

Widowhood and mortality risk of older people in rural China: Do gender and living arrangement make a difference?

ABSTRACT

Increased mortality after spousal bereavement has been observed in many populations. Few studies have investigated the widowhood effect in a traditional culture where the economy is underdeveloped. The reasons for the widowhood effect and its gender dynamic are not well understood. In this study, we assessed whether the widowhood-associated excess mortality exists and differs by gender and living arrangement in rural China. We used a six-waves panel of data derived from rural people over 60 years old in the Chaohu region of China. Cox-regression analyses suggest that there was a positive effect of spousal loss on mortality for older rural Chinese and that there was a gender difference in this effect. Our findings also suggest that living with adult children after spousal loss played a protective role in reducing the risk of older men's death, though it tended to increase older men's mortality risk in general.

KEY WORDS – spousal loss; living arrangements; gender difference; rural elders; mortality;

Introduction

China's population is aging at a faster rate than most Western societies due to falling fertility and increasing longevity. Together with population aging, the number of widowed elders will also increase rapidly. It is estimated that by 2050, the population of widowed elders will reach 118 million, and the majority of the widowed elders reside in rural areas (Wang 2013). Marriage has long been recognized as a fundamental social institution that provides important protective barriers

against stressful consequences of external threats (Umberson 1992). Its effects on health and mortality have been systematically examined by sociologists and demographers (Hu & Goldman 1990; Musick and Bumpass 2012). As a common and inevitable major life event, the loss of one's spouse has also been widely recognized as one of life's most potent stressors.

It has been suggested that people experiencing the loss of a spouse are at a greater risk of dying than those whose partner is still living (Schaefer et al. 1995; Stroebe et al. 2007). Spousal loss is believed to contribute to excess mortality, especially in the near term, by stress responses such as immune system disruption (Gerra et al. 2003) and cardiovascular effects (Buckley et al. 2010), or by triggering health-hazardous behaviors such as self-neglect or substance abuse (Mellström et al. 1982). The rapid effects of grief have been consistently confirmed in most empirical studies, and the increased mortality risk was reported highest within the first six months following spousal loss (Martikainen & Valkonen 1996b; Moon et al. 2014; Shah et al. 2012). However, evidence suggests that the increased mortality of the surviving spouse is not due to specific incidents or worsening chronic health conditions following bereavement (Schaefer et al. 1995; Shah et al. 2012). Many researchers have argued that elevated mortality risk following spousal loss is not necessarily a result of the bereavement itself, and it was difficult to distinguish the widowhood effect from those of spousal similarity, selection, and shared environmental exposure (Elwert & Christakis 2008; Schaefer et al. 1995; Boyle et al. 2011). A number of studies have examined the possible contribution of spousal similarities to the excess mortality by adjusting confounders or distinguishing causes of death. Although some studies confirmed that loss of a spouse was independently associated with excess mortality (Schaefer et al. 1995; Williams et al. 2011), the magnitude of the widowhood effect was attenuated after adjustment (Mellström et al. 1982; Skulason

et al. 2012), which suggests that lifestyle factors could not be excluded as a possible explanation for excess mortality of the bereaved. Studies considering causes of own or spousal death also produced inconsistent findings. A generalized increase in mortality risk in the decedent spouse was found (Boyle et al. 2011), but some evidence indicated differential mortality risk by cause of death and excess mortality was found to be markedly higher when the spouse dies from accidental, violent, or alcohol-related causes (Martikainen & Valkonen 1996a; Shah et al. 2013). These inconsistent findings suggest the link between widowhood and causes of death is not yet clear.

Although a few studies report no significant effect (Helsing et al. 1981; Jones 1984; Ward 1976), and the magnitude of the effect varies substantially, considerable excess mortality risk was observed in most studies. It is now generally accepted that spousal loss is causal although the effect is relatively small and short-lived (Martikainen & Valkonen 1996b). The variability in findings was partly attributable to differences in sample sizes, geographic regions, and levels of statistical adjustment (Shor et al. 2012). It has been argued that this differential responsiveness to stress can be explained in terms of both individual and environmental differences (Kessler and Cleary 1980). Given the public health importance of health inequalities according to socio-economic status, spousal loss may lead to differential exposure to risk for different subpopulations or in different countries, and marriage may also play a different role in the context of different cultural values and social systems. Whether the effect of bereavement on mortality varies between socio-economic groups was addressed in recent studies, and the evidence suggests that the bereaved with higher-status had more, rather than less, excess mortality, although higher-status individuals are associated with lower mortality in general (Boyle et al. 2011; Manor & Eisenbach 2003; Shah et al. 2012). One study also examined whether the widowhood effect was culture-specific by distinguishing the race

of partners, and showed that whites in endogamous marriages suffered a large increase in mortality, but this effect was not evident among blacks (Elwert and Christakis 2006). However, most widowhood studies were conducted in Western societies, and primarily with European samples (Li et al. 2005); relatively few explored the widowhood effect in developing countries, such as China, with substantially different cultural values and social systems from Western societies.

It is well documented that individual social and cultural backgrounds are strongly shaped by division among gender roles (Pizzetti & Manfredini 2008). Marriage is expected to be more beneficial for men than for women (Umberson 1992), which suggests that it is harder for men to adjust to widowhood because they are more likely than women to rely on their spouse to maintain social interactions and carry out domestic tasks (Lee et al. 2001). The gender dynamic for mortality excess following bereavement has been tested in a number of studies. Those studies suggest that there is a causal effect only among men (Elwert & Christakis 2008; Martikainen & Valkonen 1996b; Mineau et al. 2002). However, other studies have argued that the relationship is causal for both sexes (Boyle 2011; Ytterstad & Brenn 2015), and the bereavement effects on mortality is similar for males and females (Manor and Eisenbach 2003; Schaefer et al. 1995). A British study even reported there was only a slight early excess mortality among women, but no effect among men (Jones et al. 1984). Family function and expected roles of husbands and wives vary across countries and regions, with different rates and meanings of widowhood, suggesting that widowhood effects and gender differences are very likely to be culture-specific. However, little information is available on whether the widowhood-associated mortality risk varies by gender in developing countries. A study in Taiwan examined gender differences in widowhood effects among community-dwelling elders between 1989-2000 and suggested that spousal

loss-related mortality was increased by lowering the probability of death at baseline ascertainment for widowers, while the risks for females seemed rather homogeneous (Fang et al. 2012). Another study concerning the gender dynamic of the widowhood effect in Chinese older-oldest between 1998-2001 suggested that the negative effect was higher among women than among men (Gu 2003). These disparate results suggest the need for further studies that examine gender differences in widowhood effects in more birth cohorts as gender role norms change, especially those concerning the effect of gender-age interaction. Previous studies have shown that the widowhood effect especially among women varies considerably across birth cohorts (Manzoli et al. 2007; Mineau et al. 2002), and the effect is more pronounced for younger cohorts than older ones (Martikainen & Valkonen 1996a).

In most countries, especially those with underdeveloped social and institutional support systems, adult children have long been the primary source of long-term care for their older parents and co-reside with them as necessary (Pezzin et al. 2007; Ward 2008). Numerous studies have examined the association between structural family support and elders' health in a wide variety of countries. However, they have produced inconsistent findings. Some studies suggested that living alone had a health disadvantage and higher death risk (Kharicha et al. 2007; Lund et al. 2002). However, a protective effect between living alone on health and lower mortality risk among elders living alone was seen in other studies (Hughes & Waite 2002; Walter-Ginzburg et al. 2002). Studies examined the association of living arrangement and death risk in China found that living with adult children increased mortality risk, especially among those elders with cardiovascular diseases (Li et al. 2009; Liu et al. 2015). Family support has also been identified as a major contributor that buffers the effects of widowhood on health (Li et al. 2005). Empirical evidence

from the USA indicated that structural and functional family support moderated the increase in psychological distress associated with widowhood (Ha et al. 2006; Silverstein & Bengtson 1994), and affectionate relations with adult children offset mortality risk associated with spousal death (Silverstein & Bengtson 1991). Two studies in Italy and the Pacific found that living alone plays a protective role for death risk of elders following spousal loss (McNally 2003; Pizzetti & Manfredini 2008). Studies in Asian countries have found that living with children was psychologically beneficial for widowed women (Do & Malhotra 2012) and support from children buffers the effect of widowhood on depression among both older men and women (Li et al. 2005). However, it is still unclear whether family support buffers the effects of widowhood on mortality risk in Asian countries and whether the dynamic differs by gender.

The main purpose of this paper, therefore, is to investigate the widowhood effect on death risk and whether living arrangement buffers the effect of spousal loss on mortality in the strong family-oriented Chinese culture, by distinguishing those who are widowed before baseline from those who become widowed in follow-up. In particular, we investigate gender difference in mortality following death of a spouse, and whether the effect of widowhood and its gender dynamic varies by cohort, cause of death and survey period.

Data, measures, and method

Data collection

The data used in this longitudinal study come from the survey “Well-being of Elderly Survey in Anhui Province (WESAP)”. As a joint project between Xi’an Jiaotong University and the University of Southern California, the survey has been conducted every three years between 2001 and 2015 in rural townships in Chaohu, Anhui province. Using a stratified multistage method,

potential respondents were from 72 randomly selected villages within six rural townships in the Chaohu region and residents aged 60 and older were identified in selected villages and randomly chosen from household rosters, with a proportionate oversampling of people aged 75 and older. A questionnaire survey was administered to the subjects over 60 years old in the respondents' homes. Of the 1,800 elders identified as eligible respondents, 1,715 completed the baseline survey in 2001. All of the follow-up surveys include re-interviews with surviving participants, and a cohort of 420 individuals ages 60 to 68 replacing deceased and lost-to-follow-up elders was added to the sample in 2009. Based on six waves of data, we constructed up to two longitudinal transition intervals (2001-2009,2009-2015)for the observations. All the missing cases (mainly were migrants) at the follow-up surveys were excluded. In the present study, we also restricted the sample to respondents who were married or widowed with adult children at baseline and in follow-up, and those people who were divorced or never married at baseline surveys were excluded. Finally, there were 1413 older people aged 60+ were used for data analysis during the period 2001-2009 and 1058 respondents were used for data analysis during the period 2009-2015.

Table 1 shows the characteristics of the sample. Among the 2471 Chinese rural elders, the average age is 72 years old, with 49 percent male. More than 70 percent are illiterate, nearly 95 percent are farmers. On average, they have four children, and usually two are sons. Only about 30 percent of respondents live with at least one of their children. More than half live alone or only with their spouse. Almost 40 percent of respondents were widowed before 2001 or 2009 and over 10 percent lost their spouse during the follow-up surveys. Almost 40 percent died between 2001and 2009 or between 2009 and 2015, and of these over 78 percent died from known illnesses. For gender differences among respondents, only the number of children and death percentage do

not exhibit significant differences. The female sample is older on average, more widowed, includes more farmers, is less educated, and has lower annual household income. Among the deceased respondents, more men died from some illness. However, women reported worse health conditions including greater incidence of chronic diseases. In addition, a larger share of respondents who were widowed before 2001 or 2009 and who live with a child were women.

Table 1 here

Dependent variables

Mortality risk refers to the likelihood of death of a respondent before follow-up contact.

Information on survival status and date of death were collected for the deceased and the survivors in follow-up interviews. Survival status was coded as survival versus death. Survival time was counted as months from the date of the baseline interviews in 2001 or 2009 to the date of the survey in 2009 or 2015 for the survivors, and to the date at death for the deceased. Respondent's initial age in 2001 or 2009 was also controlled for survival analyses.

Independent variables

The key independent variables of interest are marital status and living arrangements. At baseline surveys and each follow-up wave of interviews, the respondents were asked their marital status.

Given that those who died before baseline were no longer eligible for investigation of effects of widowhood, analyses limited to the sample of those remained alive may result in mis-estimation of the effects of widowhood. We therefore divide marital status into widowed before (marital status was "widowed" before the baseline survey), widowed after (marital status became "widowed" during follow-up interviews) and married (marital status remained "married" during

the whole survey period). Marital status and its changes for the deceased were also collected from their children or other family members during the follow-up waves. Living arrangements were classified into one of the following three categories: living alone (or only with spouse), living with at least one adult child, and living with others. In this study, pre-bereaved living arrangement and those after widowhood are distinguished by including both widowed and married respondents at baseline surveys.

Confounders

Health status at baseline is included as a potential confounder, and was evaluated through a series of questions about chronic conditions and self-reported health. Incidence of chronic disease is assessed for twelve diseases including diabetes, hypertension, heart disease, and stroke. ‘Incidence of chronic disease’ is scored as 1 if the respondent reports having one or more of the 12 diseases, and otherwise as 0. Respondents were also asked to evaluate their health status by a single question: What do you think about your current health status? A four-point scale was provided for the responses. We have reverse-coded self-reported health so that higher values indicate better health.

Individual SES and demographic indicators, which had been identified as important factors of health outcome of older people, were also considered confounders in this study. Individual education, family income and occupation were used to assess SES. Educational attainment was coded as a dichotomous variable: “illiterate” and “literate (primary school and above)”; household income was assessed by the total amount of earnings of the individual and his/her spouse in the previous year, including pensions, and was transformed using $\ln+1$. Occupation was coded as a dichotomous variable: 0 = “others,” 1 = “farmers.” Demographic characteristics included gender, age. Age was assessed as a continuous variable. Gender was measured as female versus male

(male = 1). Given that family members, especially children, are the most important resources for old-age support of elderly parents under the culture of filial piety, the number of children was also controlled as a continuous variable.

Data analysis

By distinguishing those widowed before baseline from those in follow-up, the bias due to the selection was estimated. Gender differences were also identified by gender-specific analysis. To explore the moderating effect of living arrangements, two models were used for these regression analyses: the main effects of status of widowhood and living arrangements on mortality risk of rural elders were examined in model 1; the moderating effect of living arrangements on widowhood and mortality risk were tested in model 2. All the data analyses were completed using Stata 11.

Results

Widowhood, living arrangements and mortality risk

Table 2 shows the results of Cox regression for mortality risk of rural elders. Model 1 examined the associations between marital status, living arrangement and mortality without controlling potential confounders. It shows that the mortality risk of widowed elders who lost their spouse before baseline surveys was significantly higher than for those with surviving spouses, but excess mortality of elders widowed in follow-up was not statistically significant. After controlling for the confounders (shown as model 2), the mortality risk of widowed elders instead declined significantly more than that of those with surviving spouses, while the associations between living arrangement and mortality remained statistically significant. When the moderating effect of living

arrangement was further controlled in model 3, the main effects of marital status and living arrangement remained statistically significant, and the moderating effect was also significant.

Although spouse loss and living alone (or only with spouse) were associated with lower mortality risk in general, the mortality risk of widowed elders was significantly higher when they lived only with their spouse before widowhood or live alone after widowhood. In addition, widowed elders who lost their spouse in follow-up also had a higher mortality risk when they lived with others before widowhood.

Among the controlled variables, only gender, age, family income and health condition were significantly correlated with mortality risk. Mortality risk was higher among men than among women. The death risk of older people increased with age and decreased as family income increased. Older people with good self-reported health were less likely to die than those with bad self-reported health. The onset of chronic disease was also significantly associated with higher mortality risk.

Table 2 here

Gender difference in widowhood, living arrangements and mortality risk

Gender-specific analysis confirmed that there was a significant gender difference for the effects of widowhood and living arrangements on mortality risk (shown as table 3). Model 1 examined the main effects of widowhood and living arrangements controlled for the potential cofounders.

Spousal loss was more likely to reduce the death risk of older women but not of older men in model 1. Compared with living alone or with others, living with at least one adult child significantly increased the death risk of older men but not of older women. When the moderating effect of living arrangement was considered in model 2, the main effects of widowhood on

mortality became statistically significant among older men while the main effect of becoming widowed in follow-up was no longer significant among older women. Both the main and moderating effects of living arrangements was significant among older men, which suggests that living alone after widowhood increases the chance of death for widowed men, although living alone was associated with a lower chance of death than living with adult children in general. In addition, living with others or only with spouse before widowhood also increased the death risk of widowed men who lost their spouse within follow-up. However, both the main effect and moderating effect of living arrangements were not significant for older women. There is no significant gender difference in the effects of confounders.

Table 3 here

Robustness check by age group, cause of death and survey period

To examine whether our estimates are robust to age group, death causes and survey period, we classified the sample into adult elders (age<75) and older elders (age>=75), then distinguished those who died from disease and those who died from other causes, and finally divided our sample into two sub-groups, namely those interviewed between 2001-2009 and those interviewed between 2009-2015.

Table 4 here

As table 4 shows, the estimates for different cohorts based on age at baseline suggest that the effects of widowhood and living arrangement and their gender dynamics varied across cohort. For adult elders, the mortality risk was not significantly different between married men and widowed men, and spousal loss before baseline significantly reduced women's mortality risk but the effect was no longer significant after controlling the moderating effect of living arrangement. Both the

main effect and moderating effect of living arrangement were almost insignificant among adult elders and there was no gender difference in these estimates. For older elders, bereavement significantly reduced mortality risk of women while only spousal loss in follow-up was significantly correlated with lower mortality risk of men. However, the estimate of widowed before baseline became significant among men and bereavement was no long significant among women when the moderating effect of living arrangement was controlled. Both the main effect and moderating effect of living arrangement were significant for men but not for women.

The estimates for different sub-samples divided by cause of death are also shown in Table 4, where we see that the impacts of widowhood and living arrangements depended on the causes of the respondent's death. Widowhood only significantly reduced the chance of death from disease and this was not significant for death risk from other reasons. The estimates of living arrangements were also inconsistent across sub-groups in terms of their statistical significance and effect magnitude among older men. However, the moderating effect of living alone remained consistent across these two sub-groups, which suggested that living alone could significantly increase all-cause death risk of widowed men.

As to the robustness check for different sub-groups classified according to the survey period, Table 4 shows that although the estimates of widowhood and living arrangements varied across the two survey periods in terms of their statistical significance and effect magnitude, the beneficial effect of widowhood and living alone or with others remained stable. The main effect of widowed in follow-up was greater during the period 2001-2009 than during 2009-2015. However, the risk estimates of death associated with living with adult children were greater during the period 2009-2015 than during 2001-2009. Though the moderating effect of living arrangements remained

consistent across these two survey periods, the risk estimate of death associated with living alone among older men who lost their spouses in follow-up was only significant during the period 2001-2009.

Conclusion and Discussion

Using data from a six-waves panel derived from rural elders over 60 years old, this study provides the first systematic evaluation of mortality after spousal loss and its gender difference in rural China. Our study extends bereavement studies conducted in Western developed countries to areas with underdeveloped economies and traditional culture of filial piety, and provides greater understanding of the role of family support on mortality risk of rural elders.

The effect of bereavement in China

Our results confirm the socio-economic differences in the effect of bereavement found in previous studies (Boyle et al. 2011; Elwert and Christakis 2006; Shah et al. 2012). However, unlike other studies on the effect of bereavement in Western societies and in urban areas of China (Fang et al. 2012), our findings suggest that spousal loss reduces rather than increases the mortality risk of rural elders in China, after adjusting for social-demographic characteristics and health condition at baseline. A possible explanation is that the rural elderly, especially in their heavily dependent old age, have less to lose from bereavement while multiple supportive ties and meaningful family roles in China may protect the rural elderly from the deleterious effects of spousal loss (Li et al. 2005). Different from the strong public institutions for old-age support and autonomous values in Western societies, family-based assistance acting as functional solidarity has long been the primary source of support for the rural elderly in China. When rural elders become widowed, they are likely to receive more care and help from their adult children, which can compensate for the

emotional vacuum and financial or instrumental deficit after spousal loss. Support from adult children has been confirmed to offset the decline in positive mood and mortality risk associated with spousal loss (Silverstein & Bengtson 1991, 1994). The relief model of caregiving burden (Keene & Prokos 2008; Schulz et al.1997) may also shed some light on the positive effect of widowhood found in our study. A spouse is not only a resource but also a demander of care support. Caregiving has been proved to be a stressful situation for caregivers in previous studies (Capistrant et al. 2012; Pinquart & Sörensen 2003), especially when the activities exceed the caregiver's abilities and resources, which may lead to health decline or higher mortality risk for the married elders with spouses in ill health. This situation may resolve after the death of spouse, resulting in better health for the bereaved caregivers. Previous evidence has confirmed a lower rate of depression of caregivers after spousal death (Keene & Prokos 2008) and worse physical and mental health for individuals approaching widowhood but no difference after widowhood (Vable et al. 2015).

Gender differences in the effect of bereavement

It has been suggested in most previous studies that the mortality risk associated with spousal loss is gender dependent and the widowhood effect is more prominent in male elders. In this study, we found that spousal loss was more likely to be correlated with reduced mortality of elder women compared to elder men after adjustment of confounders. However, the positive effect of widowhood was more profound in elder men after controlling further for the moderating effect of living arrangement. These findings may suggest that the widowhood effect is adjusted by a gender-dependent pattern of living arrangement after widowhood; that is, more widows than widowers are likely to live with adult children. Role theory, which has been used to explain the

pathways between bereavement and mortality (Gove 1984), may also explain the gender dynamics in the effect of bereavement. It has been suggested that men's main source of vulnerability after spousal loss stems from loneliness and difficulty in household management while women are more likely to experience financial hardship (Umberson et al. 1992). Given that financial support is more constrained than other kinds of help in underdeveloped rural areas, financial dependence may place widows rather than widowers who have just been relieved of caregiving burden at greater risk. However, to avoid financial strain, widows are more likely to live with their adult children after spousal loss. Our robustness check by age group, cause of death, and survey period confirmed the gender difference in the relative risk of mortality after spousal loss, and further showed that the gender dynamic of widowhood effect seems to depend not only on age but also on cause of death. Spousal loss is more likely to reduce the mortality risk among male older elders and tends to reduce men's risk of death from disease, which may suggest that older elders especially those who have a disease may suffer more caregiving burden between couples. Gender difference in the widowhood effect is almost consistent across different survey periods, which suggests that caring for an ill spouse is still a big burden in current rural China, although some pilot projects on institutional old-age support (e.g., New Rural Social Pension Insurance; Senior Center at Village) have been initiated since 2009 and generally benefit rural elders' quality of life (Liu et al. 2015).

The role of living arrangement

In agreement with previous studies evaluating the effect of living arrangement on mortality risk in China (Li et al. 2009; Liu et al. 2015), our study confirmed that living with adult children increased the mortality risk of older men in rural China. However, different from previous findings that

living alone played a protective role for elders' risk of death following spouse loss (McNally 2003; Pizzetti & Manfredini 2008), our findings suggest that living alone were likely to increase spousal loss-related mortality among older men. These findings suggest that living with adult children after spousal loss plays an important role in reducing death risk of older men in rural China, though it tended to increase older men's mortality risk in general. Additionally, this study also found that living only with spouse or with others before widowhood also increased spousal loss-related mortality among older men, which may also confirm the relief model of caregiving burden. Robustness check by age group, cause of death and survey period further showed that the role of living arrangement and its gender difference was largely consistent across different causes of death and survey periods, but apparently varied across different age groups. Living alone significantly increases widowers' death risk irrespective of the cause of death and survey period. In addition, living with adult children is more likely to generally increase the death risk of men aged over 75 years but prevent them from increased death risk after spousal loss. This may be attributed to the increasing dependence of older men on their family support as they age.

limitations

A prospective and two-stage follow-up design with a representative community sample of rural elderly in China is well-suited to investigating the widowhood effect. Distinguishing widowhood at baseline from those widowed in follow-up, may also reduce potential bias resulting from selection and competing risks between death and widowhood. Some limitations warrant caution when interpreting our findings. Given the great regional heterogeneity in economic development, a major limitation of this study is that our data come from a well-defined area of central China, which is thought to typify the social and cultural conditions of poor rural areas. The extent to

which our findings can be generalized to other rural elderly in China needs to be addressed by replicating the study in other rural areas. Another data limitation pertains to the lack of information concerning deceased spouses, including marriage quality and cause of death. Both are likely to be confounders of the observed relationship between individual widowhood and mortality. Furthermore, while our models control for socioeconomic status and health conditions, data limitations prohibited us from considering health behavior, which is likely to influence mortality and confound the relationship between widowhood and mortality. However, this may not be a serious problem with our analysis because health behavior is an indicator of health condition, and the latter was controlled in our models as a confounder. Finally, changes in living arrangements between baseline and follow-up waves were not included, although a few respondents changed their living arrangements during the follow-up.

References

- Boyle, P.J., Feng, Z., Raab, G.M., 2011. Does widowhood increase mortality risk? Testing for selection effects by comparing causes of spousal death. *Epidemiology*. 22(1), 1–5.
- Buckley, T., McKinley, S., Tofler, G., & Bartrop, R., 2010. Cardiovascular risk in early bereavement: A literature review and proposed mechanisms. *Int J Nurs Stud*. 47(2), 229–238.
- Capistrant, B.D., Moon, J.R., Berkman, L.F., et al., 2012. Current and long-term spousal caregiving and onset of cardiovascular disease. *J Epidemiol Community Health*. 66(10), 951-956.
- Do, Y.K., & Malhotra, C., 2012. The effect of coresidence with an adult child on depressive symptoms among older widowed women in South Korea: An instrumental variable

- estimation. *J Gerontol B Psychol Sci Soc Sci.* 67 (3), 384-391.
- Elwert, F., & Christakis, N.A., 2008. Wives and ex-wives: A new test for homogamy bias in the widowhood effect. *Demography.* 45(4), 851–873.
- Espinosa, J. & Evans, W.N., 2008. Heightened mortality after the death of a spouse: Marriage protection or marriage selection? *J Health Econ.* 27(5), 1326–1342.
- Fang, S., Huang, N., Chen, K. et al., 2012. Gender difference in widowhood effects among community-dwelling elders by causes of death in Taiwan. *Ann Epidemiol.* 22(7), 457–465.
- Gerra, G., Monti, D., Panerai, A. E., et al., 2003. Long-term immune-endocrine effects of bereavement: Relationships with anxiety levels and mood. *Psychiatry Res.* 121(2), 145–158.
- Gove, W. R., 1984. Gender differences in mental and physical illness: The effects of fixed roles and nurturant roles. *Soc Sci Med.* 19(2), 77–91.
- Gu, D., 2003. Analysis of gender differences in the effect of marriage on the health and longevity to the elderly in China. *Chinese Journal of Population Science.* 3, 32-40. In Chinese.
- Ha, J.H, Carr, D., Utz, R.L., Nesse, R., 2006. Older adults' perceptions of intergenerational support after widowhood: How do men and women differ? *J Fam Issues.* 27(1), 3–30.
- Helsing, K. M., Szklo, M., & Comstock, G. W., 1981. Factors associated with mortality after widowhood. *Am J Public Health.* 71(8), 802–809.
- Helsing, K., & Szklo, M., 1981. Mortality after bereavement. *Am J Epidemiol.* 114 (1), 41–52.
- Hu, Y. R., & Goldman, N., 1990. Mortality differentials by marital status: An international comparison. *Demography.* 27(2), 233–250.
- Hughes, M.E., & Waite, L.J., 2002. Health in household context: Living arrangements and health in late middle age. *J Health Soc Behav.* 43(1), 1–21.

- Jones, D. A., Goldblatt, P. O., & Leon, D., 1984. Bereavement and cancer: Some data on deaths of spouses from the longitudinal study of office of population censuses and surveys. *Br Med J (Clin Res Ed)*. 289, 461–464.
- Keene, J. R., & Prokos, A. H., 2008. Widowhood and the end of spousal care-giving: Relief or wear and tear? *Ageing & Society*. 28, 551–570.
- Kessler, R. C., and Cleary, P. D., 1980. Social class and psychological distress. *Am Sociol Rev*. 45(3), 463–478.
- Kharicha, K., Iliffe, S., Harari, D., et al., 2007. Health risk appraisal in older people: are older people living alone an “at-risk” group? *Br J Gen Pract*. 57(537), 271–276.
- Lee, G. R., DeMaris, A., Bavin, S., & Sullivan, R., 2001. Gender differences in the depressive effect of widowhood in later life. *J Gerontol B Psychol Sci Soc Sc*. 56(1), S56-61.
- Li, L., Liang, J., Toler, A., & Gu, S., 2005. Widowhood and depressive symptoms among older Chinese: Do gender and source of support make a difference? *Soc Sci Med*. 60(3), 637–647.
- Li, L.W., Zhang, J., Liang, J., 2009. Health among the oldest-old in China: Which living arrangements make a difference? *Soc Sci Med*. 68(2), 220–227.
- Liu, H. J., Xiao, Q.Y., Cai, Y.Z., & Li, S.Z., 2015. The Quality of Life and Mortality risk of Elderly People in Rural China: The Role of Family Support. *Asia Pac J Public Health*. 27(2), NP2232-45.
- Lund, R., Due, P., Modvig, J., et al., 2002. Cohabitation and marital status as predictors of mortality: An eight year follow-up study. *Soc Sci Med*. 55(4), 673–79.
- Manor, O., & Eisenbach, Z., 2003. Mortality after spousal loss: are there socio-demographic differences? *Soc Sci Med*. 56 (2), 405–413.

- Manzoli, L., Villari, P., Pirone, G. M., & Boccia, A., 2007. Marital status and mortality in the elderly: A systematic review and meta-analysis. *Soc Sci Med.* 64(1), 77–94.
- Martikainen, P., & Valkonen, T., 1996a. Mortality after death of a spouse: Rates and causes of death in a large Finnish cohort. *Am J Public Health.* 86(8), 1087–1093.
- Martikainen, P., & Valkonen, T., 1996b. Mortality after death of a spouse in relation to duration of bereavement in Finland. *J Epidemiol Community Health.* 50(3), 264–268.
- McNally, J.W., 2003. Health, widowhood, and family support in the north and south Pacific: A comparative study. *J Women Aging.* 15(2-3), 29-47.
- Mellström, D., Nilsson, A., Oden, A., et al., 1982. Mortality among widowed in Sweden. *Scand J Soc Med.* 10(2), 33–41.
- Mineau, G.P., Smith, K.R., & Bean, L.L., 2002. Historical trends of survival among widows and widowers. *Soc Sci Med.* 54(2), 245–254.
- Moon, J.R., Glymour, M.M., Vable, A.M. et al., 2014. Short- and long-term associations between widowhood and mortality in the United States: longitudinal analyses. *J Public Health (Oxf).* 36(3),382-389.
- Musick, K., & Bumpass, L., 2012. Reexamining the case for marriage: Union formation and changes in well-being. *J Marriage Fam.* 74(1), 1–18.
- Pezzin, L. E., Pollak, R. A., & Schone, B. S., 2007. Efficiency in family bargaining: Living arrangements and caregiving decisions of adult children and disabled elderly parents. *CESifo Econ Studies.* 53(1), 69–96.
- Pinquart, M.,& Sörensen, S., 2003. Differences between caregivers and noncaregivers in psychological health and physical health: a meta-analysis. *Psychol Aging.* 18(2), 250-267.

- Pizzetti, P., & Manfredini, M., 2008. The shock of widowhood? evidence from an Italian population (Parma, 1989-2000). *Soc Indic Res.* 85(3), 499-513.
- Schaefer, C., Quesenberry, C. P., and Wi, S., 1995. Mortality following conjugal bereavement and the effects of a shared environment. *Am J Epidemiol.* 141(12), 1142–1152.
- Schulz, R., Newsom, J.T., Fleissner, K., et al., 1997. The effects of bereavement after family caregiving. *Aging Ment Health.* 1(3), 269-282.
- Shah, S. M., Carey, I.M., Harris, T., et al., 2012. Do good health and material circumstances protect older people from the increased risk of death after bereavement? *Am J Epidemiol.* 176(8), 689–698.
- Shah, S.M., Carey, I.M., Harris, T., 2013. The effect of unexpected bereavement on mortality in older couples. *Am J Public Health.* 103(6), 1140-1145.
- Shor, E., Roelfs D., J. Curreli, M., et al., 2012. Widowhood and mortality: A meta-analysis and meta-regression. *Demography.* 49(2), 575-606.
- Silverstein, M., & Bengtson, V. L., 1994. Does intergenerational social support influence the psychological wellbeing of older parents? The contingencies of declining health and widowhood. *Soc Sci Med.* 38(7), 943–957.
- Silverstein, M., & Bengtson, V. L., 1991. Do close parent-child relations reduce the mortality risk of older parents?. *J Health Soc Behav.* 32(4), 382–395.
- Skulason, B., Jonsdottir, L.S., Sigurdardottir, V., & Helgason A.R., 2012. Assessing survival in widowers, and controls - A nationwide, six- to nine-year follow-up. *BMC Public Health.* 12:96.
- Stroebe, M., Schut, H., & Stroebe, W., 2007. Health outcomes of bereavement. *Lancet.* 370(9603),

1960–1973.

Umberson, D., 1992. Gender, marital status and the social control of health behavior. *Soc Sci Med.* 34(8), 907–917.

Umberson, D., Wortman, C. B., & Kessler, R. C., 1992. Widowhood and depression: explaining long-term gender differences in vulnerability. *J Health Soc Behav.* 33(1), 10–24.

Vable, A.M., Subramanian, S.V., Rist, P.M., & Glymour, M.M., 2015. Does the “widowhood effect” precede spousal bereavement? results from a nationally representative sample of older adults. *Am J Geriatr Psychiatry.* 23(3), 283-292.

Walter-Ginzburg, A., Blumstein, T., Chetrit, A., Modan, B., 2002. Social factors and mortality in the old-old in Israel: the CALAS study. *J Gerontol B Psychol Sci Soc Sc.* 57(5), S308–318.

Wang, G.Z., & Ge, Y.X., 2013. Status of widowed elderly population in China and its development trend. *Scientific Research on Aging.* 1(1):44-55. In Chinese

Ward, A., 1976. Mortality of bereavement. *Br. med. J.* 1,700-702.

Ward, R. A., 2008. Multiple parent-adult child relations and well-being in middle and later life. *J Gerontol B Psychol Sci Soc Sc.* 63(4), S239–247.

Williams, B.R., Zhang, Y., Sawyer, P. et al., 2011. Intrinsic association of widowhood with mortality in community-dwelling older women and men: Findings from a prospective propensity-matched population study. *J Gerontol A Biol Sci Med Sci.* 66A(12), 1360–1368.

Ytterstad, E., & Brenn, T., 2015. Mortality after the death of a spouse in Norway. *Epidemiology.* 26(3), 289-294.

Table 1. Characteristics of the sample and gender difference

Variables	Whole sample (N=2471)	Older men (N=1218)	Older women (N=1253)
Age(avg.)	72(0.16)	71(0.21)	73(0.23)***
Education(literate)	26.39%	43.92%	9.34%***
Household income(Yuan)	1486(61.78)	1803(97.31)	1178(75.81)***
Occupation(farmer)	93.85%	92.12%	95.53%***
Self-reported health	2.06(0.02)	2.19(0.02)	1.94(0.02)***
Onset of chronic disease	77.01%	72.66%	81.25%***
Number of children	3.89(0.03)	3.89(0.05)	3.89(0.04)
Living arrangement			*
Living alone(or only couple)	50.10%	52.30%	47.96%
Living with children	30.76%	26.52%	34.88%
Living with others	19.14%	21.18%	17.16%
Marital status			**
Married	48.89%	63.55%	34.64%
Widowed before	39.74%	26.52%	52.59%
Widowed after	11.37%	9.93%	12.77%
Death	38.65%	39.82%	37.51%
Death to disease	78.43%	83.09%	73.62%***
Death to other reason	21.57%	16.91%	26.38%***

Note. Significance for t-test/f-test *** P<0.001, **P<0.01, *P<0.05 (t-test/F-test)

Table 2. Cox hazard regression model for widowhood, living arrangement and mortality risk

Variables	All widowed		
	Model 1	Model 2	Model 3
Gender		1.66***	1.67***
Age		1.10***	1.10***
Education(illiterate for reference)		0.89	0.88
Family income		0.94***	0.94***
Occupation(others for reference)		1.00	1.01
Self-reported health		0.74***	0.74***
Chronic disease		1.20*	1.21*
Child number		0.99	0.98
Marital status(married for reference)			
Widowed before	1.79***	0.77**	0.62***
Widowed after	1.06	0.72**	0.44**
Living arrangement(Living with children for reference)			
Living alone (or only couple)	0.82**	0.85*	0.67**
Living with others	0.52***	0.75**	0.59**
Interactions			
Widowed before* Living alone			1.37*
Widowed before* Living with others			1.27
Widowed after* Living alone			1.78*
Widowed after* Living with others			2.69**

Note. Significance levels: +P<0.1, *P<0.05, **P<0.01, *** P<0.001

Table 3. Gender difference in Cox hazard regression model for widowhood, living arrangement and mortality risk

Variables	Older men		Older women	
	Model 1	Model 2	Model 1	Model 2
Gender				
Age	1.09***	1.09***	1.11***	1.11***
Education(illiterate for reference)	0.91	0.90	0.82	0.82
Family income	0.94***	0.94***	0.94***	0.94***
Occupation(others for reference)	0.92	0.93	1.13	1.12
Self-reported health	0.76***	0.76***	0.72***	0.73***
Chronic disease	1.24+	1.24+	1.20	1.18
Child number	0.99	0.99	0.98	0.98
Marital status(married for reference)				
Widowed before	0.86	0.61**	0.63**	0.66+
Widowed after	0.79	0.40**	0.60**	0.57
Living arrangement (Living with children for reference)				
Living alone (or only couple)	0.79*	0.57***	0.92	1.01
Living with others	0.71*	0.56**	0.82	0.68
Interactions				
Widowed before* Living alone		1.74*		0.86
Widowed before* Living with others		0.83		1.40
Widowed after* Living alone		2.22*		1.08
Widowed after* Living with others		4.91**		1.19

Note. Significance levels: +P<0.1, *P<0.05, **P<0.01, *** P<0.001

Table 4. Cox hazard regression model for robustness check by age group, cause of disease and survey period

	Older men		Older women		Older men		Older women	
	Model	Model	Model	Model	Model	Model	Model	Model
	1	2	1	2	1	2	1	2
Age group	Adult elders				Older elders			
Marital status(married for reference)								
Widowed before	0.76	0.69	0.57*	0.66	0.85	0.43***	0.66*	0.69
Widowed after	1.12	0.95	0.61+	0.27+	0.64*	0.20***	0.64+	0.83
Living arrangement(Living with children for reference)								
Living alone (or only couple)	0.85	0.81	1.06	1.05	0.74*	0.34***	0.88	0.95
Living with others	0.76	0.72	0.55+	0.54	0.68+	0.41**	1.08	0.94
Interactions								
Widowed before* Living alone		1.32		0.74		2.85***		0.92
Widowed before* Living with others		0.33		0.84		1.36		1.22
Widowed after* Living alone		0.94		2.87		4.75**		0.69
Widowed after* Living with others		2.80		2.48		6.61**		0.79
Cause of death	Death from disease				Death from other reasons			
Marital status								
Widowed before	0.84	0.62*	0.56***	0.61+	1.36	0.54	1.00	0.95
Widowed after	0.77	0.44*	0.57**	0.55	1.38	0.18	0.82	0.74
Living arrangement								
Living alone (or only couple)	0.75*	0.57***	0.84	0.95	0.90	0.34*	0.99	1.02
Living with others	0.65**	0.55**	0.76	0.67	0.93	0.43	0.96	0.44
Interactions								
Widowed before* Living alone		1.74*		0.82		3.29*		0.94
Widowed before* Living with others		0.51		1.33		2.25		2.65
Widowed after* Living alone		1.82		1.03		11.12*		1.11
Widowed after* Living with others		5.17**		1.10		11.79+		1.57
Survey period	2001-2009				2009-2015			
Marital status								
Widowed before	0.86	0.61*	0.64*	0.63	0.80	0.43*	0.58*	0.72
Widowed after	0.72+	0.35**	0.53**	0.53	0.82	0.33+	0.77	0.63
Living arrangement								
Living alone (or only couple)	0.95	0.67*	0.99	1.02	0.60*	0.38**	0.80	0.97
Living with others	0.86	0.69+	1.01	0.73	0.53*	0.35**	0.55+	0.62
Interactions								
Widowed before* Living alone		1.80*		0.94		2.28*		0.75
Widowed before* Living with others		0.75		1.64		1.42		0.79
Widowed after* Living alone		2.52*		1.00		2.64+		1.22
Widowed after* Living with others		4.62**		1.04		8.84*		1.56

Note. Significance levels: +P<0.1, *P<0.05, **P<0.01, *** P<0.001