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Marital status and cognitive impairment in the United States: evidence from the National Health and Aging Trends Study

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ABSTRACT

Purpose: We provide population-based longitudinal evidence of marital status differences in the risk of cognitive impairment and dementia in the United States.
Methods: Data were from the longitudinal National Health and Aging Trends Study, 2011–2018. The sample included 7508 respondents aged 65 years and older who contributed 25,897 person-year records. We estimated discrete-time hazard models to predict the risk of dementia and cognitive impairment, not dementia (CIND), as well as impairment in three major cognitive domains: memory, orientation, and executive function.
Results: Relative to their married counterparts, divorced and widowed elders had higher odds of dementia and CIND, as well as higher odds of impairment in each of the cognitive domains. Never-married elders had higher odds of impairment in memory and orientation than their married counterparts but did not differ significantly in the odds of impaired executive function, dementia, or CIND. Cohabiting elders did not differ significantly from married respondents on any measure of cognitive impairment. We found no gender differences in the associations between marital status and the measures of cognitive impairment.
Conclusions: Marital status is a potentially important but overlooked social risk/protective factor for cognitive impairment. Divorced and widowed older adults are particularly vulnerable to cognitive impairment.

Introduction

With the rapid aging of the U.S. population, dementia and cognitive impairment have emerged as serious and growing public health concerns [1,2]. Dementia is a stage of severe cognitive impairment that is associated with disability, premature death, and increased need for medical and personal care [1,3–6]. In 2018, about 5.7 million people in the United States were living with dementias and the annual estimated cost of dementia care would reach $277 billion [3]. In recent decades, researchers have devoted serious efforts to identifying risk factors for dementia and designing preventive strategies. These efforts have focused predominantly on proximate behavioral and biological factors. Although the etiology of cognitive impairment and dementia extends beyond these factors [1,2], there is less research on social risk factors for dementia [1,7–12]. For example, although a number of studies have shown that married people are healthier, both mentally and physically, and live longer than unmarried people [13–28], it is unclear whether marital status is associated with the risk of cognitive impairment, particularly in the U.S. population. In this study, we assess marital status as a potential social risk/protective factor, examining its association with cognitive impairment and progression of dementia among older adults in the United States. Given prior evidence of gender differences in the association between marital status and health [17,19,21,29,30], we also consider whether the associations of marital status with cognitive outcomes differ for women and men.

A small group of studies based on regional and community samples outside the United States have explored basic patterns of marital status differences in dementia and revealed mixed evidence [31–38]. For example, a study of Swedish adults found that unmarried men and women had a significantly higher risk of

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developing dementia than their married counterparts [31]. An earlier study among a cohort from southwestern France found that never-married older adults had a higher risk of dementia and Alzheimer's disease (AD), the most common type of dementia, than their married and cohabiting counterparts, but that neither the risk of dementia nor the risk of AD was elevated among divorced and widowed older adults [32]. In contrast, a study of the Korean population found that being divorced, widowed, or single was associated with a greater risk of AD [36]. Furthermore, a study of the Chinese population found that never-married and widowed Chinese men had greater odds of cognitive impairment than married Chinese men but did not identify significant marital status differences among Chinese women [37]. A meta-analysis of 15 studies using data from 812,047 participants (all from outside the United States) found that both never-married and widowed people had a higher risk of dementia (42% and 20% higher, respectively) than married people [38].

The United States has witnessed remarkable changes in marriage in the past decades, accompanied by rapid population aging. Divorce rates among older Americans doubled between 1990 and 2010 [39]. More than 1/3 of American marriages end in divorce by the age of 55 years and older in 2009 [40]. Surprisingly, research on cognitive impairment in the United States, mostly based on regional samples, either ignored marital status or simply included it as a covariate. For example, a recent study of the Framingham Heart Study Offspring cohort in Massachusetts examined a range of lifestyle-related risk factors for dementia and found widowhood was related to increased risk of dementia [41]. Studies of older residents aged 70–89 years in Olmsted County, Minnesota, found that being never married and previously married (widowed or divorced) were related to higher risk of mild cognitive impairment for men but not for women [42,43]. A study of 1221 married older couples aged 65 years and older in a rural county in northern Utah reported that among subjects whose spouse had dementia, men were at greater risk of developing dementia than women [44]. Nevertheless, nationally representative studies on marital status differences in cognitive impairment and dementia in the United States are limited.

Data and sample

Data were drawn from the National Health and Aging Trends Study (NHATS), 2011–2018, which was conducted by the Johns Hopkins University Bloomberg School of Public Health in collaboration with the University of Michigan. NHATS gathers information, through annual in-person interviews, from a nationally representative sample of Medicare beneficiaries aged 65 years and older who live in communities, residential care, or nursing homes within the contiguous United States (i.e., excluding Alaska, Hawaii, and Puerto Rico) to foster research that will reduce disability, maximize health and independent functioning, and enhance quality of life at older ages [45]. NHATS used Medicare's enrollment database as the sampling frame and oversampled older persons and black individuals [45]. In 2011, 8245 respondents aged 65 years and older completed the initial (wave 1) interview (71% response rate). Respondents have been reinterviewed annually to document changes over time, with the most recently released follow-up being the 2018 wave.

We excluded nursing home residents in the analysis because they were not eligible for the NHATS sample person (SP) interview where most of our analytic variables were derived. We further restricted the analysis to respondents who had complete data on cognitive measures and other key variables. The final sample includes 7508 respondents (3135 men and 4373 women), who contributed 25,897 person-year records (10,614 person-years for men and 15,283 person-years for women). In our baseline sample, 5527 respondents had normal cognition, 982 had cognitive impairment, not dementia (CIND), and 999 had dementia. In terms of marital status, the baseline sample included 3609 married, 151 cohabiting, 2542 widowed, 913 divorced, and 293 never-married respondents. Table S1 in the Appendix provides detailed frequencies for marital status and cognitive status, including transitions across waves.

Measures

Cognitive impairment and dementia

NHATS respondents completed a series of performance-based tests that measured their cognitive status. These cognitive tests evaluated three key domains of cognitive functioning: memory (immediate and delayed 10-word recall), orientation (date, month, year, and day of the week; naming the president and vice president), and executive function (clock drawing test) [46–48]. Following previous studies, we defined impairment as a cognitive score of 1.5 standard deviations below the mean or lower [46–48]. The cutoff points for the specific domains of impairment were $\leq$3 for orientation (range = 0–8) and memory (range = 0–20) and $\leq$1 for executive functioning (range = 0–5). We analyzed cognitive impairment (1 = yes, 0 = no) in these three domains separately. Following revised criteria for diagnosing AD and related dementia [48,49], we also created an overall measure of cognitive impairment/dementia by combining the three domains and categorizing respondents into three groups: (1) dementia, defined as impairment in at least two domains; (2) CIND, defined as impairment in only one domain; and (3) normal cognition, defined as impairment in no domain. These cognitive test criteria yield prevalence rates of dementia that align with rates calculated from reports of diagnosis [46].

For those respondents who could not participate in the study by themselves, the NHATS survey was completed by a proxy (a spouse or adult child). About half of the proxies said the SP could participate in the cognitive tests, and in those cases, the sample respondent completed the tests. For respondents who were unable to complete the cognitive tests (1.66%), cognitive status was measured via the proxy's report of AD diagnosis or their responses to the Ascertain Dementia 8, one of the most frequently used information-based instruments for assessing early memory loss, temporal orientation, judgment, and function [50,51]. In these cases, the SP was categorized as having dementia if the proxy reported that the SP had been diagnosed with dementia or if the Ascertain Dementia 8 score met the criteria for likely dementia (score $\geq$2).

Marital status

Marital status was measured as a time-varying covariate reflecting marital status at the time of the survey, with five categories: married (reference), cohabiting, divorced/separated, widowed, and never married.

Other covariates

Age was categorized into six groups: 65–69 (reference), 70–74, 75–79, 80–84, 85–89, and 90 years and older. Race/ethnicity was self-reported and included four categories: non-Hispanic white (reference), non-Hispanic black, Hispanic, and other. Education included four categories: less than high school (reference), high school degree or equivalent, some college, and college graduate. Nativity indicated whether the respondent was born in the United States (1 = yes, 0 = no). Proxy report indicated whether dementia

status was reported by a proxy (1 = proxy report, 0 = self-report). Age was measured as a time-varying covariate; all other covariates were time invariant based on wave 1 data.

Statistical methods

To compare the risk of cognitive impairment across marital status groups, we estimated discrete-time hazard models. Specifically, we created person-year record files and then estimated two types of models: binary logit models to predict cognitive impairment in each of the specific domains and multinomial logit models to predict overall dementia/CIND risk. A respondent contributes an observation for each wave at which they were interviewed, up to the onset of impairment or right censoring (i.e., loss to follow-up or death). The discrete-time hazard model is specified as follows:

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

where $h(t_{ij})$ indicates the discrete hazard (i.e., conditional probability) of the onset of impairment for individual i at wave j. $h_0(t_{ij})$ indicates the discrete hazard of baseline cognitive status for individual i at wave j. $\sum_{j=1}^{8} \alpha_j D_{ij}$ represents the set of intercepts for the eight periods/years of NHATS, 2011–2018, 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 conducted two models: model 1 estimated the main effects of marital status, and model 2 added the interaction terms for marital status categories by gender. All covariates were included in both models. All analyses were weighted using the wave-specific weight.

Results

Table 1 shows the descriptive statistics of unweighted frequencies and weighted proportions for all analyzed variables for the total sample as well as by marital status. The prevalence of CIND was significantly higher among widowed (8.39%) and divorced (6.50%) respondents than among married respondents (5.27%). The prevalence of dementia was higher among widowed (6.31%), never married (5.59%), and divorced (3.59%) respondents than among married respondents (2.70%). The prevalence of impairment in orientation was higher among widowed (6.44%) and never-married (5.39%) respondents than among married respondents (2.65%). The prevalence of impairment in executive function was higher among divorced (4.52%) and widowed (5.38%) respondents than among married respondents (3.26%). Finally, the prevalence of impairment in memory was higher among divorced (5.67%), widowed (9.31%), and never-married (7.00%) respondents than among married respondents (4.17%). Cohabiting and married respondents did not have significantly different prevalence of cognitive impairment.

Table 2 presents the estimated odds ratios of cognitive impairment from the discrete-time hazard models. The results of model 1 show that both divorced and widowed respondents had significantly higher odds of all types of cognitive impairment—CIND, dementia, and impairment in each specific

Table 1
Descriptive statistics of person-period files (unweighted frequencies and weighted proportions), NHATS, 2011-18

Variables	Total		Married		Cohabiting		Divorced and separated		Widowed		Never married	
	N	%	N	%	N	%	N	%	N	%	N	%
Cognitive impairment												
Normal cognition	22,440	89.86	11,431	92.02	462	93.07	2833	89.91*	6937	85.30*	777	88.07*
CIND	2044	6.26	814	5.27	33	3.95	244	6.50*	873	8.39*	80	6.34
Dementia	1413	3.88	480	2.70	20	2.98	140	3.59*	693	6.31*	80	5.59*
Impairment in orientation†	1623	3.87	522	2.65	22	1.90	153	3.23	838	6.44*	88	5.39*
Impairment in executive function‡	1569	4.08	569	3.26	21	2.63	191	4.52*	705	5.38*	83	5.14
Impairment in memory§	2299	5.84	789	4.17	34	3.57	250	5.67*	1113	9.31*	113	7.00*
Male	10,614	42.74	7320	56.07	285	53.30	1122	34.01*	1555	18.91*	332	37.69*
Age groups												
65–69	2820	16.34	1731	19.36	112	27.85*	480	19.92	360	6.91*	137	19.54
70–74	6362	31.48	3691	35.01	173	37.80	1079	39.61*	1141	19.25*	278	35.46
75–79	6051	23.29	3310	24.29	107	19.98	795	22.73	1643	22.18*	196	20.62
80–84	5224	15.60	2373	13.63	62	8.14*	523	11.75	2100	22.55*	166	12.91
85–89	3471	9.17	1235	6.21	45	4.82	237	4.26*	1849	18.11*	105	8.42
90+	1969	4.12	385	1.52	16	1.42	103	1.74	1410	11.01*	55	3.05
Race/ethnicity												
White	19,399	84.60	10,264	87.29	395	83.67	1928	76.22*	6246	84.18*	566	75.97*
Black	4742	7.18	1589	4.60	72	5.04	1018	13.55*	1756	8.70*	307	14.97*
Hispanics	1130	5.15	538	4.88	23	5.16	168	6.30	344	4.72	57	8.47
Others	626	3.07	334	3.23	25	6.13	103	3.93	157	2.40	7	0.58*
Education												
Less than high school	4966	15.99	1849	12.78	103	19.94	686	17.13*	2088	21.12*	240	20.69*
High school	8953	34.77	4064	32.19	165	32.57	1038	32.57	3431	42.25*	255	28.03
Some college	8548	34.47	4623	36.94	190	35.36	1121	37.12	2357	28.65*	257	29.87
College above	3430	14.77	2189	18.09	57	12.13	372	13.18*	627	7.98*	185	21.41
Proxy report	506	1.66	197	1.38	8	1.52	42	1.00	213	2.02*	46	5.58
Born in the United States	23,692	90.72	11,590	90.17	486	93.99	2920	90.80	7863	92.01	833	87.05
N of respondents	7508	100.00	3609	100.00	151	100.00	913	100.00	2542	100.00	293	100.00
N of person-periods	25,897	100.00	12,725	100.00	515	100.00	3217	100.00	8503	100.00	937	100.00

* Difference between married and the specific unmarried group is significant at $P < .05$.
† N of person-periods = 30,625.
‡ N of person-periods = 30,266.
§ N of person-periods = 28,730.

Table 2
Adjusted odds ratios from discrete-time hazard models, NHATS, 2011-18

Variables	Cognitive impairment		Impairment in separate domains		
	Base category: Normal cognition				
	CIND	Dementia	Orientation	Executive function	Memory
Model 1					
Marital status (ref: Married)					
Cohabiting	0.76 (0.46–1.23)	1.16 (0.65–2.06)	0.75 (0.49–1.13)	0.88 (0.48–1.60)	0.94 (0.61–1.45)
Divorced	1.29* (1.11–1.48)	1.42† (1.11–1.80)	1.23‡ (1.01–1.50)	1.45* (1.18–1.78)	1.42* (1.23–1.65)
Widowed	1.25‡ (1.04–1.50)	1.35† (1.10–1.65)	1.31† (1.09–1.58)	1.23‡ (1.02–1.48)	1.39* (1.22–1.57)
Never married	1.13 (0.74–1.73)	1.31 (0.78–2.19)	1.66‡ (1.08–2.56)	1.37 (0.88–2.13)	1.45‡ (1.09–1.93)
Model 2					
Marital status (ref: Married)					
Cohabiting	0.71 (0.25–2.00)	0.68 (0.25–1.83)	0.83 (0.32–2.18)	1.10 (0.45–2.67)	0.88 (0.40–1.90)
Divorced	1.42† (1.10–1.84)	1.24 (0.88–1.75)	1.13 (0.83–1.54)	1.31 (0.97–1.78)	1.51† (1.16–1.97)
Widowed	1.38† (1.09–1.74)	1.22 (0.95–1.55)	1.28 (0.98–1.66)	1.13 (0.89–1.44)	1.34† (1.11–1.61)
Never married	1.19 (0.68–2.08)	1.01 (0.53–1.91)	1.75 (0.97–3.16)	1.27 (0.75–2.14)	1.39 (0.97–1.99)
Male	1.63* (1.26–2.10)	0.97 (0.75–1.25)	1.11 (0.87–1.42)	1.22 (0.94–1.57)	1.30† (1.07–1.58)
Marital status X male					
Cohabiting X male	1.12 (0.31–4.03)	2.28 (0.82–6.33)	0.84 (0.24–2.98)	0.68 (0.22–2.10)	1.12 (0.40–3.15)
Divorced X male	0.83 (0.52–1.31)	1.29 (0.75–2.23)	1.21 (0.74–2.00)	1.21 (0.78–1.87)	0.86 (0.57–1.28)
Widowed X male	0.80 (0.58–1.10)	1.21 (0.84–1.75)	1.06 (0.74–1.51)	1.20 (0.85–1.69)	1.13 (0.88–1.44)
Never married X male	0.94 (0.49–1.78)	1.90 (0.85–4.24)	0.84 (0.45–1.59)	1.15 (0.66–1.99)	1.10 (0.67–1.82)
N of respondents	7508		7508	7508	7508
N of person-periods	25,897		30,625	30,266	28,730

All models control for gender, age, race/ethnicity, education, proxy report, and born in the United States.
* $P < .001$.
† $P < .01$.
‡ $P < .05$.

domain—after controlling for all covariates. Specifically, compared with their married counterparts, those who were divorced had 29% higher odds of CIND (OR = 1.29, 95% CI = 1.11,1.48), 42% higher odds of dementia (OR = 1.42, 95% CI = 1.11,1.80), 23% higher odds of orientation impairment (OR = 1.23, 95% CI = 1.01,1.50), 45% higher odds of executive function impairment (OR = 1.45, 95% CI = 1.18, 1.78), and 42% higher odds of memory impairment (OR = 1.42, 95% CI = 1.23, 1.65). The widowed group had 25% higher odds of CIND than the married group (OR = 1.25, 95% CI = 1.04, 1.50), as well as 35% higher odds of dementia (OR = 1.35, 95% CI = 1.10, 1.65), 31% higher odds of orientation impairment (OR = 1.31, 95% CI = 1.09, 1.58), 23% higher odds of executive function impairment (OR = 1.23, 95% CI = 1.02, 1.48), and 39% higher odds of memory impairment (OR = 1.39, 95% CI = 1.22, 1.57). Never-married respondents had 66% and 45% higher odds of impairment in orientation (OR = 1.66, 95% CI = 1.08, 2.56) and memory (OR = 1.45, 95% CI = 1.09, 1.93), respectively, than their married counterparts, but did not have significantly different odds of CIND, dementia, or executive function impairment. Cohabiting respondents did not differ significantly from married respondents in any of the cognitive outcomes. The results of model 2 (Table 2) show no significant gender interactions, suggesting that the associations between marital status and cognitive outcomes did not vary by gender.

Sensitivity analysis

We conducted a series of sensitivity analyses to test the robustness of the results. First, we excluded all cases with any cognitive impairment at the baseline survey to eliminate the influence of the baseline association between marital status and cognition. The resulting analysis focused on the incidence of impairment across waves (results shown in Appendix A, Table S2). In a second set of models, we excluded proxy cases (i.e., we restricted the analysis to self-reporting respondents) to determine whether including proxy cases had introduced bias in the estimates (results shown in Appendix A, Table S3). Finally, the results of additional analyses (not shown but available on request) showed that, on average, those who were lost to follow-up were older, less educated, and more likely to be unmarried and cognitively impaired than those who had complete information, suggesting that the primary sample excluded the most vulnerable respondents, and therefore, the main estimates of cognitive impairment might be overly conservative. Thus, in a third set of models, we restricted the analysis to respondents who had complete follow-up information across all waves to test whether loss to follow-up had introduced bias in the estimates (results shown in Appendix A, Table S4). All sensitivity test results were similar to the findings reported in the article, although the significance levels of some effects declined because of smaller sample sizes.

Discussion

This study provides population-based evidence of marital status differences in cognitive impairment and dementia in the United States. A number of studies have shown that married people are healthier (both mentally and physically) and live longer than unmarried people [17,19,24,25,27], but few of these studies have examined cognitive health. Our analysis of nationally representative longitudinal data from the NHATS extends the evidence of this long-observed marital advantage to cognitive impairment and dementia, which are emerging public health concerns in the context of rapid population aging. Results suggest that marital status is a potentially important but understudied social risk/protective factor for cognitive impairment and the development of dementia, and that there is significant heterogeneity in cognitive health across marital status.

We found that divorced and widowed respondents were the most disadvantaged in cognitive health in late life. Compared with their married counterparts, divorced and widowed older adults had significantly higher odds of impairment in all examined cognitive domains as well as in overall cognitive impairment and dementia. These results are consistent with our expectations as well as with

the general literature suggesting that married people enjoy better health than unmarried people, in particular when compared with those who were previously married [19,21,23,24,26]. The results are also consistent with the previous studies conducted outside the United States, which found significantly higher risks of dementia among the divorced and widowed than among the married [32,37,39]. Furthermore, this study found that the cognitive disadvantage experienced by divorced and widowed people relative to married people occurred in all the assessed domains of cognition (i.e., memory, orientation, and executive function), suggesting that limitations in each specific domain of cognition contribute to overall cognitive disadvantage.

Never-married individuals also had higher odds of impairment in memory and orientation than their married counterparts but did not differ in the domain of executive function or the overall odds of either cognitive impairment or dementia. Although the specific reasons for this variation across cognitive outcomes remain unclear, this finding is consistent with previous studies that found mixed evidence for health differences between never-married and married individuals, with some suggesting moderate differences [18–20] and others suggesting no differences [52]. In fact, there is some evidence that in recent decades, the never married have become more like the married in terms of self-rated overall health [19]. Nevertheless, our sample of never-married respondents is small relative to the samples of divorced and widowed respondents, which may have limited statistical power and increased the risk of type 2 error.

This is one of the first studies to compare the risk of cognitive impairment among cohabitors and married people. Previous studies, based primarily on European data, have combined married and cohabiting respondents in studies of the association between marital status and dementia risk [34]. We found no significant difference in cognitive impairment between cohabitors and married respondents, which is consistent with previous literature suggesting that cohabitation and marriage tend to be similar in predicting health outcomes among older people [51], although the meanings and functions of these two types of unions differ for younger people [52]. Nevertheless, we note that the sample of cohabitors is the smallest of all the marital status groups in the NHATS. Among the cohabitors in the focal sample, only 20 had dementia and 33 had CIND across the entire study period. Therefore, the findings for this specific group should be interpreted with caution.

Next, we hypothesized that the associations of marital status with cognitive impairment and dementia may vary by gender for several reasons. For example, the prevalence of dementia appears to differ for men and women, although the evidence is mixed, with some studies suggesting that women suffer more memory problems, faster rates of cognitive decline, and a higher risk of dementia [53–55] and others suggesting that the incidence of vascular dementia is higher for men than women in all age groups [56]. In addition, within traditional marriages, women tend to take on more responsibilities for maintaining social connections to family and friends and are more likely to provide physical care and emotional support for their spouse—factors that promote health and may also reduce the risk of cognitive impairment for married men [17,19,21,29,30]. Contrary to our expectations, we found no gender differences in the links between marital status and cognitive impairment. Although prior studies of other health outcomes suggest that men tend to receive more health benefits from marriage than women, and women are more psychologically and physiologically vulnerable to marital stress than men [17,26,29], the current results suggest that being divorced or widowed is related to a higher risk of cognitive impairment for both men and women. Future studies should investigate the specific pathways by which divorce and widowhood affect cognitive health for older men and women and whether the specific pathways vary by gender, even if the overall pattern of association does not.

Being married is associated with multiple advantages that may translate to cognitive health and reduced dementia risk. For example, married people have access to greater economic resources than unmarried people through pooled income and health insurance via a spouse's employment [14,16,57]. These economic resources available to married individuals and, to a lesser degree, cohabitors may enhance overall health status and cognitive capacity through providing better nutrition and care in the event of illness, and allowing the purchase of medical treatment and other health-enhancing products [14,16]. Having a spouse is also an important source of social support (e.g., love, advice, and care) and enlarges individuals' networks by connecting them with, for example, the spouse's friends and family. A growing number of studies suggest that 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 strengthens the ability to cope with neuropathological damage [38,58]. Conversely, divorce and widowhood may undermine health and increase stress [17,21,59,60], which is pathogenic and associated with a higher risk of cognitive impairment and dementia [61,62]. Future research should investigate these specific mechanisms through which marital status is linked to cognitive impairment. Such research will be necessary for the development of specific evidence-driven interventions and policy guidelines that promote cognitive well-being and reduce dementia risk among vulnerable groups such as the divorced and widowed.

This study has several limitations. First, the measures of cognitive impairments are based on cognitive tests and proxy reports rather than clinical diagnosis. Although previous research has demonstrated that using the NHATS cognitive tests yields prevalence estimates of dementia that align with estimates calculated from reports of diagnosis [46], the issue of potential misclassification cannot be ignored. Second, the analytical sample is relatively small for some of the unmarried groups, such as the never married and cohabitors. Thus, future studies should use data sets with larger sample sizes to confirm or refute the current findings. Third, although we controlled for basic demographic covariates in the analysis, there are other important confounding psychosocial and neurological factors that may influence cognition and marital status, which should be considered in future analyses. Finally, although we developed research hypotheses based on causal implications from previous studies, the current analysis focused primarily on documenting general associations rather than determining causality. Future studies should use a clearly defined causal estimand with the exposure and outcome mechanism specified via the guidance of causal theories to better understand the causal process underlying the association between marital status and cognitive impairment.

Conclusions

The study results suggest that being divorced or widowed at older ages may be a risk factor for cognitive impairment and progression to dementia for both men and women, highlighting that divorced and widowed older adults may be particularly vulnerable to dementia. The number of divorced and widowed older adults in the United States continues to grow as people live longer and their marital histories become more complex. Therefore, it is important to further explore the complex life-course characteristics of marital relationships (e.g., marital histories, marital quality, and marital duration) that might contribute to the risk of cognitive impairment and dementia so that effective interventions can be implemented to

reduce those risks. The current findings imply that routine medical dementia screening and cognition-promoting intervention strategies should be customized according to marital status to address key pathways to reduce the risk of cognitive impairment and dementia.

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Appendix

Table S1
Unweighted frequencies of marital status and cognitive status at the baseline survey and subsequent follow-up

	Men (n = 3135)	Women (n = 4373)	Total (n = 7508)
Baseline marital status			
Married	2124	1485	3609
Cohabiting	93	58	151
Divorced	331	582	913
Widowed	477	2065	2542
Never married	110	183	293
Marital transitions across waves			
Transition to widowhood in Waves 2–8	192	266	458
Transition to divorce in Waves 2–8	33	19	52
Transition to (re)marriage in Waves 2–8	23	11	34
Baseline cognitive status			
Normal cognition	2306	3221	5527
CIND	459	523	982
Dementia	370	629	999
Impairment in orientation	281	475	756
Impairment in executive function	326	399	725
Impairment in memory	471	658	1129
Cognitive transitions across waves			
Normal cognition to CIND waves 2–8	448	614	1062
Normal cognition/CIND to dementia waves 2–8	150	264	414

Table S2
Adjusted odds ratios from discrete-time hazard models (sample with baseline cognitive impairments excluded), NHATS 2011-18

	Cognitive impairment		Impairment in separate domains		
	Base category: Normal cognition				
	CIND	Dementia	Orientation	Executive function	Memory
Model 1					
Marital status (ref: Married)					
Cohabiting	0.85 (0.43–1.68)	1.90§ (0.89–4.07)	0.72 (0.30–1.73)	0.85 (0.37–1.95)	1.26 (0.65–2.44)
Divorced	1.31† (1.08–1.58)	2.00† (1.27–3.17)	1.31 (0.91–1.88)	1.76† (1.26–2.46)	1.69* (1.34–2.12)
Widowed	1.17 (0.95–1.43)	1.47‡ (1.03–2.10)	1.34‡ (1.03–1.73)	1.30§ (0.97–1.74)	1.51* (1.22–1.87)
Never married	1.11 (0.69–1.78)	0.64 (0.26–1.58)	1.46 (0.83–2.58)	0.73 (0.39–1.39)	1.34 (0.88–2.04)
Model 2					
Marital status (ref: Married)					
Cohabiting	0.99 (0.27–3.63)	0.60 (0.18–1.98)	0.46 (0.10–2.19)	1.41 (0.43–4.66)	0.72 (0.24–2.16)
Divorced	1.44‡ (1.05–1.98)	1.59 (0.82–3.05)	1.12 (0.72–1.74)	1.65‡ (1.02–2.68)	1.72† (1.16–2.58)
Widowed	1.26§ (0.97–1.63)	1.21 (0.84–1.75)	1.22 (0.87–1.70)	1.17 (0.83–1.65)	1.50† (1.13–1.98)
Never married	1.12 (0.62–2.01)	0.54 (0.18–1.57)	1.75 (0.74–4.10)	0.38‡ (0.15–0.96)	1.30 (0.78–2.18)
Male	1.49† (1.13–1.97)	0.80 (0.56–1.16)	1.14 (0.80–1.63)	1.17 (0.81–1.69)	1.42‡ (1.07–1.89)
Marital status X male					
Cohabiting X male	0.78 (0.15–4.00)	5.37‡ (1.26–22.86)	1.97 (0.30–12.75)	0.31 (0.06–1.50)	2.22 (0.51–9.65)
Divorced X male	0.82 (0.49–1.37)	1.62 (0.64–4.11)	1.37 (0.68–2.74)	1.10 (0.60–2.00)	0.94 (0.53–1.69)
Widowed X male	0.84 (0.60–1.18)	1.51 (0.86–2.64)	1.25 (0.77–2.03)	1.28 (0.79–2.07)	1.01 (0.69–1.48)
Never married X male	1.03 (0.45–2.32)	1.43 (0.28–7.37)	0.44 (0.10–1.97)	3.62‡ (1.05–12.42)	1.07 (0.45–2.53)
N of respondents	5527		5527	5527	5527
N of person-periods	23,916		26,171	25,768	25,179

Note: All models control for gender, age, race/ethnicity, education, proxy report, and born in the U.S.
* $P < .001$.
† $P < .01$.
‡ $P < .05$.
§ $P < .1$.

Table S3
Adjusted odds ratios from discrete-time hazard models (sample of self-reports only), NHATS 2011-18

	Cognitive impairment		Impairment in separate domains		
	Base category: Normal cognition				
	CIND	Dementia	Orientation	Executive function	Memory
Model 1					
Marital status (ref: Married)					
Cohabiting	0.77 (0.47–1.26)	0.90 (0.46–1.77)	0.73 (0.48–1.12)	0.85 (0.45–1.60)	0.86 (0.54–1.39)
Divorced	1.29* (1.12–1.49)	1.36‡ (1.03–1.80)	1.23§ (0.99–1.52)	1.42† (1.13–1.78)	1.39* (1.20–1.62)
Widowed	1.27‡ (1.06–1.53)	1.35† (1.08–1.67)	1.33† (1.10–1.61)	1.22† (1.01–1.49)	1.36* (1.19–1.55)
Never married	1.19 (0.78–1.84)	1.50 (0.89–2.53)	1.66‡ (1.04–2.66)	1.37 (0.83–2.26)	1.46‡ (1.06–2.03)
Model 2					
Marital status (ref: Married)					
Cohabiting	0.72 (0.25–2.03)	0.80 (0.29–2.15)	0.87 (0.33–2.28)	1.15 (0.47–2.82)	0.92 (0.42–2.00)
Divorced	1.44† (1.11–1.85)	1.29 (0.88–1.89)	1.16 (0.85–1.58)	1.30 (0.94–1.80)	1.54† (1.17–2.02)
Widowed	1.40† (1.10–1.78)	1.25§ (0.96–1.64)	1.31§ (1.00–1.71)	1.14 (0.90–1.44)	1.33‡ (1.10–1.62)
Never married	1.31 (0.74–2.32)	1.21 (0.65–2.28)	1.74§ (0.91–3.32)	1.32 (0.74–2.37)	1.49§ (0.98–2.26)
Male	1.63* (1.25–2.11)	1.07 (0.82–1.39)	1.13 (0.88–1.45)	1.25§ (0.97–1.60)	1.35† (1.10–1.64)
Marital status X male					
Cohabiting X male	1.11 (0.31–4.01)	1.24 (0.34–4.50)	0.75 (0.21–2.64)	0.58 (0.18–1.84)	0.91 (0.32–2.61)
Divorced X male	0.82 (0.52–1.29)	1.09 (0.60–1.97)	1.14 (0.70–1.86)	1.18 (0.76–1.85)	0.78 (0.51–1.19)
Widowed X male	0.81 (0.58–1.11)	1.17 (0.79–1.71)	1.04 (0.73–1.50)	1.18 (0.85–1.64)	1.10 (0.86–1.41)
Never married X male	0.84 (0.44–1.62)	1.64 (0.74–3.64)	0.87 (0.43–1.78)	1.05 (0.59–1.86)	0.96 (0.56–1.66)
N of respondents	7242		7284	7279	7269
N of person-periods	25,391		30,048	29,680	28,229

Note: All models control for gender, age, race/ethnicity, education, and born in the U.S.
* $P < .001$.
† $P < .01$.
‡ $P < .05$.
§ $P < .1$.

Table S4
Adjusted odds ratios from discrete-time hazard models (sample of complete follow-up data across waves), NHATS 2011-18

	Cognitive impairment		Impairment in separate domains		
	Base category: Normal cognition				
	CIND	Dementia	Orientation	Executive function	Memory
Model 1					
Marital status (ref: Married)					
Cohabiting	0.81 (0.37–1.77)	1.33 (0.47–3.76)	0.89 (0.44–1.79)	0.94 (0.31–2.88)	0.98 (0.52–1.87)
Divorced	1.19 (0.91–1.56)	2.05* (1.36–3.10)	1.01 (0.64–1.57)	1.90* (1.33–2.71)	1.26 (0.92–1.72)
Widowed	1.32§ (1.00–1.73)	1.29 (0.84–1.99)	1.52‡ (1.09–2.10)	1.29 (0.94–1.77)	1.35‡ (1.04–1.75)
Never married	1.06 (0.62–1.81)	0.74 (0.22–2.51)	2.44† (1.32–4.50)	1.52 (0.75–3.05)	1.23 (0.66–2.30)
Model 2					
Marital status (ref: Married)					
Cohabiting	0.46 (0.11–1.93)	0.65 (0.16–2.72)	1.21 (0.34–4.37)	0.84 (0.23–3.11)	1.14 (0.38–3.44)
Divorced	1.26 (0.84–1.91)	2.18† (1.33–3.57)	0.89 (0.49–1.62)	1.65‡ (1.01–2.68)	1.58§ (0.99–2.51)
Widowed	1.55† (1.13–2.14)	1.33 (0.86–2.05)	1.77† (1.18–2.65)	1.28 (0.88–1.86)	1.54† (1.12–2.10)
Never married	1.10 (0.57–2.13)	0.59 (0.16–2.14)	2.86‡ (1.29–6.34)	1.19 (0.46–3.06)	1.41 (0.69–2.89)
Male	1.73* (1.26–2.37)	0.92 (0.59–1.44)	1.45§ (0.96–2.18)	1.27 (0.86–1.90)	1.51‡ (1.10–2.06)
Marital status X male					
Cohabiting X male	2.29 (0.49–10.73)	3.24 (0.52–20.12)	0.61 (0.16–2.37)	1.18 (0.43–3.21)	0.78 (0.18–3.39)
Divorced X male	0.94 (0.48–1.83)	0.83 (0.32–2.15)	1.39 (0.63–3.04)	1.34 (0.67–2.68)	0.60 (0.29–1.27)
Widowed X male	0.59‡ (0.38–0.90)	0.84 (0.34–2.06)	0.63 (0.31–1.27)	0.89 (0.58–1.38)	0.77 (0.50–1.19)
Never married X male	1.01 (0.40–2.55)	2.77 (0.58–13.24)	0.71 (0.26–1.93)	1.70 (0.60–4.86)	0.77 (0.32–1.87)
N of respondents	2478		2478	2478	2478
N of person-periods	15,257		18,147	17,654	17,013

Note: All models control for gender, age, race/ethnicity, education, proxy report, and born in the U.S.
* $P < .001$.
† $P < .01$.
‡ $P < .05$.
§ $P < .1$.