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Article

Does widowhood affect cognitive function among Chinese older adults?

Zhenmei Zhang[a,*], Lydia W. Li[b], Hongwei Xu[c], Jinyu Liu[d]

[a] Department of Sociology, Michigan State University, East Lansing, MI 48824, USA
[b] School of Social Work, University of Michigan, USA
[c] Department of Sociology, Queens College - CUNY, USA
[d] School of Social Work, Columbia University, USA

A B S T R A C T

There is growing evidence from Western countries that widowhood may affect cognitive health in later life. However, little is known about whether widowhood is associated with cognitive health in Eastern Asian countries such as China and what factors may explain the association between widowhood and cognitive health. We add to this line of research by investigating the effect of widowhood on 2-year change in cognitive function among Chinese adults ages 55 and older from 2011 to 2013, using data from the China Health and Retirement Longitudinal Study. Cognitive function was measured by episodic memory and mental intactness (i.e., attention and time orientation). Our results showed that Chinese older adults who were continually widowed at both waves had significantly lower episodic memory scores at Wave 2 than their continually married counterparts, controlling for episodic memory at Wave 1, age, gender, education, and other sociodemographic variables. This suggests that the continually widowed experienced greater decline in episodic memory than the continually married over the 2-year period. After further controlling for economic resources, health, and social engagement, the difference in memory decline between the continually widowed and the continually married barely changed. The effect of widowhood on memory decline was similar for men and women. However, the continually widowed were not significantly different from the continually married in the decline of mental intactness. In addition, newly widowed adults were not significantly different from the continually married in the change of episodic memory and mental intactness. We conclude that staying widowed for 2 years or more may be an independent risk factor for episodic memory decline in China. More research is needed to investigate the mediating and moderating mechanisms underlying the association between widowhood and memory decline.

1. Introduction

For many older adults, one inevitable and difficult role transition is from being married to widowhood. Widows and widowers constitute a vulnerable group in later life because bereavement is one of the most stressful events one can experience, which can lead to grief, depression, and financial hardships (Li, Liang, Toler, & Gu, 2005; Sasson & Umberson, 2014; Zhang & Lin, 2017). Previous research has found that widowhood is associated with an increased risk of illnesses, depression, disability, and mortality (Lee & DeMaris, 2007; Rendall, Weden, Favreault, & Waldron, 2011). However, few studies have extended this line of inquiry to cognitive health. Cognitive function is an important component of health and well-being in later life, as people with cognitive impairment often have difficulty performing tasks of daily living and need significant medical and personal care (Institute of Medicine U.S., Blazer, Yaffe, & Liverman, 2015; Langa et al., 2001). In recent years, scholars have begun to investigate the effect of widowhood on cognitive health in later life, and most studies are conducted in the United States and European countries. While some studies found that widowhood was associated with a higher risk of dementia and more rapid declines in several domains of cognitive function, including episodic memory, verbal meaning, and spatial ability (Aartsen, Van Tilburg, Smits, Comijs, & Knipscheer, 2005; Grimby & Berg, 1995; Gow & Mortensen, 2016; Karlamangla et al., 2009; Mousavi-Nasab, Kormi-Nouri, Sundstrom, & Nilsson, 2012; Sommerlad, Ruegger, Singh-Manoux, Lewis, & Livingston, 2018), other studies did not detect an increased risk of dementia among the widowed (see Helmer et al., 1999; Vidarsdottir et al., 2014). Further, few studies have explored the factors that may explain the association between widowhood and cognitive health in later life.

The current study aims to examine whether widowhood is associated with change in cognitive function among older Chinese. Furthermore, we investigate the extent to which economic resources, adulthood health, and social engagement account for this association.

1.1. Marital status and cognitive health

To understand how stable marital status (being married/widowed) or transitioning out of a marital category (e.g., becoming widowed) may influence cognitive health in later life, researchers often draw on two perspectives: the marital resource model and the stress model. The marital resource model suggests that marriage provides social,

* Corresponding author.
E-mail address: zhangz12@msu.edu (Z. Zhang).

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psychological, and economic resources, which in turn promote health and well-being (Waite & Gallagher, 2000). Specifically, marriage facilitates access to social support and social integration, both of which are associated with better cognitive function in later life (Ertel, Glymour, & Berkman, 2008; Ellwardt, Aartsen, Deeg, & Steverink, 2013; Gow, Corley, Starr, & Deary, 2013). In terms of economic resources, marriage leads to an increase in income and wealth through within-household specialization (i.e., spouses specialize in specific tasks such as labor market activities and domestic work), economies of scale, and the pooling of wealth. Economic resources also directly enhance health through their positive effects on access to nutritious food and medical or other health-enhancing resources (Killewald & Gough, 2013; Liu, 2012). In addition, marital interaction can provide daily cognitive stimulation for married individuals, which is conducive to the maintenance of cognitive function (Fratiglioni, Paillard-Borg, & Winblad, 2004; Mousavi-Nasab et al., 2012). Based on the marital resource model, the widowed should be expected to fare worse in cognitive health than the married due to their permanent loss of health-enhancing resources provided by marriage.

The stress model suggests that the stress of bereavement can be an important factor undermining the cognitive health of the widowed (Aartsen et al., 2005). Widowhood is one of the most stressful events in life (Williams & Umberson, 2004), which can entail acute and chronic stress including loss of confidant, changes in residence and daily routine, and an increase of economic hardship (Liu, 2012; Zhang & Hayward, 2006). Recent research found that perceived stress was associated with faster cognitive decline and a higher risk of dementia (Aggarwal et al., 2014; Johansson et al., 2010). Stress and grief following bereavement often increase the risk of depression and other chronic health problems among the widowed, which can in turn negatively affect their cognitive function (Jorm, 2000; Morley, 2017). In addition, stress and depression may lower widowed individuals' interest in participating in social activities, a protective factor of cognitive function in later life (Dong, Li, & Simon, 2014; Feng et al., 2014). On the other hand, the majority of the widowed seem to recover over time in terms of depressive symptoms, usually within 24 months (Sasson & Umberson; 2014; Umberson, Thomeer, & Williams, 2013). Thus, the stress perspective would predict that the widowed, the newly widowed in particular, may experience greater decline in cognitive function than the married. These two theoretical perspectives may complement each other. While the marital resource model emphasizes the protective effect of marital resources on cognitive health, the stress model posits that the stress and strains of bereavement itself can have negative effects on cognitive health. It is possible that both processes contribute to the association between widowhood and cognitive health outcomes.

1.2. Widowhood and cognitive health in Asian countries

The effect of widowhood on health may vary across sociocultural contexts due to differences in formal and informal support available to older adults (Mathison, 1970; Zhang & Lin, 2017). However, very few studies have examined the association between widowhood and cognitive health in Asian settings. In one study, being widowed was associated with higher odds of cognitive impairment compared to being married among community-dwelling Chinese older adults in Singapore, but the association was statistically significant only among men and not women (Feng et al., 2014). The authors suggested that widows may adjust to widowhood better than widowers due to the broader networks of intimate friends and social ties that women tend to have compared to men. Based on a population-based cross-sectional survey in Taiwan, researchers found that widowed individuals had higher odds of dementia than their married counterparts, even after controlling for age, gender, education, comorbidities, and lifestyles (Fan et al., 2015). Similar results were reported in China. For example, one large regional study of 34,807 community residents ages 55 and over in four cities (i.e., Beijing, Chengdu, Shanghai, and Xi'an) found that widowed individuals faced a higher risk of Alzheimer's disease but a lower risk of vascular dementia compared to the married (Zhang et al., 2006). Another regional study in China found that being unmarried (never married/divorced/widowed) was significantly associated with higher odds of cognitive impairment among adults aged 60 years and older (Giri, Chen, Yu, & Lu, 2016). In that study, widowed people were grouped together with the never married and the divorced, so it is not clear whether widowhood itself was a significant correlate of cognitive impairment. Similarly, a recent study in South Korea found that widowed older Koreans had a higher risk of Alzheimer's disease than their married counterparts (Bae et al., 2015). In sum, a handful of Asian studies have found that widowed individuals had higher rates of cognitive impairment, Alzheimer's disease, and dementia than their married counterparts. It is important to point out that most of these studies relied on cross-sectional data, which makes it impossible to establish causal links between widowhood and cognitive outcomes. In comparison, most studies in Western countries used longitudinal data. As mentioned above, findings from Western studies are mixed (Sommerlad et al., 2018; Vidarsdottir et al., 2014), which may be due to the different cognitive outcomes examined (e.g., memory, spatial ability, cognitive impairment, and dementia), variations in the length of follow-up, or different sociocultural contexts.

1.3. The present study

We aim to test three hypotheses related to the association between widowhood and cognitive change among older adults in China. First, we expect the widowed to have greater decline in cognitive function than their married counterparts, controlling for sociodemographic characteristics. Second, we hypothesize that the greater cognitive decline of widowed Chinese adults is explained in part by economic resources, adulthood health, and social engagement. Third, we posit that the effect of widowhood on cognitive decline is stronger for men than for women.

Our study extends previous studies in several ways. First, unlike most prior studies conducted in Asia that used cross-sectional data to describe the association between widowhood and cognitive outcomes, we analyze longitudinal data from a nationally representative sample of older adults in China. Second, we are one of the few to examine potential mechanisms underlying the association between widowhood and cognitive change. Third, we explore the moderating role of gender, an overlooked aspect in the literature, in the association between widowhood and cognitive change.

2. Data and methods

2.1. Data

We drew on the first two waves (2011 and 2013) of the China Health and Retirement Longitudinal Study (CHARLS) to examine the association between widowhood and change in cognitive function in later life. The CHARLS is a longitudinal survey of community-dwelling Chinese adults aged 45 years and older and their spouses, all of whom are followed every two years. A probability sample was obtained using multistage stratified sampling methods. Between June 2011 and March 2012,12,740 households were contacted for interview, and 10,257 households completed at least one module of the survey via computer-assisted personal interviews, which yielded a response rate of 80.5%. The baseline sample included 17,708 respondents (some households have 2 respondents: husband and wife) from 150 counties in 28 provinces. In the 2013 follow-up survey, 15,186 (about 86%) of the baseline respondents were successfully re-interviewed (Smith, Tian, & Zhao, 2013; Zhao, Hu, Smith, Strauss, & Yang, 2014). The CHARLS is one of the most up-to-date longitudinal data sets collected in China to study the health and well-being of older adults. Our analytic sample was restricted to those respondents aged 55 and older who stayed

married, stayed widowed or become widowed between the baseline and the follow-up (N = 9203). We restricted the sample to those who were 55 years and older because widowhood is a rare event for those younger than 55. We also excluded those respondents who had missing values on all cognitive tests in either wave (n = 1279). All the exclusion criteria resulted in a final sample size of 7924 respondents.

2.2. Measures

We constructed two cognitive measures based on previous studies: episodic memory and mental intactness (Hu, Lei, Smith, & Zhao, 2012; Lei, Smith, Sun, & Zhao, 2013).

2.2.1. Episodic memory

Episodic memory is an important dimension of cognitive function and is crucial for reasoning and daily functioning. List learning tests are commonly used by neuropsychologists to measure episodic memory (Gavett & Horwitz, 2012; Lachman, Agrigoroaei, Murphy, & Tun, 2010). Respondents in the CHARLS were asked to recall ten simple Chinese nouns right after they were read to them (immediate recall) and then four minutes later (delayed recall). We averaged the scores of immediate recall and delayed recall to create a measure of episodic memory. In additional analyses, we used immediate recall and delayed recall as separate dependent variables and the results were similar.

2.2.2. Mental intactness

The CHARLS adopted several questions from the *Telephone Interview of Cognition Status (TICS)* battery to evaluate intact mental status. Our measure of mental intactness consists of respondents' correct answers from five items on time orientation (i.e., awareness of date, month, year, day of week, and the season of the year) and the numbers of correct subtractions in the serial 7's test. This test asks respondents to repeatedly subtract 7 starting from 100 for five trials. The value of the mental intactness measure ranges from 0 to 10.

2.2.3. Marital status continuity and change

We classified older adults into three groups based on their marital status in Wave 1 and Wave 2: continually married (reference group) refers to those who were married in both waves; continually widowed refers to those who were widowed in both waves; and newly widowed refers to those who were married in Wave 1 but became widowed in Wave 2.

2.2.4. Economic resources

We used annual household per capita expenditures (PCE) to measure economic resources. The existing literature suggests that expenditures constitutes a better measure of economic resources available to the family than income in developing countries, and in low-income rural settings in particular (Lei et al., 2014). We used the logged value of expenditures because the variable is skewed.

2.2.5. Adulthood health

We used two indicators of adulthood health at baseline: functional limitations and depressive symptoms. Functional limitations is a variable reflecting physical health and was coded as 1 if the respondent reported having some difficulty doing any of the following seven activities: walking 1 km; getting up from a chair after sitting for a long period; climbing several flights of stairs without resting; stooping, kneeling or crouching; reaching arms above shoulders; carrying ten pounds; or picking up a small coin from a table. It was otherwise coded as 0. The measure of functional limitations is validated and commonly used in previous research (Zimmer, Martin, Jones, & Nagin, 2014). The depressive symptoms variable reflects mental health and was measured by the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10), which was previously validated among older Chinese in Hong Kong (Boey, 1999; Cheng & Chan, 2005). The sum of the CESD-10 scores ranged from 0 to 30 with higher scores indicating more depressive symptoms. Previous research has shown that both depression and functional limitations were associated with increased rate of cognitive decline and risk of dementia (Auyeung, Lee, Kwok, & Woo, 2011; Buchman, Boyle, Wilson, Tang, & Bennett, 2007; Jorm, 2000; Wang, Larson, Bowen, & van Belle, 2006).

2.2.6. Social engagement

Social engagement was measured by participation in one or more social activities (e.g., visiting neighbors/friends, playing majong/cards, going to dance or exercise in parks or other places, going to a sports or social club, etc.) in the last month. We dichotomized the variable (1 = participate in one or more activities) because the level of social engagement was quite low in our sample: A majority of the respondents (55%) did not participate in any activity, and most of the rest participated in one activity only.

2.2.7. Controls

We included the respondent's age, gender (1 = female), education, *hukou* status (1 = rural), living arrangements (1 = living with children), and baseline cognitive scores. Age categories are 55–59 (reference category), 60–64, 65–69, and 70 and above. Education was coded into five categories: no schooling, less than elementary but can read and write, elementary school, middle school, and high school or more. In China, the household registration system (*hukou*) was instituted in the 1950s and it classified all citizens into 'agricultural' (rural) or "non-agricultural' (urban). *Hukou* status was controlled for because adults with urban *hukou* have access to a broad range of privileges such as medical care and retirement pensions, while their counterparts with rural *hukou* are provided little (Whyte, 1999).

Some of the variables we used in our analysis come from the harmonized CHARLS data set provided by the Gateway to Global Aging Data, which includes cleaned and processed variables from CHARLS.

2.3. Analytic strategy

We first present weighted descriptive statistics of the study variables in the sample by marital status. Baseline individual-level weights were used to adjust for sample selection and household and individual non-response. We then used a lagged dependent variable approach (LDV) to examine the association between widowhood and cognitive function at Wave 2, controlling for Wave 1 cognitive function and other covariates. The basic form of the LDV model in our analysis can be written as:

$$\textit{Cognitive function}_{w2} = \beta_0 + \beta_1\, \textit{continually widowed} + \beta_2\, \textit{newly widowed} + \beta_3\, \textit{cognitive function}_{w1} + \beta_4\, \textit{covariates}_{w1} + \varepsilon$$

where β_s are regression parameters. Specifically, the LDV models test the effects of staying widowed and transitioning into widowhood on the change in cognitive function between Wave 1 and Wave 2. Thus, a negative coefficient of the continually widowed would indicate a greater decline in cognitive function compared to the continually married over a two-year period (Johnson, 2005; Luo, Pan, & Zhang, 2018). The base model included the continually widowed, the newly widowed, and sociodemographic characteristics. Indicators of economic resources, physical and mental health, and social engagement at Wave 1 were then added in a series of nested models to examine whether the association between widowhood and cognitive function at Wave 2 attenuates with these variables added. Finally, to test the moderating role of gender, we added interaction terms between the widowhood variables and gender into the full model. To adjust for sample selection and longitudinal attrition, we used longitudinal weights provided by the CHARLS team in the regression analysis. Most of our independent variables in the analytic sample had very few missing data (< 1%) except for depressive symptoms and household PCE, which had 5% and 15.7% missing respectively. Thus, we

Table 1
Weighted Sample Statistics by Marital Status 2011–2013, CHARLS (N = 7924).

	Continually Married (n = 6631)	Continually Widowed (n = 1084)	Newly Widowed (n = 209)
Cognitive function			
Episodic memory W2	3.33	2.58[a]	2.89[b]
Episodic memory W1	3.43	2.92[a]	2.97[b]
Mental intactness W2	6.56	5.31[a]	5.75[b]
Mental intactness W1	6.67	5.32[a]	5.85[b]
Economic resources (W1)			
Household consumption per capita (ln)	8.51	8.39	8.44
Mental and physical health (W1)			
Depressive symptoms	8.18	10.14[a]	10.23[b]
Any functional limitations (ref: no)	55.27	69.85[a]	68.68[b]
Social engagement (W1)			
Any social activities (ref: no)	46.17	48.57	44.08
Sociodemographic controls (W1)			
Age groups (%)			
55–59	36.95	13.08[a]	18.51[b]
60–64	27.56	16.75[a]	20.18[b]
65–69	17.92	16.68	20.48
70 and above	17.57	53.49[a]	40.83[b]
Female (ref: male)	46.49	72.77[a]	69.76[b]
Education (%)			
No schooling	28.10	49.61[a]	47.95[b]
Less than elementary school	20.82	17.39	16.39
Elementary school	24.43	18.11[a]	21.92
Middle school	16.56	11.25[a]	8.86[b]
High school or more	10.09	3.63[a]	4.88[b]
Rural *hukou* (ref: urban)	71.77	75.60	75.01
Living with children (ref: not)	50.83	62.65[a]	49.30

Note. W1: Wave 1 (2011). W2: Wave 2 (2013).
[a] The difference between the continually widowed and the continually married is statistically significant at $p < 0.05$.
[b] The difference between the newly widowed and the continually married is statistically significant at $p < 0.05$.

conducted multiple imputation to replace missing data. The results were based on 10 random, multiple-imputed replicates. We conducted all analyses using Stata 14.

3. Results

3.1. Sample characteristics

Table 1 presents the distribution of all study variables in our sample by marital status. The continually widowed and newly widowed had significantly lower scores on episodic memory and mental status than the continually married at both waves. The two widowed groups also reported more depressive symptoms and were more likely to have functional limitations than the continually married. There were no significant differences in household PCE or social engagement across the three groups. In addition, the continually widowed and the newly widowed were older, more likely to be female, and less educated than the continually married. The continually widowed were also more likely to live with children than the continually married (62.7% vs. 50.8%).

3.2. Widowhood and change in cognitive function

We first examined the association between widowhood status and change in episodic memory. Results in Model 1 of Table 2 show that respondents who were continually widowed at both waves had significantly lower episodic memory scores in the follow-up survey, compared to their counterparts who remained married, net of age, gender, education, rural *hukou*, living with children, and baseline episodic memory scores. This suggests that the continually widowed had greater memory decline than the continually married in the 2-year period. However, those who were newly widowed were not significantly different from the continually married in episodic memory at follow-up. After adding household PCE in Model 2, the coefficient of the continually widowed did not change and remained statistically significant. In order to determine whether physical and mental health differences might explain the greater decline in episodic memory of the continually widowed, we added functional limitations and depressive symptoms to Model 1. Results of Model 3 show that the coefficient of the continually widowed was reduced slightly. In Model 4, we added social engagement to Model 1, and the coefficient of the continually widowed remained almost unchanged. In our full model (Model 5), after controlling for all covariates, the continually widowed still had significantly lower episodic memory scores than the continually married.

Table 2
Regression Coefficients for Episodic Memory Among Chinese Adults ages 55 and older, CHARLS, 2011–2013.

	Episodic Memory				
	Model 1	Model 2	Model 3	Model 4	Model 5
Marital status W1-W2 (ref: Continually married)					
Continually widowed	−0.15*	−0.15*	−0.13*	−0.16*	−0.14*
Newly widowed	0.05	0.05	0.07	0.05	0.07
Economic resources (W1)					
Household consumption per capita		0.04			0.04
Mental and physical health (W1)					
Depressive symptoms			−0.01*		−0.01*
Any functional limitations (ref: no)			−0.17**		−0.17**
Social engagement (W1)					
Any social activities (ref: no)				0.12**	0.10*
Sociodemographic controls (W1)					
Age groups (ref: 55–59)					
60–64	−0.16**	−0.16**	−0.14**	−0.16**	−0.13*
65–69	−0.40**	−0.39**	−0.37**	−0.39**	−0.36**
70 and above	−0.75**	−0.75**	−0.73**	−0.76**	−0.72**
Female (ref: male)	0.11*	0.11*	0.15*	0.11*	0.14**
Education (ref: no schooling)					
Less than elementary school	0.45**	0.45**	0.46**	0.45**	0.45**
Elementary school	0.71**	0.70**	0.69**	0.70**	0.69**
Middle school	1.11**	1.10**	1.09**	1.10**	1.08**
High school or more	1.21**	1.19**	1.18**	1.19**	1.15**
Rural *hukou* (ref: urban)	−0.48**	−0.46**	−0.46**	−0.47**	−0.43**
Living with children (ref: not)	−0.05	−0.04	−0.06	−0.05	−0.05
Episodic memory W1	0.30**	0.30**	0.29**	0.30**	0.29**
Constant	2.28	1.91	2.45	2.24	2.08
R^2	0.30	0.30	0.31	0.31	0.31

Note. W1: Wave 1(2011). W2: Wave 2(2013).
Unstandardized regression coefficients are presented. The results are based on 10 multiple-imputed data sets.
* $p < 0.05$.
** $p < 0.01$.

We have also included interaction terms between gender and the widowhood variables (female x continually widowed and female x newly widowed) in the full model, but neither of the interaction terms was statistically significant. These results are not shown in Table 2.

Among the covariates, we found that age increased the risk of decline in episodic memory. Women and those with higher levels of education had better, whereas old adults with rural *hukou* had worse episodic memory at 2-year follow-up. Older adults with functional limitations and more depressive symptoms at baseline also had worse episodic memory at follow-up. Social engagement at baseline was positively associated with better episodic memory at follow-up.

To examine the effects of widowhood on mental intactness, we repeated the series of analysis as done for episodic memory described above. We found that neither the continually widowed nor the newly widowed were significantly different from the continually married in the change of mental intactness over the 2-year period (results not shown).

4. Discussion

Recent research on widowhood and cognitive health in later life suggests that widowhood may be a risk factor for cognitive decline, cognitive impairment, and dementia (Sommerlad et al., 2018). Most of the research has been conducted in Western countries. Using the nationally representative CHARLS data, we investigated whether widowed Chinese adults had greater cognitive decline than the married during a 2-year period. The analyses produce four major findings. First, our results indicate that staying widowhood for 2 years or longer may be an independent risk factor for episodic memory decline in China. Even after controlling for various potential confounders, the association between staying in widowhood and episodic memory at follow-up was robust. Surprisingly, the newly widowed did not suffer from greater cognitive decline than the continually married. Taken together, these findings suggest that the duration of exposure to widowhood matters and that two processes may be involved. First, there may be a burst of social support from adult children, relatives and friends in the early stages of the transition into widowhood. The increased social support may temporarily shield the widowed from the negative effects of spousal loss on cognitive function, but it may gradually dissipate over time. Second, brain change occurs slowly, and it may simply take time for the negative effects of widowhood to manifest.

Second, we hypothesized that economic resources, health, and social engagement would partially account for the association between widowhood and cognitive decline. However, we did not find these factors to be major underlying mechanisms in our study. Our results are consistent with findings from previous research that socioeconomic resources and social engagement did not account much for the negative effect of widowhood on cognitive outcomes (e.g., Feng et al., 2014; Sundstrom, Westerlund, & Kotyrlo, 2016). Nonetheless, it is important to recognize that our measures of economic resources and social engagement may not have fully captured the differences between the widowed and the married in these domains. Future studies should collect more precise data on economic hardship and daily social activities of older adults.

Previous research has found that the loss of spouse often has harmful effects on mental health due to stress and depression, which can lead to increased cortisol secretion. High cortisol levels have been associated with poorer memory in middle and late life (Geoffroy, Hertzman, Li, & Power, 2012; Lee et al., 2007; van Gelder et al., 2006). In addition, the widowed often have higher rates of functional limitations than the married, which researchers have attributed to their less healthy lifestyles and the stress of caring for a sick spouse prior to death (Carr & Springer, 2010; Hughes & Waite, 2009). However, few previous studies have examined whether depressive symptoms and functional limitations accounted for the association between widowhood and cognitive outcomes. In our study, we found that these two health variables are significantly associated with episodic memory but together they only accounted for a small proportion (about 13%) of the difference between the married and the continually widowed in memory decline. Future research can further explore whether other chronic health conditions, biomarkers, and lifestyles can account for the negative effects of widowhood on cognitive health.

Third, we did not find gender differences in the effect of widowhood on change in cognitive function. This differs from the findings of a cross-sectional study of Chinese older adults in Singapore (Feng et al., 2014) but is consistent with findings in Western countries (e.g., Aartsen et al., 2005; Karlamangla et al., 2009).

Fourth, our results indicate that the effects of widowhood on cognitive function may vary across cognitive domains (Mousavi-Nasab et al., 2012). We found no evidence to support an association between widowhood and change in mental intactness, although we found that those who were widowed for more than two years had greater memory decline than the continually married during the follow-up. In this study, mental intactness captured time orientation and attention, which may involve a different part of the brain and neurological process than those responsible for memory (Xu, Zhang, Li, & Liu, 2018). Mousavi-Nasab and coauthors (2012) also found that widowhood was not associated with semantic memory (i.e., memory associated with knowledge and fluency) in their Swedish sample.

Nevertheless, our study is not without limitations. First, the measure of cognitive function in CHARLS is limited. Given that the effects of widowhood differ for mental intactness and episodic memory in our analyses, future studies should include other important measures of cognitive function such as processing speed, executive function, and verbal fluency as outcomes so as to better understand how widowhood affects cognition. Second, because widowhood is associated with a higher risk of mortality (Rendall et al., 2011), our sample of widowed older adults may represent 'healthy survivors', which would lead to an underestimation of the negative effects of widowhood on cognitive decline.

Despite these limitations, our study makes an important contribution to the literature on widowhood and cognitive health in later life. Utilizing longitudinal data from a probability sample of older adults in China, we found that compared with those who remained continually married between 2011 and 2013, the continually widowed show greater decline in episodic memory. This is true for both men and women, and the differences persist after controlling for economic resources, physical and mental health, social engagement and other sociodemographic variables. Our findings suggest that staying in widowhood status may be a risk factor for greater episodic memory decline. Although the specific mechanisms underlying the relationship between widowhood and cognitive decline are unknown, we speculate that in mid- and late life, spouse may be one of the best sources of daily cognitive stimulation. Spousal relationship may also provide social support that buffers adverse life events (e.g., illness of self, illness of a relative or a friend, death of a relative or a friend), which can negatively affect cognitive function (Sundstrom et al., 2016). More research is needed to find out potential mechanisms so that health professionals and policymakers can develop effective interventions to improve cognitive health of widowed individuals.

Declarations of interest

None.

Ethics approval statement

The research did not involve human subjects as it was conducted using publicly available, de-identified secondary data. Therefore, the researchers will have no access to personal identifiers or personal health information that can be linked to individuals while analyzing the data.

References

Aartsen, M. J., Van Tilburg, T., Smits, C. H., Comijs, H. C., & Knipscheer, K. C. (2005). Does widowhood affect memory performance of older persons? *Psychological Medicine, 35*(2), 217–226.

Aggarwal, N. T., Wilson, R. S., Beck, T. L., Rajan, K. B., Leon, C. F. M. D., Evans, D. A., et al. (2014). *Perceived stress and change in cognitive function among adults 65 years and older. Psychosomatic Medicine*, *76*, 80–85.

Auyeung, T. W., Lee, J. S., Kwok, T., & Woo, J. (2011). Physical frailty predicts future cognitive decline - a four-year prospective study in 2737 cognitively normal older adults. *Journal of Nutrition, Health, and Aging, 15*(8), 690–694.

Bae, J. B., Kim, Y. J., Han, J. W., Kim, T. H., Park, J. H., Lee, S. B., & Kim, K. W. (2015). Incidence of and risk factors for Alzheimer's disease and mild cognitive impairment in Korean elderly. *Dementia and Geriatric Cognitive Disorders, 39*(1-2), 105–111.

Boey, K. W. (1999). Cross-validation of a short form of the CES-D in Chinese elderly. *International Journal of Geriatric Psychiatry, 14*(8), 608–617.

Buchman, A. S., Boyle, P. A., Wilson, R. S., Tang, Y., & Bennett, D. A. (2007). Frailty is associated with incident Alzheimer's disease and cognitive decline in the elderly. *Psychosomatic Medicine, 69*(5), 483–489.

Carr, D., & Springer, K. W. (2010). Advances in families and health research in the 21st century. *Journal of Marriage and Family, 72*(3), 743–761.

Cheng, S. T., & Chan, A. (2005). The center for epidemiologic studies depression scale in older Chinese: Thresholds for long and short forms. *International Journal of Geriatric Psychiatry, 20*(5), 465–470.

Dong, X., Li, Y., & Simon, M. A. (2014). Social engagement among U.S. Chinese older adults—findings from the PINE Study. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 69*(Suppl_2), S82–S89.

Ellwardt, L., Aartsen, M., Deeg, D., & Steverink, N. (2013). Does loneliness mediate the relation between social support and cognitive functioning in later life? *Social Science and Medicine, 98*, 116–124.

Ertel, K. A., Glymour, M. M., & Berkman, L. F. (2008). Effects of social integration on preserving memory function in a nationally representative US elderly population. *American Journal of Public Health, 98*(7), 1215–1220.

Fan, L. Y., Sun, Y., Lee, H. J., Yang, S. C., Chen, T. F., Lin, K. N., et al. (2015). Marital status, lifestyle and dementia: A nationwide survey in Taiwan. *PLoS One, 10*(9), e0139154.

Feng, L., Ng, X. T., Yap, P., Li, J., Lee, T. S., Håkansson, K., et al. (2014). Marital status and cognitive impairment among community-dwelling Chinese older adults: The role of gender and social engagement. *Dementia and Geriatric Cognitive Disorders Extra, 4*(3), 375–384.

Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *Lancet Neurology, 3*(6), 343–353.

Gavett, B. E., & Horwitz, J. E. (2012). Immediate list recall as a measure of short-term episodic memory: Insights from the serial position effect and item response theory. *Archives of Clinical Neuropsychology, 27*(2), 125–135.

Geoffroy, M. C., Hertzman, C., Li, L., & Power, C. (2012). Morning salivary cortisol and cognitive function in mid-life: Evidence from a population-based birth cohort. *Psychological Medicine, 42*(8), 1763–1773.

Giri, M., Chen, T., Yu, W., & Lu, Y. (2016). Prevalence and correlates of cognitive impairment and depression among elderly people in the world's fastest growing city, Chongqing, People's Republic of China. *Clinical Interventions in Aging, 11*, 1091–1098.

Gow, A. J., Corley, J., Starr, J. M., & Deary, I. J. (2013). Which social network or support factors are associated with cognitive abilities in old age? *Gerontology, 59*(5), 454–463.

Gow, A. J., & Mortensen, E. L. (2016). Social resources and cognitive ageing across 30 years: The Glostrup 1914 Cohort. *Age and Ageing, 45*(4), 480–486.

Grimby, A., & Berg, S. (1995). Stressful life events and cognitive functioning in late life. *Aging (Milano), 7*(1), 35–39.

Helmer, C., Damon, D., Letenneur, L., Fabrigoule, C., Barberger-Gateau, P., Lafont, S., & Dartigues, J. F. (1999). Marital status and risk of Alzheimer's disease: A French population-based cohort study. *Neurology, 53*(9), 1953–1958.

Hu, Y., Lei, X., Smith, J. P., & Zhao, Y. (2012). Effects of social activities on cognitive functions: Evidence from CHARLS. In J. P. Smith, & M. Majmundar (Eds.). *Aging in Asia: Findings from new and emerging data initiatives* (pp. 279–305). Washington, D.C.: National Academies Press.

Hughes, M. E., & Waite, L. J. (2009). Marital biography and health at mid-life. *Journal of Health and Social Behavior, 50*(3), 344–358.

Institute of Medicine (U.S.) (2015). In D. G. Blazer, K. Yaffe, & C. T. Liverman (Eds.). *Cognitive aging: Progress in understanding and opportunities for action* (pp. 17–30). Washington, D.C: The National Academies Press.

Johansson, L., Guo, X., Waern, M., Östling, S., Gustafson, D., Bengtsson, C., & Skoog, I. (2010). Midlife psychological stress and risk of dementia: A 35-year longitudinal population study. *Brain, 133*, 2217–2224.

Johnson, D. R. (2005). Two-wave panel analysis: Comparing statistical methods for studying the effects of transitions. *Journal of Marriage and Family, 67*, 1061–1075.

Jorm, A. F. (2000). Is depression a risk factor for dementia or cognitive decline? A review. *Gerontology, 46*(4), 219–227.

Karlamangla, A. S., Miller-Martinez, D., Aneshensel, C. S., Seeman, T. E., Wight, R. G., & Chodosh, J. (2009). Trajectories of cognitive function in late life in the United States: Demographic and socioeconomic predictors. *American Journal of Epidemiology, 170*(3), 331–342.

Killewald, A., & Gough, M. (2013). Does specialization explain marriage penalties and premiums? *American Sociological Review, 78*(3), 477–502.

Lachman, M. E., Agrigoroaei, S., Murphy, C., & Tun, P. A. (2010). Frequent cognitive activity compensates for education differences in episodic memory. *American Journal of Geriatric Psychiatry, 18*(1), 4–10.

Langa, K. M., Chernew, M. E., Kabeto, M. U., Herzog, A. R., Ofstedal, M. B., Willis, R. J., & Fendrick, A. M. (2001). National estimates of the quantity and cost of informal caregiving for the elderly with dementia. *Journal of General Internal Medicine, 16*(11), 770–778.

Lee, G. R., & DeMaris, A. (2007). Widowhood, gender, and depression: A longitudinal analysis. *Research on Aging, 29*, 56–72.

Lee, B. K., Glass, T. A., McAtee, M. J., Wand, G. S., Bandeen-Roche, K., Bolla, K. I., & Schwartz, B. S. (2007). Associations of salivary cortisol with cognitive function in the Baltimore memory study. *Archives of General Psychiatry, 64*(7), 810–818.

Lei, X., Smith, J. P., Sun, X., & Zhao, Y. (2013). Gender differences in cognition in China and reasons for change over time: Evidence from CHARLS. *Journal of the Economics of Ageing, 4*, 46–55.

Lei, X., Sun, X., Strauss, J., Zhao, Y., Yang, G., Perry Hu, Y. H., & Yin, X. (2014). Health outcomes and socio-economic status among the mid-aged and elderly in China: Evidence from the CHARLS national baseline data. *The Journal of the Economics of Ageing, 4*, 59–73.

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? *Social Science and Medicine, 60*(3), 637–647.

Liu, H. (2012). Marital dissolution and self-rated health: Age trajectories and birth cohort variations. *Social Science Medicine, 74*, 1107–1116.

Luo, Y., Pan, X., & Zhang, Z. (2018). Productive activities and cognitive decline among older adults in China: Evidence from the China Health and Retirement Longitudinal Study. *Social Science Medicine*. https://doi.org/10.1016/j.socscimed.2018.09.052.

Mathison, J. (1970). A cross-cultural view of widowhood. *OMEGA - Journal of Death and Dying, 1*(3), 201–218.

Morley, J. E. (2017). Cognition and chronic disease. *The Journal of the American Medical Directors Association, 18*(5), 369–371.

Mousavi-Nasab, S. M., Kormi-Nouri, R., Sundstrom, A., & Nilsson, L. G. (2012). The effects of marital status on episodic and semantic memory in healthy middle-aged and old individuals. *Scandinavian Journal of Psychology, 53*(1), 1–8.

Rendall, M. S., Weden, M. M., Favreault, M. M., & Waldron, H. (2011). The protective effect of marriage for survival: A review and update. *Demography, 48*, 481–506.

Sasson, I., & Umberson, D. J. (2014). Widowhood and depression: New light on gender differences, selection, and psychological adjustment. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 69*(1), 135–145.

Smith, J. P., Tian, M., & Zhao, Y. (2013). Community effects on elderly health: Evidence from CHARLS national baseline. *Journal of the Economics of Ageing, 1*, 50–59.

Sommerlad, A., Ruegger, J., Singh-Manoux, A., Lewis, G., & Livingston, G. (2018). Marriage and risk of dementia: Systematic review and meta-analysis of observational studies. *Journal of Neurology, Neurosurgery Psychiatry, 89*(3), 231–238.

Sundstrom, A., Westerlund, O., & Kotyrlo, E. (2016). Marital status and risk of dementia: A nationwide population-based prospective study from Sweden. *BMJ Open, 6*(1), e008565.

Umberson, D., Thomeer, M., & Williams, K. (2013). Family status and mental health: Recent advances and future directions. In C. S. Aneshensel, J. C. Phelan, & A. Bierman (Eds.). *Handbook of the sociology of mental health* (pp. 405–431). Dordrecht: Springer Publishing.

van Gelder, B. M., Tijhuis, M., Kalmijn, S., Giampaoli, S., Nissinen, A., & Kromhout, D. (2006). Marital status and living situation during a 5-year period are associated with a subsequent 10-year cognitive decline in older men: The FINE study. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 61*(4), P213–219.

Vidarsdottir, H., Fang, F., Chang, M., Aspelund, T., Fall, K., Jonsdottir, M. K., & Valdimarsdottir, U. (2014). Spousal loss and cognitive function in later life: A 25-year follow-up in the AGES-Reykjavik study. *American Journal of Epidemiology, 179*(6), 674–683.

Waite, L. J., & Gallagher, M. (2000). *The case for marriage: Why married people are happier, healthier and better off financially?* New York: Doubleday.

Wang, L., Larson, E. B., Bowen, J. D., & van Belle, G. (2006). Performance-based physical function and future dementia in older people. *Archives of Internal Medicine, 166*(10), 1115–1120.

Whyte, M. (1999). Social change and the urban-rural divide in China. In F. Hong, & J. C. Gottwald (Eds.). *The Irish Asia strategy and its China relations 1999–2009* (pp. 45–60). Amsterdam: Rozenberg Publishers.

Williams, K., & Umberson, D. (2004). Marital status, marital transitions, and health: A gendered life course perspective. *Journal of Health and Social Behavior, 45*, 81–98.

Xu, H., Zhang, Z., Li, L., & Liu, J. (2018). Early life exposure to China's 1959-61 famine and midlife cognition. *International Journal of Epidemiology, 47*(1), 109–120.

Zhang, Z., & Hayward, M. D. (2006). Gender, the marital life course, and cardiovascular disease in late midlife. *Journal of Marriage and Family, 68*, 639–657.

Zhang, Z., & Lin, I.-F. (2017). Intergenerational support among widowed older adults in China. *International Journal of Population Studies, 3*(1), 94–109.

Zhang, Z. X., Zahner, G. E., Roman, G. C., Liu, X. H., Wu, C. B., Hong, Z., et al. (2006). Socio-demographic variation of dementia subtypes in china: Methodology and results of a prevalence study in Beijing, Chengdu, Shanghai, and Xian. *Neuroepidemiology, 27*(4), 177–187.

Zhao, Y., Hu, Y., Smith, J. P., Strauss, J., & Yang, G. (2014). Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *International Journal of Epidemiology, 43*(1), 61–68.

Zimmer, Z., Martin, L. G., Jones, B. L., & Nagin, D. S. (2014). Examining late-life functional limitation trajectories and their associations with underlying onset, recovery, and mortality. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 69*(2), 275–286.