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Young Kyung Do, assistant professor, Program in Health Services and Systems Research, Duke–NUS Graduate Medical School Singapore
Chetna Malhotra, Program in Health Services and Systems Research, Duke–NUS Graduate Medical School Singapore

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For information, contact: Karen N. Eggleston (翁笙和)
Walter H. Shorenstein Asia-Pacific Research Center
Freeman Spogli Institute for International Studies
Stanford University
616 Serra St., Encina Hall E311
Stanford, CA 94305-6055
(650) 723-9072; Fax (650) 723-6530
karene@stanford.edu

STANFORD UNIVERSITY
ENCINA HALL, E301
STANFORD, CA 94305-6055

T 650.725.9741
F 650.723.6530

The Effect of Coresidence with an Adult Child on Depressive Symptoms among Older Widowed Women in South Korea: An Instrumental Variable Estimation

Young Kyung Do,[1] Chetna Malhotra
Program in Health Services and Systems Research
Duke–NUS Graduate Medical School Singapore

Abstract

The objective of this paper is to estimate the causal effect of coresidence with an adult child on depressive symptoms among older widowed women in South Korea. Data from the first and second waves of the Korea Longitudinal Study of Aging were used. Analysis was restricted to widowed women aged ≥ 65 years with at least one living child (*N*=2,449). We use an instrumental variable approach that exploits the cultural setting where number of sons predicts the probability of an elderly woman's coresidence with an adult child but is not directly correlated with the mother's depressive symptoms. Our models adjust for age, education, total assets, residence, functional limitations, self-rated health, and various illnesses. Our robust estimation results indicate that, among older widowed women, coresidence with an adult child has a significant protective effect on depressive symptoms, but that this effect does not necessarily benefit those with clinically relevant depressive symptoms. Future demographic and social transitions in South Korea portend that older women's increasing vulnerability to poor mental health is an important though less visible public health challenge.

Keywords: living arrangements, coresidence, depressive symptomatology, elderly, KLoSA

[1] Corresponding author: Young Kyung Do, assistant professor, Program in Health Services and Systems Research, Duke–NUS Graduate Medical School Singapore, 8 College Road, Singapore 169857. Tel: +65 6516-2790. Fax: + 65 6534-8632. E-mail: young.do@duke-nus.edu.sg

Introduction

The proportion of older adults (aged ≥ 65 years) in South Korea, currently 9%, is projected to reach 38% by 2050, making South Korea one of the oldest countries in the world (Howe N *et al.* 2007). At the age of 65 years, older Korean women are likely to survive men by 4.4 years, life expectancy at age 65 years being 21.0 years for women vs. 16.6 years for men, making older widowed women a large and fast-growing group in the country (National Statistical Office 2009). Concerns for this population group have been raised, especially due to a decrease in parent-child coresidence, which has served as the major structure of support provided by adult children. This change in elderly living arrangements results from an array of factors, such as declining fertility, migration from rural to urban areas, and increased female labor force participation (Grundy 1992; Kweon 1998; Sung 2001; Yi *et al.* 2001).

It is well documented that widowed people experience higher rates of depression than married ones, and that women in general are more likely to be psychologically distressed than men, irrespective of their marital status (Hinton *et al.* 2006; Minicuci *et al.* 2002; Ried *et al.* 2002; Sonnenberg *et al.* 2000; Zunzunegui *et al.* 1998). Clinical depression and depressive symptoms, in turn, have been linked to greater health care utilization, higher spending on care, and higher mortality rates (Arnow *et al.* 2009; Egede 2007; Fu *et al.* 2003; Katon 2003). Suicide, a growing social and public health problem in South Korea, is also related to clinical depression (Organization for Economic Co-operation and Development 2009; Shah *et al.* 2008). Though decrease in coresidence with an adult child in South Korea has been argued to explain older widowed women's depressive symptoms and suicide, there is surprisingly little evidence to support this hypothesis. Further, while a growing body of research shows living arrangements of older adults are associated with their mental health status, most of this research focuses on the effect of living alone versus living with others, which may or may not include an adult child. (Chou *et al.* 2006; Dean *et al.* 1992; Mui 1999; Ostbye *et al.* 2000; Ramos *et al.* 2003; Russell *et al.* 2009; Zunzunegui *et al.* 2001). Less is known about the effect of coresidence with an adult child. Further, most research on mental health of widowed older adults either focuses on the effect of losing a spouse or on differences in depressive symptoms among men and women (Li *et al.* 2005; Silverstein *et al.* 1994). Again, little is known about how coresiding with an adult child affects the mental health of older widowed women.

Some studies from Western countries have found that older married couples may not benefit from the emotional or instrumental support provided by their children due to lower self-esteem associated with loss of autonomy and functional/emotional dependence on their children (Mutran *et al.* 1984; Silverstein *et al.* 1994). There is, however, reason to believe that living with an adult child and receiving their support might benefit older widowed women, especially in Asian settings (Silverstein *et al.* 2006). Many Asian societies, including that of South Korea, place a strong emphasis on filial piety. It has been the norm for adult children, in particular the eldest son, to live with parents even after marriage (Koo 1987; Park *et al.* 2005). In such cultures, parents tend to have strong expectations that their children will support and live with them in their old age. This may be especially true for women who, having been the primary caretakers of their children, are more likely to expect and receive support from them in later life. Further, loss of spousal support may increase the economic vulnerability of these older widowed Korean women, given their lower educational status and lower rates of employment as well as limited pension and welfare programs in South Korea (S.-J. Choi 2002; S. Choi 2008; Lee *et al.* 1992). For these widowed women, living with an adult child can provide greater financial, material, instrumental, and emotional support than living alone, while some may still opt for privacy and autonomy over support from coresiding adult children. Taking care of grandchildren may also provide these women with a sense of purpose in life and keeps them engaged, although the demands of caring for grandchildren may cause stress and other negative health effects (Grinstead *et al.* 2003). Given the potential positive and negative effects of coresidence, the mental health effect of intergenerational coresidence is ultimately an empirical question.

Most previous studies on living arrangements and depressive symptoms have been cross-sectional in design (Chan *et al.* 2010; Jeon *et al.* 2007; Russell *et al.* 2009; Zunzunegui *et al.* 2001). A major methodological challenge in such study designs is that coresidence with an adult child is not determined randomly; that is, individual and family decisions on coresidence and caregiving may be correlated with the widowed woman's functional limitations as well as physical and mental health, including depressive symptoms (Brown *et al.* 2002; Coe *et al.* 2009). It is therefore difficult to say whether coresidence with an adult child was an antecedent to or a result of the poor mental or physical health of an older adult. Further, widowed women living with an adult child may differ from those not living with an adult child in various unmeasured characteristics. The strength of the relationship between an older woman and her adult children is an example of unobserved characteristics that are related to both intergenerational coresidence and depressive symptoms among elders. Coresidence can also be a reflection of unobserved yet important socioeconomic characteristics of both older widowed women and of their adult children, such as bequest possibilities and expectations. Ignoring this reverse causality and selection with respect to coresidence can lead to a biased estimate of the effect of coresidence with an adult child on an older woman's psychological well-being.

This paper aims to estimate the causal effect of coresidence with an adult child on depressive symptoms among older widowed women in South Korea, using an instrumental variable (IV) approach. We hypothesize that, after controlling for observed and unobserved characteristics, coresidence with an adult child as a structural indicator for parental support has a beneficial effect on older widowed women's depressive symptoms.

Methods

Data source: Korea Longitudinal Study of Aging (KLoSA)

The KLoSA is a nationally representative study of noninstitutionalized South Korean adults in 15 large administrative areas. Assuming a target sample size of 10,000 persons and an average household size of 1.67 members aged 45 years and above, a total of 1,000 enumeration districts were selected and stratified by type of area (urban/rural) and type of housing (apartment/non-apartment). The first wave of the survey, conducted between July and December 2006, involved 10,254 older adults (aged 45 years and above) in 6,171 households. All participants were interviewed face to face using a computer-assisted personal interviewing method. The second wave of the survey, conducted between July and November 2008, involved re-interviews with 8,688 (84.7%) respondents from the first wave. The current analysis has been restricted to widowed women 65 years and above (in 2006) with at least one living child (N=2,477). After excluding 28 observations (1.13% of 2,477) with missing values for variables used in the analysis, our final sample consisted of a total of 2,449 observations (1,279 observations from the first wave and 1,170 from the second wave).

Variables

Depressive symptoms were examined using the short-form (10-item) Center for Epidemiological Studies – Depression (CES-D) scale. This scale has been widely used for measuring the severity of depressive symptoms among older adults (Kohout *et al.* 1993; Cho *et al.* 1998; SN Jang *et al.* 2009; Y Jang *et al.* 2010). Each symptom on the CES-D 10 used in the KLoSA was scored 0 (very rarely [less than one day]), 1 (sometimes [1–2 days]), 2 (often [3–4 days]), and 3 (almost always [5–7 days]). After reverse coding two positive items, scores for the 10 items were summed up to give a total score ranging from 0 (least depressed) to 30 (most depressed). We used this continuous variable as our primary dependent variable in the current study. In addition, we considered a binary indicator variable of CES-D score ≥ 10 to examine clinically relevant depressive symptoms (Andresen *et al.* 1994).

The main explanatory variable in the analysis was a binary indicator variable of coresidence with an adult child (1 if yes, 0 if no) derived from the survey question, "Is [your child n's NAME] currently coresiding with you?" If a child lived away from home due to schooling or job, the child was regarded as not coresiding with the respondent. In our final study sample of widowed women 65 years and above, all their coresiding children were reported to be 20 years or older. We focused on coresidence with the respondent's own children, not including coresidence with other individuals. This was done because coresidence was asked explicitly only about the respondent's own living children. In our wave 2 data, there were 3 respondents who did not report coresiding with any of their own children but reported having a child-in-law living in the same household. We chose not to define these observations as coresidence in order to be consistent with our initial definition of coresidence with an adult child.

Covariates included a set of demographic, socioeconomic and health-related variables, namely age, education (elementary school, middle school, high school, college), quintile of total assets in the first wave, residence area (Seoul, other metropolitan areas, and province), limitations in activities of daily living (ADL) or instrumental ADL, self-rated health (very good,

good, fair, poor, very poor) and various disease indicators available in the KLoSA survey (hypertension, diabetes, cancer, chronic lung disease, liver disease, heart disease, stroke, psychiatric problems, arthritis, injury due to traffic accidents, a fall in the past two years, and urinary incontinence).

Statistical analysis

Initial descriptive statistics were used to compare the characteristics of women living and not living with an adult child during the 2006 baseline survey. In the descriptive analysis, χ^2-test was used for categorical variables and *t*-test for continuous variables, to examine differences in the distribution of depressive symptoms score, the proportion of subjects with clinically relevant depressive symptoms and other covariates.

Our analyses aimed to estimate the following multivariable model:

$$DEP = f(\beta CORESIDE + \delta X + \varepsilon)$$

where *DEP* indicates either a continuous variable of depressive symptom scores or binary variable for clinically relevant depressive symptoms (CES-D score ≥ 10), *CORESIDE* denotes coresidence with an adult child, *X* denotes a set of covariates, and ε is an error term. The link function *f* is linear for the continuous variable of depressive symptom scores and a probit for the binary variable of clinically relevant depressive symptoms. The goal is to obtain an unbiased estimate of β. Our hypothesis predicts that coresidence has a beneficial effect on depressive symptoms and therefore that β has a negative coefficient.

The main estimation issue is that coresidence with an adult child (*CORESIDE*) is correlated with the error term (ε) for the aforementioned reasons related to reverse causality and selection. To account for this issue, we use the IV estimation method. In our IV estimation, good IVs must satisfy two requirements. They must be correlated with coresidence but uncorrelated with the woman's depressive symptoms other than the pathway through coresidence. We used dummy variables of number of sons ("having 1-2 sons", "having 3 or more sons", with the omitted category of no sons (daughters only)) as two IVs. These dummy variables were created based on the non-linear relationship between coresidence with an adult child and number of sons. In traditional Korean culture, adult sons take on primary responsibility for coresidence and other parental support (Kweon 1998). The eldest son is typically defined as the oldest son only among sons, not including daughters, and carries the highest level of responsibilities for parental support. Even the younger sons have greater responsibilities than daughters, though parental expectations of support diminish with increasing birth order among sons. Number of sons is therefore expected to be a strong predictor of an older widowed woman's coresidence with an adult child, similar to number of living children in Western culture (Elman *et al.* 1995; Soldo *et al.* 1990). In our data, we found coresidence with an adult child to be significantly higher among those with 1-2 sons and with 3 or more sons compared to those with no sons (daughters only).

Another key assumption for our IV estimation is that these IVs should not be correlated with older women’s depressive symptoms in our models. Before turning to the formal statistical test, it is instructive to speculate why this assumption might fail. We considered three possible pathways by which number of sons can be correlated with older widowed women's depressive symptoms. First, our assumption on IV validity fails if not having any sons (or more sons) itself has a direct negative effect on their mental health. Most widowed women in our sample had their childbearing period in the 1960-70s when strong son preference was prevalent in Korean society. However, while the negative mental health effect of having no sons may last beyond their childbearing age, it is unlikely to persist into their old age. Second, number of sons can reflect past and present socioeconomic and health status that is not controlled in our models. On one hand, having greater number of sons can be correlated with lower socioeconomic status if total fertility rates were higher among lower socioeconomic groups (with lower rates of female labor force participation) and if greater investment in children resulted in less wealth and savings left for old age. On the other hand, having any sons (or more sons) could be correlated with better economic conditions if, under the influence of son preference, wealthier families were more successful in finally having at least one son, by making more attempts, for example. Although both scenarios are possible, the independent correlation between number of sons and elderly mother's socioeconomic status is unlikely to be remain in our models controlling for current wealth of older women. Third, our IV validity may fail if sons provide substantially more transfers of time and money than daughters to their mothers and if such transfers affect older widowed mother's depressive symptoms. Although sons still are more likely than daughters to make financial and other non-monetary transfers, this gender gap has likely diminished. Moreover, older individuals' reliance on private transfers for their main income source has diminished considerably over the past decades (Kim 2007). It is also not clear whether and to what extent intergenerational transfers by extraresidential children contribute to the mental health of older widowed women. Given these theoretical counterexamples, the validity of our IVs depends on how well our statistical models control for these potential pathways directly running from number of sons to depressive symptoms.

For our dependent variable of depressive symptom scores, we estimated both the standard ordinary least squares (OLS) and IV two-stage least squares (IV-2SLS) regression models. We conducted three formal specification tests regarding this IV estimation. First, we used *F*-statistics from the first-stage regression to evaluate the strength of the IVs (a value greater than 10 generally indicates strength to ensure the validity of the IV method). Second, an overidentifying test was conducted to see whether the IVs are correlated with the dependent variable in the main model. Finally, we tested for the null hypothesis that coresidence is exogenously determined. Rejecting this hypothesis would mean that older widowed women's coresidence is selected, at least partially, in relation to their depressive symptoms. For the binary dependent variable of clinically relevant depressive symptoms, we estimated both probit and bivariate probit modes to investigate the issue of selection (Bhattacharya *et al.* 2006). When estimating the bivariate probit model, we used the same set of IVs as in the IV-2SLS estimation.

Although the KLoSA is a panel study of older South Koreans, the current analysis treated the two waves of the survey as repeated cross-sectional surveys, adjusting for clustering at the individual level. Panel data analysis using our current data revealed two major limitations. First, little variation was found across the waves in the key independent variable of coresidence with an adult child. Second, although fixed-effects estimation can be effective in controlling for the type of endogeneity arising mainly from time-invariant unobserved heterogeneity, fixed-effects estimation still cannot address the issue of contemporaneous reverse causality running from older women's health to coresidence with an adult child, which is the main potential threat for validity in the current study.

Robustness checks

Our robustness checks examined whether our main IV-2SLS estimate is robust to an alternative set of IVs used and two different definitions of the study sample, in terms of statistical significance and effect magnitude. First, we used number of living sons (continuous variable) and whether or not daughter was the eldest child of a household having both sons and daughters (dummy variable) as an alternative set of IVs. Having a daughter as the eldest child was found to increase the probability of coresidence given both sons and daughters in the family in the US (Van Houtven and Norton, 2004), and this may also be true for South Korea because birth order of the eldest son matters only among sons. Recent years have witnessed an increase in coresidence of older women with their daughters in South Korea, which is likely driven by an increasing prevalence of coresidence with the eldest-child daughter. As another robustness check, we restricted our initial sample to those who either have an adult child coresiding or living within a 30-minute distance by public transportation, with the latter being the omitted reference category in our statistical model. We assumed that, in South Korea, living within a 30-minute distance by public transportation allows for relatively frequent family interactions and therefore can facilitate a certain level of financial, material, instrumental, and emotional support from adult children. If the effect of coresidence in our primary analysis was due mainly to the difference between coresidence and living far away, this sensitivity analysis would provide a much smaller effect magnitude than was estimated in our main analysis. Finally, we restricted our study sample to observations from the first wave only (1,279).

Item-level regression analysis

We also conducted OLS and IV-2SLS regression of each item in the CES-D scale. This supplemental analysis had two purposes. First, this provided a deeper understanding of which depressive symptoms were most affected by non-coresidence. Second, this item-level analysis can offer a further test for the validity of our IVs. If number of sons had a direct effect on depressive symptoms among older widowed women other than the pathway through coresidence, the overidentification test would be more likely to reject the validity assumption of IVs in item-level models of feeling alone, for example, than of other items such as being afraid of something or feeling worthless.

Results

Table 1 shows that about 61% of the widowed women surveyed in the first wave of KLoSA coresided with an adult child. Those coresiding with an adult child had on average lower depressive symptom scores (9.2 vs. 10.5) and were less likely to have clinically relevant depressive symptoms (39.5% vs. 49.3%) than those not coresiding with an adult child. Those coresiding with an adult child were also older, richer, more likely to live in Seoul and other metropolitan areas, and more likely to have any ADL/IADL limitations but better self-rated health (Table 1).

<Table 1 Distribution of study variables, overall and by coresidence with an adult child (2006 baseline)>

Although our OLS regression analysis finds that coresidence with an adult child was associated with a reduction in depressive symptom scores by 0.65, our IV-2SLS estimate shows a larger effect magnitude (6.26) than the OLS estimate (Table 2). The relatively large difference between the OLS and IV estimates is reflected in the test of endogeneity of coresidence, which rejects the null hypothesis that coresidence is exogenous ($p<0.01$). This result implies that the OLS estimate is biased and that coresidence is correlated with important unobserved variables in the OLS model. Result of the overidentification test ($p=0.76$) suggests that our IVs are not correlated with our dependent variable in the IV model. Our IVs are found to have a good predictive power for coresidence, with an F-statistic of 13.3 in the first-stage regression.

< Table 2 Ordinary Least Squares (OLS) and instrumental variable two-stage least squares (IV-2SLS) regression of depressive symptom scores >

Despite the statistically significant and relatively large effect magnitude of our IV-2SLS estimate, results from our bivariate probit model (as well as from the probit model) do not support that coresidence with an adult child has a protective effect on clinically relevant depressive symptoms (Table 3). Given that the probit and bivariate probit estimates are not statistically different, it is not surprising to fail to reject the null hypothesis that coresidence is exogenous in the models of clinically relevant depressive symptoms. Results of two other tests suggest that our IVs are statistically significant and valid in the bivariate probit model estimation.

<Table 3 Probit and bivariate probit regression of clinically relevant depressive symptoms (CES-D score ≥ 10)>

Results from the three robustness checks show that our IV-2SLS estimates are largely consistent across different sets of IVs and samples used, in terms of their statistical significance and effect magnitude (Table 4). Item-level regression analysis reveals that OLS estimates for all individual items have a smaller magnitude than their IV estimates (Table 5, columns 1 and 2). Statistically significant estimates suggest that coresidence with an adult child influences not only the symptom of feeling alone (item 9), but also other depressive symptoms in the CES-D scale (items 1, 6, and 10). For these four models., coresidence is found to be endogenous (Table 5, column 3). The overidentification tests fail to reject the null hypothesis that our IVs are valid for in the models of each of the 10 items (Table 5, column 4).

< Table 4 Robustness checks>

< Table 5 OLS and IV-2SLS regression of each item in CES-D scale on coresidence with an adult child>

Discussion

Using the IV estimation method, we find that older widowed women's coresidence with an adult child in South Korea has a protective effect on their depressive symptoms. A reduction in total depressive symptom scores by 6.26 which is greater than one-standard deviation from the mean score, is not trivial. The beneficial mental health effect of coresidence seems to result from mitigating not only the symptom of feeling alone but also other depressive symptoms such as losing interest in most things, being afraid of something, and feeling worthless. This protective effect, however, may not necessarily alleviate clinically relevant depression in this population, as suggested by statistically insignificant results in our probit or bivariate models. Our findings, therefore, have population-level implications for the quality of life of these elders through depressive symptoms related to transitions in living arrangements. Although our results do not find any significant effects of coresidence on clinically relevant depressive symptoms, the population-level effect of coresidence is still of relevance from a public health viewpoint since subthreshold depressive symptoms (mild to moderate depressive symptoms not meeting the criteria for clinically relevant depressive symptoms) are more common than major depressive disorders (Blazer *et al.* 1987; Judd 1995; Judd *et al.* 1998). Moreover, subthreshold depressive symptoms result in considerable suffering for the individual and are associated with an increased risk of major depression, disability, medical illness, and high use of services (Judd 1995).

Our results indicate that coresidence with an adult child was higher among women with ADL/IADL limitations, suggesting that women with these limitations were more likely to move in with an adult child (or their already coresiding with an adult child were less likely to move out) as a result of these difficulties (Brown *et al.* 2002; Coe *et al.* 2009). Our IV estimation also suggests that coresidence with an adult child is endogenous to woman's mental health. Correcting for this endogeneity, thus, reveals a relatively large protective effect of coresidence that would be underestimated in the standard OLS estimation. However, probit and bivariate probit models fail to indicate any significant association between coresidence with an adult child and clinically relevant depressive symptoms. The difference in results between IV-2SLS and probit models as well as the large magnitude of IV-2SLS estimate compared with its OLS model, can be explained by the local average treatment effect (LATE) estimated through IV models. (Imbens and Angrist, 1994; Angrist *et al*. 1996) The IV-2SLS estimates are determined by variation in depressive symptoms among a subgroup of older widowed women whose coresidence with an adult child is affected by the number of their sons. This subgroup of "marginal" women (Harris and Remler 1998), are less likely to be too sick (for example, having ADL limitations) or too depressed not to be cared for by their coresiding adult children. Our main IV-2SLS estimate is, therefore, not entirely comparable to the corresponding OLS estimate in terms of its generalizability but limited to a subset of marginal individuals, but still meaningful given our question of how older widowed women's mental health is affected by changing living arrangements due to demographic and social transitions. Moreover, since the subgroup of marginal women included in the analysis for IV models may be less likely to be in the extremes of depressive symptom score or have clinically relevant depressive symptoms, the bivariate probit model with the same set of IVs as 2SLS models may have failed to reveal any statistically significant results.

Since widowhood is such a common event in old age, it is often considered an inevitable phase in the life cycle of older adults and thus neglected by researchers and policy makers (Bennett 1997b). However, we find that the prevalence of clinically relevant depressive symptoms in our sample of older widowed women is higher (43%) than what has been reported previously. A previous study among older adults (≥ 65 years), using data from the 2001 Korean National Health and Nutrition Examination Survey, found the age-adjusted prevalence of depressive symptoms to be 17% for men and 24.7% for women (Jeon *et al.* 2007). This shows that widowed, older women are a vulnerable population group at risk for depressive symptoms, although married older women also show poorer mental health compared with married men (Jang *et al.* 2009). Further, it has been reported that widows are most depressed immediately after the death of their spouse. Though the severity of their depressive symptoms later declines, it still remains higher than that of women who are married or who never married (Bennett 1997a). By focusing on the effect of coresidence, this paper contributes to a better understanding of the mental health of older women in a rapidly aging Asian society.

Our data indicate the majority of the older widowed women who had at least one living child coresided with an adult child. Even though intergenerational coresidence is currently high, with declining fertility and changing patterns of living arrangements, fewer and fewer older widowed women may coreside with an adult child, especially in rural areas. Although older widowed women in the future may be better prepared financially, physically, and mentally for their old age than in the past, these behavioral and policy changes will likely take time to help them cope with late-life challenges. In the meantime, the decreasing family support may leave many older women with various difficulties in their late life, with considerable health consequences. These health consequences may translate into an increased burden on public health care financing because older widowed women in general are also economically vulnerable and more likely to depend on public long-term care services (Cafferata 1987; Homan *et al.* 1986). Further research is required to understand the specific mechanisms by which intergenerational coresidence affects elderly health, to estimate the impact of changing living arrangements on elderly health and health care, and to propose culturally appropriate and economically sensible policy recommendations to meet this challenge.

The study is not without limitations. First, we did not measure the type and quality of the actual or perceived support received from adult children, but focused on coresidence as a structural indicator of parental support. Social networks, including interactions with other relatives and friends, may also be a possible confounder. Although some of these variables, such as frequency of visits and intergenerational transfers, are available in the KLoSA, we did not include them in our models for two reasons: these variables are potentially endogenous to coresidence decisions as well as to widowed mothers' depressive symptoms, and most of these variables are measured for non-coresiding adult children only. While our IV estimation method may address the concern for such unmeasured confounders, there is an important scope for future research on the potential mediators in the links between elderly living arrangements and health. Second, this study did not investigate potential heterogeneity in the effect of intergenerational coresidence, although important differences may exist by type of coresidence; for example, coresidence with an adult daughter versus with an adult son as well as their marital status. Third, the cut-off value of CES-D $\geq$ 10 may not capture clinically relevant depressive symptoms for this particular group of women. Our results for clinically relevant depressive symptoms are therefore suggestive and require further investigation.

Conclusion

A growing population of older widowed women, declining fertility levels and changing patterns of living arrangements in South Korea have provided the impetus to study the effect of intergenerational coresidence on psychological distress in these women. Our results indicate that, after taking into account non-random selection, living with an adult child has a protective effect on older widowed women's depressive symptoms. Future demographic and social transitions in South Korea portend that older women's increasing vulnerability to poor mental health is an important though less visible public health challenge.

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Table 1 Distribution of study variables, overall and by coresidence with an adult child (2006)

Variables	Total	Coresiding with an adult child	Not coresiding with an adult child	*p* value†
Dependent variable				
Depressive symptom score (0–30)	9.7	9.2	10.5	<0.001
Clinically relevant depressive symptoms (CES-D score ≥ 10)	43.4%	39.5%	49.3%	0.001
Explanatory variable of interest				
Coresidence with an adult child	60.5%	100.0%	0.0%	—
Instrumental variables (*# of sons)*				<0.001
No son (daughter only; omitted)	6.4%	4.1%	9.9%	
1–2 sons	61.5%	61.4%	61.8%	
3 or more sons	32.1%	34.5%	28.3%	
Demographic and socioeconomic				
Mean Age	75.7	76.8	74.0	<0.001
Education level				0.452
Elementary school	92.0%	91.7%	92.5%	
Middle school	4.1%	4.4%	3.6%	
High school	3.1%	2.8%	3.6%	
College	0.8%	1.0%	0.4%	
Total assets quintile in 1st wave				<0.001
1 (poorest)	30.3%	22.2%	42.8%	
2	30.5%	23.4%	41.4%	
3	14.5%	17.3%	10.1%	
4	10.9%	16.0%	3.2%	
5 (richest)	13.8%	21.1%	2.6%	
Residence area				0.011
Seoul	16.9%	19.1%	13.5%	
Other metropolitan area	28.9%	29.5%	27.9%	
Province	54.3%	51.4%	58.6%	
Health variables				
Any ADL/IADL limitations	30.8%	35.0%	24.4%	<0.001
Self-reported health				<0.001

Very good	0.9%	1.2%	0.6%	
Good	12.8%	14.5%	10.3%	
Fair	28.5%	31.5%	23.8%	
Poor	44.0%	41.9%	47.3%	
Very poor	13.8%	11.0%	18.0%	
Disease indicator				
Hypertension	43.1%	41.7%	45.1%	0.228
Diabetes	16.7%	16.4%	17.2%	0.701
Cancer	2.0%	1.4%	2.8%	0.088
Chronic lung disease	3.0%	3.2%	2.8%	0.642
Liver disease	0.9%	0.9%	0.8%	0.832
Heart disease	7.9%	5.8%	11.1%	0.001
Stroke	3.2%	3.9%	2.2%	0.092
Psychiatric problem	3.1%	2.6%	4.0%	0.167
Arthritis	36.0%	35.1%	37.4%	0.406
Injury due to traffic accident	7.8%	8.4%	6.9%	0.339
Fall in the past two years	9.2%	9.0%	9.5%	0.781
Urinary incontinence	22.0%	20.4%	24.6%	0.081
Number of observations	1,279	774	505	

Notes: Unweighted sample means are presented. † *t*-test for continuous variables and χ^2-test for categorical variables between coresiding and not coresiding groups. CES-D=Center for Epidemiological Studies–Depression scale.

Table 2 Ordinary least squares (OLS) and instrumental variable two-stage least squares (IV-2SLS) regression of CES-D score

Variables	OLS		IV-2SLS	
	Coefficient	(95% C.I.)†	Coefficient	(95% C.I.)†
Explanatory variable of interest				
Coresidence with an adult child	−0.65**	(−1.13, −0.16)	−6.26**	(−10.91, −1.61)
Non-coresidence (ref.)	—		—	
Demographic and socioeconomic				
Age-65	0.03	(−0.01, 0.06)	0.06**	(0.01, 0.11)
Education level				
Elementary school	1.56**	(0.41, 2.70)	1.90	(−0.14, 3.94)
Middle school	0.63	(−0.83, 2.08)	0.98	(−1.35, 3.31)
High school	0.67	(−0.81, 2.15)	−0.00	(−2.39, 2.38)
College (ref.)	—		—	
Total assets quintile in 1st wave				
1 (poorest)	0.72	(−0.01, 1.46)	−1.78	(−3.97, 0.41)
2	0.39	(−0.36, 1.15)	−2.01*	(−4.12, 0.11)
3	−0.32	(−1.10, 0.46)	−1.37*	(−2.58, −0.17)
4	0.63	(−0.21, 1.47)	0.46	(−0.44, 1.36)
5 (richest, ref.)	—		—	
Residence area				
Seoul (ref.)	—		—	
Other metropolitan area	−0.85*	(−1.51, −0.18)	−0.66	(−1.41, 0.08)
Province	−0.54	(−1.14, 0.06)	−0.67*	(−1.37, 0.03)
Health variables				
Any ADL/IADL limitations	0.56*	(0.06, 1.06)	1.18**	(0.44, 1.91)
Self-reported health				
Very good (ref.)	—		—	
Good	−0.56	(−2.27, 1.14)	−1.03	(−2.80, 0.74)
Fair	0.73	(−0.97, 2.43)	0.28	(−1.46, 2.02)
Poor	3.21**	(1.50, 4.92)	2.61*	(0.83, 4.38)
Very poor	7.28**	(5.45, 9.11)	6.31**	(4.32, 8.30)
Disease indicator				

Hypertension	−0.35	(−0.80, 0.09)	−0.37	(−0.89, 0.14)
Diabetes	−0.49	(−1.11, 0.13)	−0.53	(−1.22, 0.17)
Cancer	1.77	(−0.12, 3.67)	1.49	(−0.43, 3.42)
Chronic lung disease	0.74	(−0.41, 1.89)	0.90	(−0.35, 2.14)
Liver disease	0.98	(−0.20, 2.16)	0.50	(−0.91, 1.91)
Heart disease	−0.57	(−1.39, 0.25)	−1.24**	(−2.30, −0.18)
Stroke	1.56*	(0.33, 2.79)	2.26**	(0.74, 3.78)
Psychiatric problem	2.61**	(1.28, 3.95)	1.97**	(0.44, 3.49)
Arthritis	0.03	(−0.45, 0.51)	0.09	(−0.44, 0.63)
Injury due to traffic accident	1.12**	(0.29, 1.96)	1.65**	(0.59, 2.72)
Fall in the past two years	0.12	(−0.61, 0.85)	0.11	(−0.67, 0.90)
Urinary incontinence	1.53**	(1.04, 2.02)	1.32**	(0.73, 1.90)
Survey year 2008 (vs. 2006)	0.66**	(0.29, 1.03)	0.35	(−0.12, 0.82)
Constant	5.44**	(3.34, 7.54)	10.26**	(5.37, 15.15)
Number of observations	2,449		2,449	
Test of IV strength, $F(2,1420)$ ††			13.06	$p < 0.0001$
Test of overidentification, χ^2 (d.f.=1)			0.10	$p = 0.7551$
Test of endogeneity, $F(1, 1420)$			6.89	$p = 0.0088$

Notes: ** p<0.01, * p<0.05. †Confidence intervals are based on cluster-robust standard errors. †† Full regression results of the first-stage regression are available upon request.

Table 3 Probit and bivariate probit regression of clinically relevant depressive symptoms (CES-D score ≥ 10)

Variables	Probit		Bivariate probit‡	
	Coefficient	(95% C.I.)†	Coefficient	(95% C.I.)†
Explanatory variable of interest				
Coresidence with an adult child	−0.11	(−0.24, 0.02)	−0.37	(−1.16, 0.41)
Non-coresidence (ref.)	—		—	
Covariates††	Included		Included	
Number of observations	2,449		2,449	
Test of IV strength, χ^2 (d.f.=2)			24.83	$p < 0.0001$
Test of overidentifying restrictions‡, χ^2 (d.f.=1)				
1–2 sons			0.76	$p = 0.3822$
3 or more sons			0.01	$p = 0.9231$
Test of endogeneity, Wald test of $\rho=0$ χ^2 (d.f.=1)			0.43	$p = 0.5107$

Notes: ** $p<0.01$, * $p<0.05$. †Confidence intervals are based on cluster-robust standard errors.
††Covariates are the same set used in models in Table 2. ‡Method follows Rashad and Kaestner (2004).
‡Full probit and bivariate probit regression results are available upon request.

Table 4 Robustness checks: OLS and IV-2SLS regression of CES-D score

Variables	OLS		IV-2SLS	
	Coefficient	(95% C.I.)	Coefficient	(95% C.I.)
Panel A: Different set of IVs†				
Explanatory variable of interest				
Coresidence with an adult child	−0.65*	(−1.13, −0.16)‡	−7.35*	(−13.63, −1.07) ‡
Non-coresidence (ref.)	—		—	
Covariates††	Included		Included	
Number of observations	2,449		2,449	
Test of IV strength, $F(2,1420)$			6.72	$p = 0.0013$
Test of overidentifying restrictions, χ^2 (d.f.=1)			0.003	$p = 0.9567$
Test of endogeneity, $F(1, 1420)$			6.45	$p = 0.0013$
Panel B: Coresidence vs. ≤ 30min only				
Explanatory variable of interest				
Coresidence with an adult child	−0.55	(−1.18, 0.08) ‡	−8.65*	(−16.43, −0.87) ‡
Non-coresidence (≤ 30min, ref.)	—		—	
Covariates††	Included		Included	
Number of observations	1,802		1,802	
Test of IV strength, $F(2,1115)$			5.48	$p = 0.0043$
Test of overidentifying restrictions, χ^2 (d.f.=1)			0.46	$p = 0.4987$
Test of endogeneity, $F(1, 1115)$			5.66	$p = 0.0175$
Panel C: First-wave data only				
Explanatory variable of interest				
Coresidence with an adult child	−0.37	(−0.92, 0.19)	−7.62*	(−14.10, −1.15)
Non-coresidence (ref.)	—		—	
Covariates††	Included		Included	
Number of observations	1,279		1,279	
Test of IV strength, $F(2,1278)$			6.66	$p = 0.0013$
Test of overidentifying restrictions, χ^2 (d.f.=1)			0.15	$p = 0.6982$
Test of endogeneity, $F(1, 1278)$			7.39	$p = 0.0066$

Notes: ** $p<0.01$, * $p<0.05$. †IVs used are number of sons (continuous variable) and whether or not the eldest child is a daughter given both genders (binary variable). ††Covariates are the same set used in models in Table 2. ‡ Confidence intervals are based on cluster-robust standard errors.

Table 5 OLS and IV-2SLS regression of each item in CES-D scale on coresidence with an adult child

Dependent variable (Items in CES-D scale)	OLS	IV-2SLS	Test of endogeneity, $F(1, 1420)$	Test of overidentifying restrictions, χ^2 (d.f.=1)
1. During the last week, how often did you lose interest in most things?	−0.06	−0.90*	6.02*	0.60
2. During the last week, how often did you have trouble concentrating?	−0.04	−0.40	1.61	0.18
3. During the last week, how often did you feel depressed?	−0.08*	−0.57	2.22	0.80
4. During the last week, how often did you feel tired out or low in energy?	−0.05	−0.54	1.90	0.49
5. How was your last week? How often did you feel pretty good? (reverse coded)	−0.04	−0.23	0.27	3.36
6. During the last week, how often were you afraid of something?	−0.05	−1.05**	8.90**	0.12
7. During the last week, how often did you have trouble falling asleep?	−0.01	−0.27	0.48	1.73
8. How often did you feel you were overall satisfied last week? (reverse coded)	−0.04	−0.41	0.88	1.20
9. How often did you feel alone last week?	−0.19**	−1.07**	6.02*	0.53
10. How often have you felt down on yourself, no good or worthless last week?	−0.08*	−0.81*	4.72*	0.10

Notes: Each item takes on a value from 0 (very rarely [less than one day]), 1 (sometimes [1–2 days]), 2 (often [3–4 days]), and 3 (almost always [5–7 days]). The two positive items (5th and 8th items) were reverse coded so that higher values capture more depressive symptoms. ** p<0.01, * p<0.05. For all regressions, covariates and IVs used are the same as in models in Table 2.