. $c_{(t-1)ik}$ denotes the receipt of informal care for an older person i at time point $t-1$ in community/village k . $z_{(t-1)ik}$

denotes the control variables at time point t-1. $\zeta_{ik}^{(2)}$ and $\zeta_k^{(3)}$ denote the subject and community-level unobserved heterogeneity (level-2 and level-3 random effects), respectively. $\zeta_{ik}^{(2)}$ and $\zeta_k^{(3)}$ are assumed to be normally distributed and uncorrelated with covariates. ε_{itk} is the error term, which is assumed to be normally distributed and uncorrelated with $\zeta_{ik}^{(2)}$, $\zeta_k^{(3)}$ and the covariates; β_{t-1} denotes the coefficient of care receipt at time point t-1; γ denotes the coefficients of the control variables.

Such a model is slightly different from the conventional three-level random effects model in the sense that the coefficients of the care receipt variable are allowed to vary for different time points (i.e. $\beta_1 \neq \beta_2$). The motivation is that we are particularly interested in understanding whether the protective effects of informal care persist or change over time. Such a model can also be regarded as a special case of the generalised structural equation model where equality constraints are imposed on the control variables for the purpose of model parsimony (Bollen & Brand, 2010) and where subject and community-level unobserved heterogeneity are included in the model as latent variables (Skrondal & Rabe-Hesketh, 2004).

The coefficients of the model were estimated by maximising the following likelihood function:

$$\mathcal{L} = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} h(\zeta_{ik}^{(2)}, \zeta_k^{(3)}) \prod_{k=1}^n \prod_{i=1}^{m_k} \prod_{t=2}^3 [f[\text{Log}(y_{tik})] | \zeta_{ik}^{(2)}, \zeta_k^{(3)}] d\zeta_{ik}^{(2)} d\zeta_k^{(3)}$$

Where $h(\zeta_{ik}^{(2)}, \zeta_k^{(3)})$ is the joint distribution of $\zeta_{ik}^{(2)}$ and $\zeta_k^{(3)}$, n denotes the total number of communities/villages, and m_k denotes the total number of people in the k th community/village. $f[\text{Log}(y_{tik})]$ denotes the probability density function of the logarithmically transformed response. The integrals in the likelihood function were approximated using adaptive quadrature with 7 quadrature points. Diagnostic tests were conducted to test the fit of the models. Alternative modelling specifications were formulated to test the robustness of the modelling results (see Appendix). The analyses were conducted using Stata 14 (syntax: gsem).

Results

In the 2011 baseline survey, the average ADL score of the older people aged 60 and over in the sample is 1.11 (table 1). The following four years see the average ADL score gradually increase, which indicates overall heightened ADL limitations of older people in the sample. However, the trajectories of ADL limitations vary according to the receipt of informal care. For informal care recipients, the average ADL score decreased to 1.35 in 2013, before it increased to 1.47 in 2015. This is in stark contrast to the average score among people without informal care, which continued to increase to 1.08 in 2013 and 1.13 in 2015, respectively.

The same pattern can be observed for IADL scores. For the entire sample, the average score increased from 1.24 in 2011 to 1.27 in 2013 and 1.36 in 2015, which means that older people in the sample have more severe IADL limitations over time. The average IADL score among informal care recipients decreased from 2.11 in 2011 to 1.77 in 2013, before rising to 1.92 in 2015. Despite an increase in the last two years, the average IADL score in 2015 was still lower than its baseline level. In contrast, the average IADL score increased from 1.07 in 2011 to 1.25 in 2015 among older people not receiving informal care.

Older people's reliance on informal care increases with the progression of their functional limitations. 16.6% of older people in the sample (n=960) were receiving informal care in 2011. The proportion of informal care recipients increased to 21.2% (n=1,226) in 2013 and 27.8% (n=1,614) in 2015. Furthermore, older people in the sample became more reliant on non-spouse care over time. The ratio of people receiving non-spouse care to those receiving spouse care increased from 0.5 in 2011 to 0.8 in 2015.

(Table 1 about here)

7.1% of older people in the sample received 1-10 hours of informal care each week in 2011. The proportions of people receiving 10-20 hours and 20+ hours of care were 2.6% and 6.9%,

respectively. For the entire sample, older people on average received 4.9 hours of informal care. In 2015, 11.6% of older people in the sample received 1-10 hours of informal care. The proportions for 10-20 hours and 20+ hours of care in 2015 were 4.5% and 11.8%, respectively. Older people on average received 12.3 hours of informal care per week in 2015, which is much higher than the 2011 level of 4.9 hours per week.

Table 2 shows the impacts of receiving informal care in waves 1 and 2 on ADL and IADL limitations in waves 2 and 3, respectively. All other things being equal, older people receiving informal care in wave 1 have less severe ADL limitations (i.e. a lower ADL score) in wave 2 than those without care (model 1, column 2). The impact is larger among older people receiving children care than those receiving spouse care ($p\text{-value}<0.001$). Compared to those without informal care, older people receiving informal care in wave 2 have more severe ADL limitations in wave 3 (model 1, column 3), but the impact does not differ between spouse care and children care ($p\text{-value}=0.70$).

All of the health conditions variables in wave 1 and wave 2 are statistically significant predictors of ADL scores in waves 2 and 3, respectively. The ADL and IADL scores in the previous wave are positively correlated with the ADL scores in the next wave. Older people with physical or mental health difficulties have higher ADL scores in the next wave. Age is the only statistically significant predictor of ADL scores among the demographic factors. Older people's ADL scores in the next wave are positively associated with their age in the previous wave. None of the lifestyle or socioeconomic factors has a significant impact on ADL scores.

(Table 2 about here)

Compared to those without care, older people receiving spouse care or receiving children care in wave 1 have less severe IADL limitations in wave 2 (model 2, column 4). Older people receiving informal care in wave 2 have more severe IADL limitations in wave 3 (model 2,

column 5). Apart from health conditions and age, IADL limitations are also affected by older people's frequency of drinking, level of education and income.

In both models, the estimated variance of the level-2 random effects (i.e. subject-level heterogeneity $\zeta_{ik}^{(2)}$) is negligibly small, and thus is dropped in the estimation process. The likelihood-ratio test shows that the level-3 random effects (i.e. $\zeta_k^{(3)}$) are statistically significant. The implication is that the functional limitations of older people are highly heterogeneous among different communities across the country, so community-level heterogeneity should be accounted for in the models.

Table 3 shows the impacts of care intensity on ADL and IADL limitations. Information on care intensity in wave 2 is unavailable in the CHARLS 2013 dataset, so we fit a two-level dynamic regression model where the dependent variable is the functional limitations in wave 2 and the independent variables are characteristics in wave 1. Level-2 random effects capture community-level unobserved heterogeneity. The relationships between care receipt and future ADL and IADL scores differ markedly according to the intensity of care. Compared to older people without informal care, those receiving less than 10 hours of care per week in wave 1 have a lower ADL or IADL score in wave 2. Older people receiving 10-20 hours of informal care have a higher ADL or IADL score two years later than those who do not receive care, but the difference between the two groups does not have statistical significance. For older people receiving more than 20 hours of informal care in wave 1, their ADL or IADL scores in wave 2 are significantly higher than those without informal care.

Discussion and Conclusion

This paper used three waves of the CHARLS data to investigate the long-term consequences of receiving informal care on the progression of functional limitations among a nationally representative sample of older people aged 60 and over in China. We tested three hypotheses

in this study. In the first hypothesis, we expected to see that receiving informal care would have a protective effect on older people and slow down their progression of functional limitations. The regression results partially confirmed this hypothesis. We found that the protective effect of informal care exists up to two years from the baseline survey of 2011, and is reversed four years after the baseline survey. Such a finding applies to both spouse and non-spouse care. Our second and third hypotheses were supported by the evidence. In the cases where receiving informal care is associated with less severe functional limitations in the future, the protective effect of spouse care is not as strong as that of care from children. Moreover, all other things being equal, as older people receive more hours of informal care each week, the protective effect dissipates or is reversed.

Mendes de Leon et al. (2001) and Lin and Wu (2011) reported that the receipt of informal care has an overall adverse effect on, or facilitates the progression of, ADL or IADL limitations in the US. Our results do not fully agree with those findings. The negative impacts of informal care are attributed to the fact that care provision is a labour-intensive task with potentially unfavourable health and employment consequences to care providers (Kaschowitz & Brandt, 2017; Van Houtven et al., 2013) and that care recipients may experience psychological distress in the course of social exchange (Bai et al., 2016; Morris, 2004). We recognise the existence of these challenges and difficulties in the Chinese context. Meanwhile, the outcomes of providing and receiving informal care are also related to people's perception of care. The Confucian values attach great importance to intra-family care and advocate older people's right to family care. Therefore, we argue that the Chinese traditional values can provide a buffer against the challenges and difficulties associated with informal care. The empirical evidence in this study seems to support this argument.

Our findings also suggest that informal care affects the progression of ADL or IADL limitations with varied timings in different social contexts. In contrast to the evidence reported

in western countries, it appears that the buffering effects of the social values help to postpone the progression of functional limitations for a short period of time. Put differently, the unfavourable consequences of informal care emerge later in China. The buffering effects have their own boundaries, however. The challenges associated with care provision can be acute when older people have low care needs but receive high-intensity care, as this imposes unnecessary workload on caregivers or reinforces care recipients' sense of dependence. As people's functional capability declines and care intensity increases, the undesirable impacts start to pile up and overwhelm the buffering effects, which seems to explain the disappearance or the reversal of the protective effects of informal care.

Informal care imposes huge (opportunity) costs on society (Joo & Liang, 2017; Langa et al., 2001; Saka et al., 2009). Prince *et al.* (2014) reported that informal care costs account for 44% of the total health and social care costs for older people with dementia in the UK. The annualised economic value of informal care in the US amounts to \$470 million (Reinhard et al., 2015). Most of the existing studies only measure the direct labour input involved in care provision, but rarely consider the indirect costs or benefits, namely its impacts on future functional limitations. Our research suggests that informal care may bring about benefits or save costs later by preventing the progression of limitations under certain conditions. This means that the economic costs of informal care are not 'society-neutral'.

The fact that the protective effects of informal care tend to dissipate in the long-run does not mean that older people should stop receiving it because informal care also serves the crucial and immediate function of meeting older people's care needs. Instead, measures should be taken to sustain the protective effects of informal care. In developed countries, professional care providers can share the responsibilities of caregiving and relieve informal care providers of some of the workload (Montgomery, 1999; Pickard, 2001). This should also be the path forward for the Chinese long-term care system. Moreover, the timing is as important as the

availability of support. For those older people who have been receiving intensive informal care for years, the government should regularly evaluate their care relationships, support networks and quality of care. Government interventions or support should step in when there are clear signs of strained relationships between caregivers and recipients or there is a decline in the satisfaction with care. In addition, the Chinese government may also want to consider coordinating the current pension and healthcare insurance systems, so that they can provide additional support to the care recipients and providers. A dedicated discussion on policy interventions will be useful in future research.

Two limitations of the study should be kept in mind. First, by excluding those older people who died or were lost to follow-up in waves 2 and 3 (figure 1) in our analyses, we assumed that the attrition in the CHARLS dataset is missing at random (MAR). To address this issue, we conducted further analyses on this group of older people. We found that the control variables included in this study (functional limitations, health conditions and age in particular) are strongly correlated with attrition, even though the receipt of informal care does not affect attrition. It seems that our regression models can effectively predict the missing mechanism in the dataset, so the MAR assumption is not totally unreasonable. The results of these supplementary analyses will be available upon request.

Second, the inclusion of a comprehensive list of control variables helps us to minimise the risks of endogeneity bias caused by missing variables. Like many other studies, we fitted dynamic models which could help us further protect against the endogeneity bias caused by reverse causation (Allison et al., 2017). Meanwhile, we fully acknowledge the difficulties and uncertainties involved in addressing the issue of endogeneity using a non-experimental dataset. We have taken all steps that can be managed in a single study to investigate this issue and have not yet found strong evidence of endogeneity bias, but it should be recognised that this may not be entirely precluded. Separate studies in the future using alternative designs or approaches

(e.g. randomised controlled trials or propensity score matching) will be useful to further test the robustness of the findings in this study.

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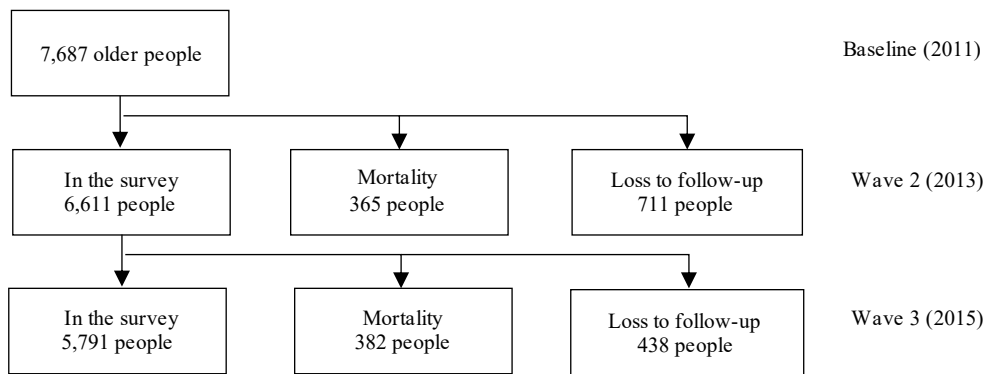


Table 1 Sample characteristics

Year	2011 (wave 1)	2013 (wave 2)	2015 (wave 3)
Sample means or proportions			
ADL scores			
Entire sample	1.11	1.12	1.19
Receiving care in wave 1	1.45	1.35	1.47
Not receiving care in wave 1	1.05	1.08	1.13
IADL scores			
Entire sample	1.24	1.27	1.36
Receiving care in wave 1	2.11	1.77	1.92
Not receiving care in wave 1	1.07	1.17	1.25
Number of diseases			
	1.59	1.56	1.57
Self-reported health			
Good	65.3%	68.4%	67.9%
Fair or poor	34.7%	31.6%	32.1%
Depression symptoms			
	9.2	8.3	8.9
Sources of informal care			
No informal care	83.4%	78.8%	72.1%
Spouse care	10.9%	13.0%	15.6%
Care from children	5.0%	7.1%	11.1%
Care from others	0.7%	1.1%	1.2%
Intensity of informal care			
No informal care	83.4%	78.8%	72.1%
1-10 hours per week	7.1%	n.a.	11.6%
10-20 hours per week	2.6%	n.a.	4.5%
20+ hours per week	6.9%	n.a.	11.8%
Average hours of informal care per week			
	4.9	n.a.	12.3
Age			
	67.6	69.6	71.6
Gender			
Males	49.5%	49.5%	49.5%
Females	50.5%	50.5%	50.5%
Residence			
Rural villages	80.9%	80.9%	80.9%
Urban communities	19.1%	19.1%	19.1%
Marital status			
Married	80.2%	77.5%	74.4%
Single, widowed, separated or divorced	19.8%	22.5%	25.6%
Living arrangements			
Living alone	8.4%	10.9%	n.a.
Living with others	91.6%	89.1%	n.a.
Smoking			
No	58.3%	58.4%	53.9%
Yes	41.7%	41.6%	46.1%
Drinking			
Less than once per month	75.7%	75.9%	73.8%
More than once per month	24.3%	24.1%	26.2%
Formal education			
No	57.1%	57.1%	57.1%
Yes	42.9%	42.9%	42.9%
Income per capita per year (thousand Yuan)			
	10.9	9.5	n.a.
Housing tenure			
Owner	87.2%	85.7%	83.3%
Renter	12.8%	14.3%	16.7%
Sample size		5,791	

Table 2 The impacts of informal care receipt on future functional limitations (three-level dynamic regression models)

	Dependent variables (ADL or IADL limitations in wave 2 or 3)			
	Model 1: Log-ADL score		Model 2: Log-IADL score	
	Wave 2	Wave 3	Wave 2	Wave 3
Informal care receipt in wave 1				
No informal care (reference)				
Spouse care	-0.026** (0.009)		-0.026 (0.014)	
Care from children	-0.074*** (0.013)		-0.036* (0.018)	
Care from others	-0.067* (0.029)		-0.080 (0.045)	
Informal care receipt in wave 2				
No informal care (reference)				
Spouse care		0.050*** (0.009)		0.042** (0.014)
Care from children		0.055*** (0.013)		0.073*** (0.019)
Care from others		0.050* (0.020)		0.077* (0.032)
Control variables in wave 1 and 2				
Health conditions				
ADL score	0.238*** (0.008)		0.116*** (0.012)	
IADL score	0.073*** (0.006)		0.234*** (0.008)	
Number of chronic diseases	0.006*** (0.001)		0.005** (0.002)	
Good health (reference)				
Fair or bad health	0.015*** (0.002)		0.031*** (0.003)	
Depressive symptom	0.002*** (0.0004)		0.003*** (0.001)	
Demographic factors				
Age	0.003*** (0.0003)		0.007*** (0.0004)	
Male (reference)				
Female	0.003 (0.005)		0.011 (0.008)	
Living in rural villages (reference)				
Living in urban communities	-0.002 (0.006)		-0.007 (0.008)	
Married (reference)				
Single, widowed, separated or divorced	0.008 (0.006)		0.004 (0.009)	
Living alone (reference)				
Living with others	0.007 (0.007)		0.021 (0.011)	
Lifestyle factors				
Non-smoker (reference)				
Smoker	0.00001 (0.005)		-0.001 (0.007)	
Drink less than once per month (reference)				
Drink more than once per month	-0.004 (0.005)		-0.018** (0.007)	
Socioeconomic factors				
No formal education (reference)				
Receipt of formal education	-0.004 (0.004)		-0.027*** (0.006)	
Income	0.0001 (0.0001)		-0.0003*(0.0001)	
House owner (reference)				
House renter	-0.005 (0.005)		-0.010 (0.008)	
Joint significance test	$\chi^2(20) = 5762***$		$\chi^2(20) = 7,179***$	
LR test of community-level heterogeneity	$\chi^2(1) = 18.4***$		$\chi^2(1) = 22.6***$	
AIC	-5379		3370	
BIC	-5213		3537	
Sample size	5,791		5,791	

Notes

(1) The figures in the parentheses are standard errors.

(2) Characteristics in wave 1 predict functional limitations in wave 2, and characteristics in wave 2 predict functional limitations in wave 3.

(3) *p<0.05, **p<0.01, ***p<0.001.

Table 3 The impacts of informal care intensity on future functional limitations (two-level dynamic regression model)

	Dependent variables (ADL or IADL limitations in wave 2)	
	Model 3 Log-ADL score	Model 4 Log-IADL score
Intensity of informal care in wave 1		
No informal care (reference)		
1-10 hours	-0.026** (0.011)	-0.054*** (0.017)
10-20 hours	0.011 (0.017)	0.048 (0.026)
20+ hours	0.029* (0.013)	0.060** (0.020)
Control variables in wave 1		
Health conditions		
ADL score	0.216*** (0.011)	0.087*** (0.017)
IADL score	0.053*** (0.008)	0.225*** (0.012)
Number of chronic diseases	0.005** (0.002)	0.0005 (0.003)
Good health (reference)		
Fair or bad health	0.014*** (0.003)	0.028*** (0.004)
Depressive symptom	0.002*** (0.0004)	0.002** (0.001)
Demographic factors		
Age	0.002*** (0.0004)	0.007*** (0.001)
Male (reference)		
Female	0.002 (0.007)	0.008 (0.010)
Living in rural villages (reference)		
Living in urban communities	0.004 (0.008)	-0.002 (0.012)
Married (reference)		
Single, widowed, separated or divorced	0.010 (0.007)	0.012 (0.011)
Living alone (reference)		
Living with others	0.026** (0.009)	0.052*** (0.015)
Lifestyle factors		
Non-smoker (reference)		
Smoker	-0.002 (0.006)	-0.004 (0.010)
Drink less than once per month (reference)		
Drink more than once per month	-0.001 (0.006)	-0.014 (0.009)
Socioeconomic factors		
No formal education (reference)		
Receipt of formal education	-0.003 (0.005)	-0.032*** (0.008)
Income	0.0001 (0.0001)	-0.0002(0.0002)
House owner (reference)		
House renter	-0.003 (0.007)	-0.015 (0.011)
Joint significance test	$\chi^2(19) = 1,708^{***}$	$\chi^2(20) = 2,205^{***}$
LR test of community-level heterogeneity	$\chi^2(1) = 36.9^{***}$	$\chi^2(1) = 30.7^{***}$
AIC	-3,471	1,443
BIC	-3,331	1,582
Sample size	5,791	5,791

Notes:

(1) The figures in the parentheses are standard errors.

(2) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.