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Research Article

Marital Status and Dementia: Evidence from the Health and Retirement Study

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Abstract

Objectives: We provide one of the first population-based studies of variation in dementia by marital status in the United States.

Method: We analyzed data from the Health and Retirement Study (2000–2014). The sample included 15,379 respondents (6,650 men and 8,729 women) aged 52 years and older in 2000 who showed no evidence of dementia at the baseline survey. Dementia was assessed using either the modified version of the Telephone Interview for Cognitive Status (TICS) or the proxy's assessment. Discrete-time hazard regression models were estimated to predict odds of dementia.

Results: All unmarried groups, including the cohabiting, divorced/separated, widowed, and never married, had significantly higher odds of developing dementia over the study period than their married counterparts; economic resources and, to a lesser degree, health-related factors accounted for only part of the marital status variation in dementia. For divorced/separated and widowed respondents, the differences in the odds of dementia relative to married respondents were greater among men than among women.

Discussion: These findings will be helpful for health policy makers and practitioners who seek to better identify vulnerable subpopulations and to design effective intervention strategies to reduce dementia risk.

Keywords: Cognitive impairment, Cohabitation, Divorce, Gender, Marriage, Never marrying, Widowhood

Marital Status and Dementia: Evidence from the Health and Retirement Study

Dementia is a disabling brain disorder associated with severe disability, increased demands for medical and personal care, and premature death (Institute of Medicine, 2015; Langa et al., 2017). Globally, about 50 million people were living with dementia in 2017 and this number is expected to rise to 152 million in 2050 (World Health Organization, 2017). In the United States, about 5.7 million people were living with Alzheimer's and related dementias (ADRD) in 2018 and the annual estimated cost of dementia care would reach $277 billion (Alzheimer's Association, 2018). The prevalence rate of dementia rises sharply with age—among adults aged 65 years and older in the United States, 10% have ADRD (Alzheimer's Association, 2018). Studies using a variety of data have consistently shown that being married is associated

with better mental and physical health and longer life expectancy, while divorce and widowhood have detrimental effects on a range of health outcomes including self-rated health, cardiovascular health, and risk of inflammation (Liu, 2009; Liu & Waite, 2014; Sbarra, 2009; Waite & Gallagher, 2000; Zhang & Hayward, 2006). However, there is little research on whether the risk of dementia varies across marital status groups in the United States.

Using data from the Health and Retirement Study (HRS) 2000–2014, we provide one of the first population-based studies on marital status differences in dementia in the United States. We address three major research questions: (a) Does the risk of dementia vary by marital status among older adults in the United States? (b) Do economic resources and health-related factors contribute to marital status differences in dementia? and (c) Are there gender differences in these patterns? The importance of this study is highlighted by the rapid growing number of unmarried older adults in the United States: The number of unmarried cohabitors researched to 3.3 million among adults aged 50 years and older in 2013 and it continues to increase (U.S. Census Bureau, 2014); and the divorce rate among adults aged 50 years and older doubled between 1990 and 2010 (Brown & Lin, 2012). The findings will also help health policy makers and practitioners identify the most vulnerable subpopulations in order to design effective intervention strategies to reduce dementia risk.

Marital Status Differences in Dementia: Previous Empirical Evidence

A small number of studies based on regional and community samples outside the United States have examined basic patterns of marital status difference in dementia. These studies provide initial evidence that marital status may be an important but underexplored risk/protective factor for cognitive decline and dementia in late life (Bae et al., 2015; Feng et al., 2014; Håkansson et al., 2009; Sommerlad, Ruegger, Singh-Manoux, Lewis, & Livingston, 2018; Sundström, Westerlund, & Kotyrlo, 2016). For example, a study of Swedish adults found that unmarried men and women are at significantly higher risk of developing dementia than their married counterparts (Sundström et al., 2016). An earlier study among a southwestern French cohort found that never married older adults had a higher risk of ADRD than their married and cohabiting counterparts, but the risk of ADRD was not elevated among divorced or widowed older adults (Helmer et al., 1999). In contrast, a Korean study found that being divorced, widowed or single was associated with a greater risk of dementia (Bae et al., 2015). A meta-analysis of 15 studies (n = 812,047)—all from outside the United States—found that never-married and widowed people have 42% and 20% higher risks of dementia, respectively, than married people (Sommerlad et al., 2018). However, no previous studies have examined the U.S. population, and more importantly, no studies have examined the potential mechanisms linking marital status to dementia, which we address in this study.

Theoretical Framework Linking Marital Status and Dementia

Many studies have shown that married people are healthier (both mentally and physically) and live longer than unmarried people (Carr, Freedman, Cornman, & Schwarz, 2014; Carr & Springer, 2010; Hughes & Waite, 2009; Liu, 2009; Liu & Umberson, 2008; Liu & Waite, 2014). Although some researchers have focused on the possibility that selection effects might account for this relationship, suggesting that individuals in better health or with more favorable health characteristics (e.g., higher education) are more likely to get married and stay married (Joung et al., 1998), most researchers focus on two primary theoretical models to identify potential pathways that link marital status to general health: the marital resource model (Waite & Gallagher, 2000) and the stress model (Williams & Umberson, 2004), which can be extended to develop research hypotheses on marital status links to dementia.

The Marital Resource Model

According to the marital resource model, being married is associated with unique social, psychological, and economic resources that cannot be obtained from other types of relationships (e.g., cohabitation) and in turn promote health and longevity (Waite & Gallagher, 2000). Married people have greater access to economic resources than unmarried people due to specialization, economies of scale, and pooling of wealth in marriage (Becker, 1981; Waite & Gallagher, 2000). Conversely, the divorced, widowed and never married cannot access the increased economic resources via marriage. Cohabitors who share living space with a partner may, to some degree, also benefit from economies of scale in ways similar to married people (thus enjoy advantages over unpartnered individuals), yet, cohabitors are less likely than married individuals to pool their income or to specialize between household and paid work, which may result in diminished economic returns (Becker, 1981; Waite & Gallagher, 2000). Economic resources may enhance overall health status and cognitive capacities and build cognitive resilience by improving nutrition, providing for care in the event of illness, and allowing the purchase of medical treatment and other health-enhancing resources (Waite & Gallagher, 2000).

In terms of sociopsychological resources, being married is related to increased access to social engagement, social support, and social integration (Cohen, 2004; Waite & Gallagher, 2000; Zunzunegui, Alvarado, Del Ser, & Otero, 2003)—all factors linked to better health and well-being (Cohen, 2004), which may include better cognitive health. A growing number of studies suggest that both higher levels of social engagement (i.e., degree of participation in a community or society) and a larger network size may reduce the risk of dementia by improving cognitive reserves, which strengthen the ability to cope with neuropathological

damage via the use of compensatory cognitive approaches (Sommerlad et al., 2018). Spouses broaden individuals' networks by connecting them with, for example, the spouse's friends and family. Moreover, daily communication with a spouse provides cognitive stimulation and may increase neural plasticity, thereby maintaining and improving cognitive reserves (Giles, Anstey, Walker, & Luszcz, 2012). Cohabitors cannot receive the same levels of sociopsychological benefits as married people due to their less commitment and/or a lack of institutional legitimacy (Waite and Gallagher, 2000). For example, some studies suggest that cohabitors are less likely than married people to receive support from friends or relatives (Eggebeen, 2005). Yet, other studies suggest that cohabitation appears to be a long-term alternative to marriage among older adults (King & Scott, 2005).

The Stress Model

The stress model emphasizes the negative aspects of marital disruption such as divorce and widowhood that create stress and undermine heath (Williams & Umberson, 2004). In this view, the stress of marital disruption rather than marriage, per se, is responsible for the marital status gap in health. Marital disruption caused by divorce or widowhood may lead to financial and emotional distress which may *directly* affect cognitive function (Håkansson, 2016; Rosnick, Small, McEvoy, Borenstein, & Mortimer, 2007; Wilson et al., 2007). The stress of divorce and widowhood can also increase the chance of engaging in unhealthier behaviors (e.g., smoking, drinking, sedentary lifestyle, reduced social activities) that *indirectly* damage cognitive health. Smoking directly provokes white blood cells in the central nervous system to attack healthy cells, leading to severe neurological damage and impaired cognitive function (Ray & Davidson, 2014; Zhou et al., 2014). Heavy drinking may damage the brain's white matter and increase the risk of both adverse brain outcomes and steeper declines in cognitive abilities (Ray & Davidson, 2014; Ridley, Draper, & Withall, 2013). Lack of physical exercise and social engagement are also negatively associated with cognitive health (Lee et al., 2010; Wheeler et al., 2017; Zhang, Li, Xu & Liu, 2019). Moreover, marital stress and dissolutions are shown to be associated with higher rates of chronic conditions such as cardiovascular diseases (Liu & Waite, 2014) and diabetes (Liu, Waite, & Shen, 2016), and such chronic conditions have been linked to cognitive impairment and dementia (Huang et al., 2015; Ray & Davidson, 2014).

The stress model further points to the heterogeneity of the unmarried groups in their experience of stress. Research suggests that the death of a spouse creates much stronger emotional consequences (e.g., psychological distress, loneliness) and thus more negative effects on health than divorce (Prigerson, Maciejewski, & Rosenheck, 2000; Pudrovska & Carr, 2008). Cohabitors are also more likely than married people to report relationship strain and experience union dissolving (Brown, 2000; Horwitz & White, 1998), although recent studies find no significant differences in psychological well-being between older cohabiting and married people (Wright & Brown, 2017). In contrast, the never-married do not experience the stress of marital disruption, and therefore, may not be as much disadvantaged as other unmarried groups.

Taken together, both the marital resource model and the stress model point to multiple theoretical pathways as drivers of the link between marital status and dementia, illustrated in Figure 1. Due to data limitations, we are unable to test the full range of these potential mechanisms. However, we test two potential mechanisms, economic resources and health-related factors, which are often cited as fundamental explanations for the marital advantage in general health (Umberson, 1992; Waite & Gallagher, 2000).

Gender Variation in the Marital Status-Dementia Link

Empirical research on gender differences in the link between marital status and dementia is scarce and results are mixed. For example, a study conducted in Sweden found no gender differences in the associations between marital status and dementia risk among adults aged 65 years and older (Sundström et al., 2016), while a study of Chinese older adults found that never-married and widowed men had greater odds of being cognitively impaired than married men but there were no significant associations among women (Feng et al., 2014). Indeed, gender has long been a central focus of the literature on marriage and health (Bernard, 1972; Bierhals et al., 1996; Carr & Springer, 2010; Hughes & Waite, 2009; Kiecolt-Glaser & Newton, 2001; Liu, 2009; Liu & Waite, 2014; Simon, 2002; Williams & Umberson, 2004; Zhang & Hayward, 2006). This line of research has produced two long-observed patterns: men tend to receive more health benefits from marriage than women, and women are more psychologically and physiologically vulnerable to marital stress than men (Bernard, 1972; Liu & Waite, 2014; Simon, 2002; Williams & Umberson, 2004). Although women tend to receive more financial benefits from their spouses than men do, men generally receive more health-promotion benefits (e.g., emotional support and regulation of health behaviors) from

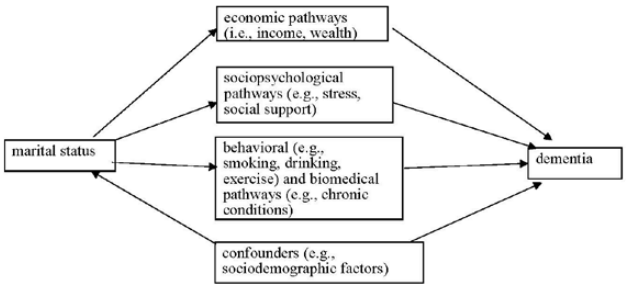

Figure 1. Theoretical pathways linking marital status and dementia.

marriage than women do (Liu & Umberson, 2008; Liu & Waite, 2014; Simon, 2002; Williams & Umberson, 2004). This pattern emerges because within traditional marriages, women tend to take on more responsibilities than men for maintaining social connections to family and friends, are more likely (than men) to care for and offer emotional support to their spouses, and are more likely (than men) to regulate their spouse's health behaviors, whereas men are more likely than women to receive such benefits from their spouses—all factors that may also reduce the risk of dementia for married men (Liu & Waite, 2014; Simon, 2002; Williams & Umberson, 2004).

Research Hypotheses

Hypothesis 1: Married adults have a lower risk of dementia than unmarried adults, including the divorced, widowed, and, to a lesser extent, cohabiting and never married in the United States (H1a). Among the unmarried, the widowed have the highest risk of dementia followed by the divorced, never married, and cohabitors (H1b).

Hypothesis 2: Marital status differences in dementia are at least partially explained by economic resources.

Hypothesis 3: Marital status differences in dementia are at least partially explained by health-related factors such as health behaviors and chronic conditions.

Hypothesis 4: Marital status differences in dementia are generally greater for men than for women.

Method

Participants

We used data from the Health and Retirement Study (HRS) (2000–2014), which is conducted by the Institute for Social Research at the University of Michigan. The 2000 wave of the HRS surveyed a national sample of 19,579 noninstitutionalized adults born before 1948 (aged 52 years and older in 2000) and their spouses (HRS, 2017; Servais, 2010). The survey oversamples Blacks and Hispanics and collects (by telephone or in person) detailed information on cognitive, physical, economic, work, and family conditions as well as health behaviors approximately every 2 years. The HRS has high response rates (81%–89%) in each wave, and provides a unique opportunity to address the current research question because of its large sample size, long-term follow-up, and high-quality measures of cognitive health and other key variables.

About 8% of the interviews in our sample were conducted through proxies (spouses or children) for those who could not participate in the survey due to health issues or death (Langa et al., 2009). In the analysis, we included both self- and proxy-reports (and control for proxy interviews) to avoid underestimating dementia cases. In the analysis, we excluded 1,350 nursing home residents and 74 respondents' spouses who were younger than age 52 in 2000. We also excluded 1,169 respondents who had dementia at the baseline survey. We further excluded missing values on marital status (n = 18), dementia (n = 4), and other key demographic covariates (n = 1,585). The final analytic sample included 15,379 respondents (6,650 men and 8,729 women, contributing to 86,538 person-periods in total) ages between 52 and 100 (mean age = 65.91, SD = 9.88) who lived in communities in 2000 and had no signs of dementia at the baseline survey. Results from additional analysis using multiple imputations for missing values (not shown but available upon request) suggested similar findings as we reported. Compared to those who were included in our analysis, those who were excluded were older on average, more likely to be unmarried and less educated with lower income/wealth and more chronic conditions (results not shown but available upon request). In this sense, we excluded a more vulnerable subset of the sample, and our results may be conservative. See Table 1 (discussed in the results section) for more demographic details of the baseline study participants.

Measures

Dementia

The measurement of cognition in HRS differs for self-respondents (92%) and proxy respondents (8%). For self-respondents, HRS assessed cognitive function via the modified version of the Telephone Interview for Cognitive Status (TICS). A small percentage of respondents (0.8%–3.1%) refused to participate in tests of immediate and delayed recall and serial 7s; HRS has developed an imputation strategy for cognitive variables for all waves (Servais, 2010). We followed previous studies in calculating a final summary score by summing the following cognitive items: immediate and delayed recall of a list of 10 words (1 point for each), five trials of serial 7s (i.e., subtract 7 from 100, and continue subtracting 7 from each subsequent number for a total of five trials, 1 point for each trial), and backward counting (2 points). The final summary score ranges from 0 (severely impaired) to 27 (high functioning) (Crimmins, Saito, & Kim, 2016). Respondents whose scores were 0–6 were classified as having dementia; those whose scores were 7–27 were classified as not having dementia (Crimmins et al., 2016).

For individuals who were unable to participate in the cognitive tests due to health issues, cognitive status was measured using the proxy's assessment. In these cases, we followed previous studies in assessing cognition on an 11-point scale using the proxy's assessments of: (a) the respondent's memory (0 = excellent, 4 = poor) and (b) the respondent's limitations in five instrumental activities of daily living (IADLs): managing money, taking medication,

Table 1. Weighted Descriptive Statistics by Marital Status, HRS 2000 (*N* of respondents = 15,379)

	Percent/Mean (*SD*)					
	Total *N* = 15,379 100%	Married *N* = 10,105 64.26%	Cohabiting *N* = 353 2.05%	Divorced/Separated *N* = 1,499 11.65%	Widowed *N* = 3,007 18.69%	Never married *N* = 415 3.35%
Dementia[a]	2.73	1.67	1.65*	2.41*	6.02*	2.46*
Demographic covariates						
Female (=1)	54.97	46.24	45.28*	61.67*	81.94*	54.47*
Black (=1)	9.12	6.24	14.24*	18.15*	11.18*	18.15*
Age	65.91 (9.88)	64.31 (9.03)	61.99* (8.45)	62.12* (7.41)	74.48* (9.76)	64.43 (8.61)
Education						
0–7 years (ref)	3.34	2.61	3.15*	3.27*	5.80*	3.90*
8–11 years	17.48	15.39	16.96*	16.87*	25.39*	15.93*
12 years	36.23	35.76	37.10*	35.12*	38.84*	33.80*
13–17 years	42.96	46.24	42.78*	44.73*	29.97*	46.38*
Proxy	6.27	8.55	5.04*	1.11*	2.73*	0.98*
Economic Resources						
Household income ($)	62,286 (1,613)	77,875 (2,087)	60,186* (5,373)	37,850* (7,418)	27,017* (954)	46,293* (9,996)
Net household wealth ($)	427,558 (22,487)	533,406 (28,716)	298,210* (63,066)	210,089* (36,514)	230,332* (15,271)	333,075* (93,415)
Health-related Factors						
Chronic conditions (0–4)	0.82	0.78	0.76*	0.79*	1.02*	0.75*
Current Smoker (ref: no)						
Yes	15.94	13.50	25.89*	29.16*	14.16*	20.74*
Missing	0.64	0.76	1.53*	0.46*	0.36*	0.00*
Current drinker (ref: no)						
Current light drinker	21.69	23.80	27.62*	20.16*	14.89*	21.02*
Current heavy drinker	9.12	10.00	18.25*	10.20*	4.28*	9.77*
Missing	0.20	0.17	0.45*	0.25*	0.27*	0.08*
Exercise (yes = 1)	45.45	49.40	47.93*	41.67*	34.42*	42.76*
Social activity (ref: yearly-never)						
Daily-monthly	69.42	69.40	60.95*	67.13*	71.29*	72.47*
Missing	1.07	1.34	1.70*	0.37*	0.64*	0.38*

Note: *Statistically significant difference compared to the married at the .05 level.

[a]All dementia cases in the baseline survey were excluded. The reported percentages of dementia were calculated based on person-period files (*N* = 86,538), reflecting dementia onset across subsequent survey waves.

preparing hot meals, using the phone, and shopping for groceries (0–5); as well as (c) interviewer's assessment of the respondent's difficulty completing the interview because of cognitive limitations (0 = none, 1 = some, and 2 = prevented completion). Proxy respondents with a summary score of 6–11 were classified as having dementia, and those with a score of 0–5 were classified as having no dementia (Crimmins et al., 2016). All cutoff points (for both self- and proxy-reports) have been validated against the prevalence of dementia in the Aging, Demographics, and Memory Study (ADAMS, an HRS substudy that applies neuropsychological and clinical assessment of dementia) by correctly classifying 78% of HRS respondents as having dementia or not (74% of self-respondents and 86% of proxy respondents) (Crimmins, Kim, Langa, & Weir, 2011; Crimmins et al., 2016; Langa et al., 2017; Zhang, Hayward, & Yu, 2016). The internal consistency reliability of the HRS cognitive measures has been verified by previous research using factor analysis which revealed large and significant factor loadings, suggesting good fit of the measures and intercorrelations between observed items (Ofstedal, Fisher, & Herzog, 2005). Supplementary Table S1 shows the detailed information on frequencies of respondents who transtioned to demenita or died/dropped out between waves.

Marital status

We measured marital status as a time-varying covariate reflecting the current marital status at the time of the survey.

The variable includes five categories: married (reference), cohabiting, divorced/separated (hereafter "divorced"), widowed, and never married.

Economic resources

We measured economic resources with two variables: total household income and net household wealth. Total household income included respondent's and spouse's income from all sources such as earnings, pensions, and annuities, Supplemental Security Income and Social Security Disability, Social Security retirement, other government transfers, unemployment and workers' compensation, household capital income, and other income for the last calendar year. Net household wealth was measured as the total value of household assets minus household debts. We used the RAND version of household income and wealth data, which included consistently imputed missing values across waves (RAND HRS Data, 2016). Because household income and wealth had zero or negative values, we further adjusted the variables by adding a constant of $1 for income and adding a year-specific constant (depending on the minimum value of wealth in that specific year) for wealth to all respondents so that all wealth and income values were transformed to positive. We then divided the imputed income and wealth by the square root of household size and took the natural logs of the values (Zhang & Hayward, 2006). Both household income and wealth were included as time-varying variables.

Health-related covariates

We included two types of health-related covariates: health behaviors and chronic conditions. We measured chronic conditions as time-varying using a comorbidity index (0–4) which is a summary score of the presence of four major chronic conditions: diabetes, stroke, heart disease, and high blood pressure. Health behaviors included smoking, drinking, physical exercise, and social activity. Smoking and drinking were measured as time-varying covariates, while physical exercise and social activities were measured at the baseline survey due to inconsistent survey questions in subsequent waves. Smoking included current nonsmoker (reference), current smoker, and missing report. Drinking was measured based on a series of questions. First, respondents were asked whether they ever drink alcoholic beverages. Those who answered yes were then asked how many days per week they consumed alcohol, and how many drinks they consumed on the days they drank in the last three months. We calculated average weekly alcohol use by multiplying the number of days per week by the number of alcoholic drinks per drinking day. Based on the recommendation of the National Institute of Alcohol Abuse and Alcoholism for older adults, respondents who drank less than seven alcoholic beverages per week during the past 3 months were classified as light drinkers and those who consumed more than seven alcoholic beverages per week on average were coded as heavy drinkers (Lin, Guerrieri, & Moore, 2011). Respondents were categorized into four groups: current nondrinker (reference), current light drinker, current heavy drinker, and missing report. Physical exercise was measured based on the question whether the respondent participated in vigorous physical activities three or more times a week (1 = yes, 0 = no). Social activity was measured based on the question asking how often the respondents socialized with friends, neighbors, or family (1 = daily to monthly, 0 = yearly to never).

Other covariates

We controlled for age (time-varying) and other time-invariant key sociodemographic variables including gender (1 = women, 0 = men), race (1 = black, 0 = all others), and education (less than 8 years [reference], 8–11 years, 12 years, and 13 or more years). We also included an indicator for proxy report (time-varying), signifying whether a proxy respondent was used for the cognitive tests due to health issues or cognitive impairment.

Statistical Analyses

To compare dementia risk across marital status groups, we estimated discrete-time hazard models. Specifically, we created person-period record files and used a logit model for the discrete-time event history analysis. A respondent contributes an observation for each wave up to the onset of dementia or censoring (i.e., loss to follow up or death). Because the analytic sample is restricted to those who had no dementia at the baseline survey, the estimates reflect the effects of the independent variables on new onsets of dementia. The discrete-time hazard model is specified as:

$$log\frac{h(t_{ij})}{h_0(t_{ij})} = \sum_{j=1}^{8} \alpha_j D_{ij} + \mathrm{X}_i{}' \, \mathrm{B}_1 + Z_{ij}{}' \, \mathrm{B}_2 \qquad (1)$$

where $h(t_{ij})$ indicates the discrete-hazard (i.e., conditional probability) of the onset of dementia for individual i at wave j; $h_0(t_{ij})$ indicates the discrete-hazard of baseline dementia status for individual i at wave j; $\sum_{j=1}^{8} \alpha_j D_{ij}$ represents the set of multiple intercepts for HRS 2000–2014, one per period; X_i indicates the vector of time-invariant covariates; and Z_{ij} indicates the vector of time-varying covariates including marital status. B_1 and B_2 are corresponding coefficient vectors.

We estimated a series of models to better understand the relationship between marital status and dementia. Model 1 controlled for basic sociodemographic covariates including age gender, race, education, and proxy report. Model 2 added economic resource variables (i.e., income and wealth) in addition to sociodemographic covariates in Model 1. Model 3 added health-related variables (i.e., health behaviors and chronic conditions) in addition to sociodemographic covariates in Model 1 (removing income and wealth). Model 4 included all covariates. Model

5 added interaction terms for gender × marital status to test for potential gender differences in the association between marital status and dementia after all covariates were controlled. We included education in Model 1 as a basic control covariate rather than in Model 2 as a measure of economic resources because education, unlike income and wealth, is more likely to be a confounder rather than a mediator in the relationship between marital status and dementia. Additional analyses (results not shown but available upon request) suggested that including education as an indicator of economic resources did not change the main findings. We conducted formal mediation testing using the Karlson–Holm–Breen (KHB) method to examine whether economic resources and health-related factors have significant mediating effects. The KHB method is useful for decomposing the total effect into the direct and indirect effects in nonlinear probability models such as logistic models (Karlson & Holm, 2011). In addition, the KHB method allows the testing of multiple mediators simultaneously (Karlson & Holm, 2011).

Results

Table 1 shows descriptive statistics for all analyzed variables in the baseline 2000 HRS study sample. The results show that widowed respondents had the highest proportion of dementia during the subsequent waves (6.02%), followed by never-married respondents (2.46%), and divorced respondents (2.41%). All these groups were significantly more likely to develop dementia than married respondents (1.67%). Cohabiting respondents (1.65%) had a slightly lower proportion of dementia during the subsequent waves than married respondents. Note, these marital status differences in dementia may be due to demographic differences. For example, widowed respondents (baseline mean age = 74.48) were significantly older while cohabiting respondents (baseline mean age = 61.99) were significantly younger than married respondents (baseline mean age = 64.31); and age is a strong predictor for dementia risk. In comparison to married respondents, all unmarried groups tended to have, on average, lower education levels, lower income, less wealth, and higher proportions of current smokers and they were also less likely to exercise. Divorced and widowed respondents had a greater number of chronic conditions than married respondents. Cohabiting respondents had a higher proportion of current drinkers (both heavy and light) than married respondents. Both cohabiting and divorced respondents had a lower proportion of participating in social activities than married respondents.

Table 2 shows the estimated odds ratios of dementia from the discrete-time hazard models. Results of Model 1 in Table 2 suggest that divorced (odds ratio [OR] = 2.052, $p < .001$, the highest odds ratio), widowed (OR = 1.519, $p < .001$), cohabiting (OR = 1.548, $p < .05$), and never-married respondents (OR = 1.595, $p < .005$) all experienced significantly higher odds of dementia than married respondents when age, gender, race, education, and proxy report were controlled. After income and wealth were added in Model 2, the size of the odds ratios decreased (but remained statistically significant) for divorced, widowed, and never-married respondents, but remained unchanged for cohabiting respondents (compared to Model 1). After health behaviors and chronic conditions were added in Model 3 (without income or wealth), the size of the odds ratios decreased slightly (but remained statistically significant) for divorced and widowed respondents, but increased for never married and cohabiting respondents (compared to Model 1). When all covariates were controlled in Model 4, all unmarried groups still had significantly higher odds of dementia than married respondents.

We conducted formal mediation tests for economic resources and health-related factors; the results are given in Table 3. The results suggest significant indirect effects of divorce, widowhood, and never marrying on dementia through economic resources. Specifically, the total effect (i.e., regression coefficient) of divorce was 0.641, of which about 13% (0.082) was through income and wealth; the total effect of widowhood was 0.374, of which 16% (0.059) was through income and wealth; and the total effect of never marrying was 0.467, of which about 18% (0.083) was through income and wealth. Health-related factors explained 7% (i.e., 0.045/0.604) of the effect of divorce on dementia, but they did not explain other marital status differences in dementia.

We added interactions between gender and marital status in Model 5 (Table 3). Figure 2 illustrates the gender differences in the estimated odds ratios of dementia across marital status groups based on results from Model 5 of Table 2. These results indicate that when all covariates were controlled, the estimated odds ratios of dementia between the married group and two of the unmarried groups—the divorced and the widowed—were significantly smaller for women than for men. Specifically, the odds of having dementia for divorced men were 2.601 times of those for married men, while the odds of having dementia for divorced women were only 1.306 times of those for married women (2.601 × 0.502). Further, the odds of having dementia were 53.1% higher for widowed men than for married men ([1.531–1] × 100%), while the odds of having dementia were 20.6% higher ([1.531 × 0.788–1] × 100%) for widowed women than for married women. Finally, we conducted KHB mediation testing separately by gender (results not shown but available upon request) but did not find different gender patterns in the mediation processes.

Sensitivity analysis

We conducted a series of sensitivity analyses to test the robustness of the results. First, although we have excluded all dementia cases at the baseline survey in the analysis, to further address concerns of including preclinical dementia

Table 2. Estimated Odds Ratios of Dementia Onset from Discrete Time Hazard Models, HRS 2000–2014 (*N* of respondents = 15,379; *N* of person-periods = 86,538)

	Model 1	Model 2	Model 3	Model 4	Model 5
Marital Status (ref: married)					
Cohabiting	1.548*	1.548*	1.655*	1.652*	1.792*
Divorced/Separated	2.052***	1.852***	1.916***	1.750***	2.601***
Widowed	1.519***	1.414***	1.457***	1.369***	1.531***
Never married	1.595**	1.437*	1.610**	1.468*	1.706*
Demographic covariates					
Female (=1)	1.179**	1.140*	1.122*	1.092	1.310**
Black (=1)	2.387***	2.222***	2.167***	2.062***	2.068***
Age	1.115***	1.114***	1.110***	1.109***	1.110***
Education (ref: 0–7 years)					
8–11 years	0.704***	0.723**	0.685***	0.698***	0.701***
12 years	0.435***	0.466***	0.441***	0.462***	0.464***
13–17 years	0.296***	0.336***	0.327***	0.355***	0.358***
Proxy	14.125***	14.030***	13.032***	13.031***	13.228***
Economic Resources					
Household income		0.851***		0.867***	0.864***
Net household wealth		1.004		1.048	1.043
Health-related Factors					
Chronic conditions (0–4)			1.297***	1.290***	1.293***
Current Smoker (ref: no)					
Yes			1.254*	1.239*	1.235*
Missing			0.795	0.804	0.804
Current drinker (ref: no)					
Current light drinker			0.576***	0.588***	0.587***
Current heavy drinker			0.565***	0.576***	0.570***
Missing			1.475	1.452	1.433
Exercise (yes = 1)			0.986	0.990	0.985
Social activity (ref: yearly-never)					
Daily-monthly			0.726***	0.730***	0.732***
Missing			0.810**	0.836*	0.833*
Interaction					
Cohabiting × Female					0.818
Divorced/Separated × Female					0.502**
Widowed × Female					0.788*
Never married × Female					0.729

Note: ***$p < .001$, **$p < .01$, *$p < .05$.

cases, we excluded preclinical dementia cases (i.e., cognitive scores < 12) at the baseline (results shown in Supplementary Table S2). In a second set of models, we excluded dementia cases in Waves 1–3 (results shown in Supplementary Table S3). Results from both sets of analyses were similar to the findings reported in the paper, although the significance levels of a few effects declined due to the reduced number of dementia cases. Moreover, we also conducted sensitivity tests on different ways of measuring marital status. Our additional analysis (results shown in Supplementary Table S4) of further distinguishing the remarried and first married suggested no significant difference between these two married groups in odds of dementia; and distinguishing the remarried and first married did not change our major findings on marital status differences in dementia as reported in the paper. In another set of additional analyses (results shown in Supplementary Table S5), we included baseline marital status (time-invariant) along with subsequent marital transitions (i.e., transition to divorce, transition to widowhood, transition into marriage) between waves. Results suggested that transition into widowhood was significantly related to higher odds of dementia in subsequent waves, but neither transition to divorce or transition into marriage was related to odds of dementia. We note that the sample sizes for dementia cases experienced by those who transitioned to divorce (n = 48) and transitioned into marriage (n = 70) were small in our sample; so, we interpret these findings as preliminary results that need further confirmation from other data sets with larger sample of marital transitions. The small number of marital transitions in our sample also limited our ability to further investigate gender differences. Nevertheless, the

Table 3. KHB Mediation Analysis Results by Economic Resources and Health-related Factors (*N* of respondents = 15,379; *N* of person-periods = 86,538)

	Economic resources				Health-related factors			
	Cohabiting	Divorced/ Separated	Widowed	Never married	Cohabiting	Divorced/ Separated	Widowed	Never married
Total effect	0.510*	0.641***	0.374***	0.467**	0.486*	0.604***	0.343***	0.374*
Direct effect	0.502*	0.559***	0.314***	0.384**	0.502*	0.559***	0.314***	0.384**
Indirect effect	0.009	0.082***	0.059***	0.083***	−0.015	0.045*	0.029	−0.009

Note: ***$p < .001$, **$p < .01$, *$p < .05$.

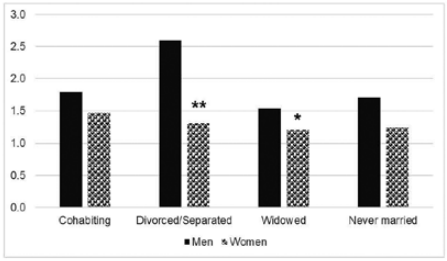

Figure 2. Adjusted odds ratios of dementia by marital status and gender.

major findings on marital status differences in dementia remained unchanged with only one exception: the effect of being never married (at the baseline) became insignificant in Supplementary Table S5 (although the direction of the effect remained unchanged).

Discussion

This study is one of the first to use nationally representative data to examine marital status as a potential social risk/protective factor for developing dementia among older adults in the United States—an emerging public health concern in the context of rapid population aging. We further advance this literature by testing whether two key potential mechanisms—economic resources and health-related factors—explain the association between marital status and dementia, with special attention to gender differences. Next, we discuss the major findings and implications.

First, we found that all unmarried groups including cohabiting, divorced, widowed, and never-married respondents had significantly higher odds of developing dementia during the 14-year study period than their married counterparts. These results are consistent with our hypothesis (Hypothesis 1a) as well as the general literature suggesting that married people enjoy better health than unmarried people. The results are also consistent with a limited number of previous studies conducted outside the United States that have found significantly higher risks of dementia among the divorced, widowed, and never married than among the married (e.g., Bae et al., 2015; Sommerlad et al., 2018; Sundström et al., 2016). Yet, inconsistent with our expectation (Hypothesis 1b), it was the divorced rather than the widowed who experienced the highest risk of dementia. This finding of the highest dementia risk among divorced older adults is consistent with a recent Swedish population study (Sundström et al., 2016). Divorce is one of the most stressful life events during adulthood. It leads to changes in individuals' social environment, usually in negative ways, and in turn hurts both mental and physical health (Brown & Lin, 2012; Liu & Umberson, 2008). Future research should investigate the specific pathways through which divorce damages cognitive function and leads to dementia.

This is the first study to find that cohabiting adults also have a higher risk of dementia than married adults. Previous studies, based primarily on European data, have combined married and cohabiting respondents when examining the association between marital status and dementia risk (Håkansson et al., 2009). Therefore, there is no prior empirical research on whether cohabitors differ from married individuals in terms of dementia risk. The current results are, nevertheless, consistent with previous studies that found a health disadvantage among cohabitors relative to married individuals (Brown, Bulanda, & Lee, 2005; Liu & Reczek, 2012). Given that more than 3.3 million adults aged 50 years and older were cohabiting in the United States in 2013 (U.S. Census Bureau, 2014) and that this number continues to increase, this finding raises public health concerns for this growing segment of the population. Cohabitors may not receive the same health benefits from their relationship as their married counterparts do because their commitment levels are lower and they have no legal protection (Waite & Gallagher, 2000). Previous studies suggest that in comparison to married people, cohabitors are less likely to receive support from friends or relatives (Eggebeen, 2005), more likely to report strain in their relationships (Horwitz & White, 1998), are more worried about their relationship dissolving (Brown, 2000), and report higher levels of psychological distress (Brown, 2000)—all factors that may have negative effects on cognitive health and increase the risk of dementia. In addition, those with certain characteristics associated with better health (e.g., higher socioeconomic status, more social support) are more likely to select into marriage than

cohabitation (Thornton, Axinn, & Xie, 2007), and this selection process may also play a role in the association between marital status and dementia.

Another way in which the current analysis moves beyond previous studies is the examination of potential pathways (i.e., economic resources and health-related factors) linking marital status and dementia onset from midlife to later life. We found that economic resources explained part (13%–18%) of the higher dementia risk among divorced, widowed, and never-married respondents relative to married respondents—a finding that supports our second hypothesis—yet, economic resources did not account for the higher dementia risk of cohabitors. Indeed, in the focal sample, the difference in average household income between cohabitors and married individuals was much smaller compared to other groups, and both groups had greater income than all other unmarried groups. Although few studies have specifically tested economic resources as a pathway linking marital status and dementia risk, our results are consistent with a recent study conducted in Sweden that found controlling for education, income, and other covariates reduced marital status differences in dementia risk (Sundström et al., 2016). Recent research suggests that perceived stress is associated with faster cognitive decline and a higher risk of dementia (Aggarwal et al., 2014; Johansson et al., 2010) and financial stress in particular is associated with worse performance on psychomotor speed tasks (Rosnick et al., 2007). Future research should investigate financial stress as a potential mechanism linking divorce, widowhood, and never marrying to dementia.

Although previous research has suggested that health-related factors may be another important mechanism linking marital status and dementia risk, our results suggest that the assessed health-related factors (i.e., health behaviors and chronic conditions) only explained 7% of the difference in odds of dementia between the divorced and married but did not explain any other marital status differences in odds of dementia (partially support our third hypothesis). We note that our measures of health behaviors and chronic conditions were relatively crude, which may have limited our ability to detect their effects on dementia. For example, the measures did not fully capture the lifetime duration of exposure to smoking or the duration or severity of chronic conditions, which may be important for developing dementia risk.

Finally, we found that the difference in dementia onset between divorced/widowed and married individuals was greater for men than for women, which supported our fourth hypothesis. This gender difference was robust to controlling for socioeconomic resources and health-related factors. This finding is consistent with a recent study from Sweden which found that divorce was more strongly associated with a higher risk of dementia for men than for women among those aged 50–64 years (Sundström et al., 2016). That study, however, did not find a gender difference among those aged 65 years and older (Sundström et al., 2016). Women are usually the kin-keepers in the family. Therefore, although divorce or widowhood may reduce women's social networks to a certain extent, divorced/widowed women may still have advantages in social support relative to their male counterparts. Previous research has suggested that married men usually rely on their spouses to be their confidants while married women have wider networks of friends and relatives as confidants (Williams & Umberson, 2004). Therefore, the loss of a spouse may hurt men's social support networks more than those of women (Lee, DeMaris, Bavin, & Sullivan, 2001; Liu & Umberson, 2008), which in turn make divorced or widowed men relatively more isolated and increasing their risk of dementia. Future studies should investigate whether gender differences in social networks, social engagement, and social integration explain the gendered patterns in the associations between marital status and dementia.

This study has several limitations. First, our measure of dementia is based on cognitive tests and proxy reports rather than clinical diagnosis. Although previous research using HRS has demonstrated that using cognitive tests and proxy reports correctly classifies 74% and 86%, respectively, of HRS subjects into clinical diagnosis categories of normal or dementia cases (Crimmins et al., 2011), the issue of misclassification cannot be ignored. Second, although we found that economic resources partially explained the marital status difference in dementia risk, the full models after controlling for all covariates still contained sizable marital status differences in dementia. Future studies should investigate additional factors, including social isolation, social support, and exposure to stressful life events, that may help explain the association between marital status and dementia onset. Third, although we build our research hypotheses based on causal implications from previous studies, our analysis is primarily to document general associations rather than to determine causality. Indeed, we could not fully tease out the reversal influence, that is, cognition may also affect later marital status. Finally, we cannot rule out the possibility that the identified marital status differences in dementia is partially driven by a marriage selection process (i.e., people who had a lower risk of dementia were more likely to be selected into and stay in marriage). Another relevant selection effect that may affect the results is mortality selection, which is particularly relevant to the widowed. The widowed are older and have experienced a stronger mortality selection process than the married. Given that those who died were more likely to have had experienced poorer health and a higher risk of dementia than those who survived, we expect that without the mortality selection, the widowed might have had even higher risk of dementia than the married. In this sense, our results are conservative.

Conclusion

Despite these limitations, the current study makes important contributions to the general marriage and health literature by extending prior research to dementia risk in later life—an emerging public health concern as the U.S. population ages. The results, which are based on longitudinal data drawn from a nationally representative sample of U.S. older adults, suggest that remaining unmarried in midlife and beyond may be a risk factor for the onset of dementia, and that the reduced economic resources of unmarried individuals only partially account for their higher dementia risk relative to their married counterparts. We also found that the association between being divorced/widowed and an increased risk of dementia was stronger for older men than for older women, suggesting that divorced and widowed older men may be particularly vulnerable to dementia. The number of unmarried older adults in the United States continues to grow as people live longer and their marital histories become more complex. It is important to further explore the specific pathways that lead to increased dementia risk for these unmarried older adults, in particular older men who were divorced or widowed, so that effective interventions can be implemented to reduce the risk.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Supplementary Table S1. Frequencies of Respondents Who Transition to Dementia or Die/Dropout Between Waves.

Supplementary Table S2. Estimated Odds Ratios of Dementia Onset from Discrete Time Hazard Models---Robust Test Excluding Cases with Cognitive Scores <12 (*N* of respondents = 13,040; *N* of person-periods = 76,107).

Supplementary Table S3. Estimated Odds Ratios of Dementia Onset from Discrete Time Hazard Models---Robust Test Excluding Dementia Cases at Waves 1–3 (*N* of respondents = 14,483; *N* of person-periods = 83,286).

Supplementary Table S4. Estimated Odds Ratios of Dementia Onset from Discrete Time Hazard Models---Distinguishing the First Married and Remarried (*N* of respondents = 15,379; *N* of person-periods = 86,538).

Supplementary Table S5. Estimated Odds Ratios of Dementia Onset from Discrete Time Hazard Models---Baseline Marital Status and Marital Transitions Between Waves (*N* of respondents = 15,379; *N* of person-periods = 86,538).

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Conflict of Interest

None reported.

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