ORIGINAL RESEARCH

Marital History and Survival After Stroke

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***Background*—**Stroke is among the leading causes of disability and death in the United States, and nearly 7 million adults are currently alive after experiencing a stroke. Although the risks associated with having a stroke are well established, we know surprisingly little about how marital status influences survival in adults with this condition. This study is the first prospective investigation of how marital history is related to survival after stroke in the United States.

***Methods and Results*—**Data from a nationally representative sample of older adults who experienced a stroke (n=2351) were used to examine whether and to what extent current marital status and past marital losses were associated with risks of dying after the onset of disease. Results showed that the risks of dying following a stroke were significantly higher among the never married (hazard ratio [HR], 1.55; 95% CI, 1.15–2.08), remarried (HR, 1.22; 95% CI, 1.05–1.43), divorced (HR, 1.22; 95% CI, 1.01–1.50), and widowed (HR, 1.32; 95% CI, 1.16–1.51) relative to those who remained continuously married. We also found that having multiple marital losses was especially detrimental to survival—regardless of current marital status and accounting for multiple socioeconomic, psychosocial, behavioral, and physiological risk factors.

***Conclusions*—**Marital history is significantly associated with survival after stroke. Additional studies are needed to further examine the mechanisms contributing to the associations and to better understand how this information can be used to personalize care and aggressively treat vulnerable segments of the population. **(*J Am Heart Assoc*. 2016;5:e004647 doi: 10.1161/JAHA.116.004647)**

Key Words: marital status • mortality • stroke

Stroke is among the leading causes of disability and death in the United States, and upwards of 800 000 adults will experience a stroke this year.[1] The onset of stroke is a major health event that can have immediate and lasting consequences on one's physical well-being and survival.[1–3] It is well established that access to quality care, the reduction of known risk factors (eg, hypertension, smoking, and obesity), and adhering to treatment regimens (eg, rehabilitative activities, medications) are important components of recovering from a stroke and improving survival outcomes.[1,4] Moreover, studies have suggested that social support, such as marriage, can have a significant impact on treatment and prognosis in adults diagnosed with cardiovascular disease.[5,6] However, the extent to which marital history is associated with survival after a stroke remains largely unknown.

Studies suggest that adults who are not married have greater risks of stroke than married adults.[7–10] Whether and to what extent marital life is associated with one's prognosis after a stroke is not well documented. The research that does exist—largely from clinical studies outside of the United States and often dated—suggests that persons who are not married are more likely to die following a stroke than those who are married.[11–14] Although the evidence is limited, these findings are consistent with a large body of literature showing that individuals who are not married have fewer economic resources, less social support, more unhealthy behaviors, and ultimately worse health outcomes than their married counterparts.[15–19] To our knowledge, however, no existing studies have examined the association between marital status and the prospects of survival after stroke in the US population. Furthermore, studies have largely ignored whether lifetime exposure to marital loss(es) may be associated with cardiovascular health and overall mortality.[20–22]

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An accompanying Table S1 is available at http://jaha.ahajournals.org/content/5/12/e004647/DC1/embed/inline-supplementary-material-1.pdf

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Received September 6, 2016; accepted October 24, 2016.

This study is the first prospective investigation of how marital history is related to survival after stroke in the United States. Data from a nationally representative sample of US older adults were used to examine whether and to what extent current marital status and past marital losses were associated with risks of dying after the onset of stroke. We examined whether multiple socioeconomic, psychosocial, behavioral, and/or physiological risk factors accounted for the associations and assessed differences by sex and race/ethnicity.

Methods

Study Population

Nationally representative data from the Health and Retirement Study (HRS) were used for analysis. The HRS is an ongoing prospective cohort study of US adults older than 50 years sponsored by the National Institute on Aging (NIA) and the Institute for Social Research at the University of Michigan.[23] The original HRS cohort included 9824 age-eligible respondents born in 1931–1941 who have been interviewed biennially since 1992. The initial response rate was 82% and reinterview response rates were ≈94% for 1994–2010, with low attrition due to nonresponse and lost tracking. Since 1998, the HRS has been supplemented with age-selective birth cohorts to replenish the nationally representative sample of older adults. Details of the multistage sampling design, implementation, and response rates have been documented in detail elsewhere.[20,23,24]

Data for this study were drawn from 10 waves of interviews (1992–2010) from 30 661 respondents in the original HRS cohort, the Asset and Health Dynamics Among the Oldest Old cohort (AHEAD; ≤1923), Children of Depression (CODA; 1924–1930), War Baby cohort (WB; 1942–1947), and the Early Baby-Boom cohort (EBB; 1948–1953), who were first interviewed in 1992, 1993, 1998, and 2004, respectively, and reinterviewed through 2010. Data for 2012 were not used for this analysis because information on respondent mortality is not currently complete for this period. The analyses were restricted to respondents who reported the incidence of stroke during the 10-wave observation period from 1992–2010 (n=2487). At each interview, participants were asked whether "a doctor ever told you that you had a stroke" and in what year (and month after 1994) it occurred. Although patients' reports of stroke are less precise than clinical data, studies show consistency between diagnostic reports of serious health events from survey respondents and those from medical evaluations, including stroke.[25,26] Although information on stroke subtype was not available, we expected that most HRS participants experienced an ischemic stroke (≈90%), comparable to national estimates.[1] We excluded 10 cases because of inconsistent or erroneous values on the timing of stroke. Forty-six respondents were excluded because their marital history (if any) could not be determined and an additional 80 cases were dropped because of missing data on other baseline measures. The final analytic sample included 2351 adults aged 41 years and older who contributed an average of 5.3 person-years over the 18-year observation period. The data used in this study were de-identified and publicly accessible and deemed exempt from the Duke University institutional review board.

Measurement

A distinctive feature of the HRS is the collection of marital histories from more than 50 years of prospective and retrospective interview data. Marital information was ascertained from detailed responses to questions about the beginning/ending dates (in years and/or months) of all marriages and marital losses reported by study participants. Although we could not confirm the dates that respondents provided for the retrospective timing of marital events, research has shown "substantial agreement" between marital dates reported retrospectively and those reported by the same individuals in a panel design.[27] Several time-varying dichotomous measures were used to capture past and present marital life. Current marital status was categorized as never married, continuously married, remarried, divorced, or widowed. The cumulative number of marital losses experienced through divorce or widowhood was categorized as 0, 1, or ≥2 marital losses. For respondents with a history of marital loss, we further disaggregated the currently remarried, divorced, and widowed participants into those with 1 or ≥2 marital losses. Preliminary analyses indicated that divorce and widowhood had comparable risks for mortality, and the limited number of respondents who reported being widowed more than once (n=22) prohibited including separate measures for marital loss(es) due to widowhood and divorce. Being continuously married (ie, never divorced or widowed) was the reference group in the analyses.

The multivariate models adjusted for background characteristics that included age at onset (in years), sex, race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic other race, or Hispanic), whether a proxy assisted the interview (yes or no), and geographic region (South). Several categories of previously identified risk factors and resources were also examined as possible factors contributing to the associations. Socioeconomic factors included the respondents' educational attainment (in years), total household income in thousands of dollars (logarithmic scale), and health insurance coverage from any source (yes or no). Psychosocial factors included having any children (yes or no), friends or relatives in the neighborhood (yes or no), regularly

attends religious services (yes or no), and number of depressive symptoms measured by the 8-item abbreviated Center for Epidemiologic Studies Depression Scale (CES-D; range=0–8). Behavioral factors included past or current smoking status (yes or no), excessive alcohol use (≥3 drinks per day; yes or no), vigorous physical exercise (<3 times per week; yes or no), and adherence to hypertension medication (yes or no). Physiological factors included body mass index (calculated as weight in kilograms divided by height in meters squared; <18.5 [underweight], 18.5–24.9 [normal weight], 25.0–29.9 [overweight], or ≥30.0 [obese]), number of activities of daily living limitations (range=0–5), diagnosed chronic illness (diagnosed with hypertension, diabetes, chronic obstructive pulmonary disease, or cancer; yes or no), and recurrent stroke (yes or no). Preliminary analyses also included variables in the models to adjust for study cohort (eg, original HRS, CODA, EBB), urban-rural residence, lifetime occupational status, household wealth, and spouses from the same household (≈55%); however, results were not significant and the variables were dropped from the final models.

Coding of the time-varying measures was facilitated by using HRS data files provided by RAND—funded by NIA and the Social Security Administration.[28] Alternative coding strategies were also assessed for the continuous variables (eg, logged, polynomial, and grouped-ordinal scales) and categorical variables (eg, different cutpoints, categories, and reference groups) and did not alter the central findings. With the exception of age, sex, and race/ethnicity, all measures were time varying and time lagged (observed in the previous wave [ie, within the prior 24 months]) in the prospective analyses to establish the temporal order of the associations among the marital factors, covariates, and subsequent mortality.[29] Alternative lag times (eg, no lag, 12 months, 48 months) were also assessed in preliminary analyses and produced largely consistent results.

Outcome

Mortality from all causes was the outcome for analysis. Deaths from all causes were included because many adults who experience a stroke die from related or other causes[1,30] and because the majority of studies examining survival after a stroke include all-cause mortality as the outcome.[1,11–14] All participants in the study were followed prospectively for mortality through 2010. Participants who died were identified using the National Death Index and the HRS tracking file.[24] Time until death was calculated from the participants' date of stroke onset and the date of death. A person-year file was constructed from the respondents' cumulative exposure to death so that each observation was a record for every additional year beyond the time of onset. A total of 1362 deaths (58%) were reported during the 15 946 person-years of observation.

Statistical Analysis

Baseline distributions of the study variables were computed for all participants and by survival status. Comparisons by survival status were calculated with *t* tests for continuous variables and chi-square tests for categorical variables. *P* values were based on 2-tailed tests and considered statistically significant at $P<0.05$. Age-adjusted plots were used to describe differences in survival rates over the study period for the separate indictors of marital history. Cox proportional hazard models were used to estimate the hazard ratios (HRs) and 95% CIs of mortality associated with marital status and marital loss(es). The number of tied events relative to the number at risk was low (<1%) and partial likelihood estimation was nearly identical using Breslow (reported here) and Efron approximations.

The first set of multivariate models examined the risks of dying after a stroke related to: (1) current marital status, (2) number of marital losses, and (3) the combination of marital losses with current marital status while adjusting for age at onset, sex, race/ethnicity, proxy interview, and geographic region. The second set of multivariate analyses adjusted for additional sets of covariates to examine the potential factors contributing to mortality risks associated with marital history. Akaike information criteria values were used to compare log-likelihood functions to assess model fit across the non-nested models.[31] The associations were also assessed for differences by sex and race/ethnicity.

Four sets of sensitivity analyses were also conducted. First, tests of interactions with analysis time and tests of Schoenfeld residuals using robust variance-covariance matrix estimation indicated that the proportional hazard assumption was not violated. Second, we assessed whether selective survival may have contributed to the findings. Excluding adults older than 90 years at baseline (n=110; 4.7%) produced results that were largely unchanged. Third, although missing data were minimal across study variables for follow-up measurements (≈2%), preliminary analyses showed that the results were unchanged using multivariate imputation, mean replacement, and forward imputation from baseline/prior interview data (used here). Finally, the data were not weighted because the study focuses on a selective subsample of HRS respondents (stroke survivors) and the multivariate models included variables related to initial sample selection (age, sex, race, region) to produce unbiased estimates.[32] All analyses were conducted using Stata 13.0 (StataCorp, College Station, TX).

Results

Table 1 presents the baseline characteristics of the study participants for the entire sample and by survival status.

Table 1. Characteristics of Study Participants From the Health and Retirement Study at Baseline

	Total (n=2351)	Survived (n=989)	Died (n=1362)	*P* Value
Background characteristics				
Age, median (IQR), y	72.7 (11.3)	68.9 (10.20)	75.4 (11.2)	<0.001
Male	44.4	45.2	43.8	0.511
Non-Hispanic black	18.3	17.6	18.7	0.484
Non-Hispanic other race	2.0	2.1	1.8	0.619
Hispanic	8.3	9.6	7.3	0.049
Proxy interview	19.1	9.5	26.1	<0.001
Lives in the South	44.9	43.8	45.7	0.364
Marital status				
Never married	3.2	2.6	3.5	0.220
Continuously married	35.4	41.7	30.8	0.002
Remarried	18.8	19.9	18.1	0.256
Divorced	11.0	13.8	9.0	<0.001
Widowed	31.6	22.0	38.6	<0.001
Marriage loss(es)				
No marital loss	38.5	44.3	34.4	<0.001
1 marital loss	48.8	42.1	53.7	<0.001
2+ marital losses	12.6	13.7	11.9	0.206
Socioeconomic factors				
Years of education, mean (SD)	11.4 (3.4)	12.0 (3.2)	11.0 (3.5)	<0.001
Median household income (IQR), $ thousand	37.6 (157.0)	51.1 (237.6)	27.9 (36.9)	<0.001
No health insurance	5.4	7.2	4.0	<0.001
Psychosocial factors				
No children	8.5	6.1	10.2	<0.001
No nearby friends and/or relatives	22.1	24.7	20.3	0.011
Never attends religious services	25.1	24.9	25.3	0.801
CES-D depressive symptoms (0–8)	2.2 (2.2)	2.0 (2.2)	2.4 (2.2)	<0.001
Behavioral factors				
Current or former smoker	62.2	61.1	63.0	0.342
Drinks alcohol in excess	14.2	16.5	12.4	0.004
No vigorous exercise	80.5	75.6	84.0	<0.001
Does not take HTN medication	12.3	9.4	14.3	<0.001
Physiological factors				
Underweight, BMI <18.5	3.2	1.2	4.7	<0.001
Overweight or obese, BMI ≥25.0	59.0	65.5	54.2	<0.001
ADL limitations (0–5)	1.0 (1.6)	0.5 (1.1)	1.4 (1.8)	<0.001
Diagnosed chronic illness	79.7	77.2	81.6	0.008
Recurrent stroke	20.5	19.0	21.6	<0.001

ADL indicates activities of daily living; BMI, body mass index; CES-D, Center for Epidemiologic Studies Depression Scale; HTN, hypertension; IQR, interquartile range.

Following a stroke, respondents who died were significantly more likely to be older, less educated, and have lower levels of income compared with respondents who survived through the study period. Those who died were also more likely to have no children, more depressive symptoms, exercise less frequently, less likely to take hypertension medication, have

lower body mass index, more activities of daily living limitations, and more likely to have other diagnosed chronic illness(es) and require a proxy-assisted interview. In terms of marital history, adults who experienced no marital loss ($P<0.001$) and were continuously married ($P=0.002$) at baseline were significantly more likely to survive after a stroke than their adult counterparts with marital instability. Figure 1 further illustrates the age-adjusted survival rates for each of the marital status and marital loss groups over the study period. Compared with adults who were continuously married, survival rates were significantly lower for those who were never married ($P=0.005$), remarried ($P=0.010$), divorced ($P=0.048$), or widowed ($P\leq0.001$). Similarly, adults with one ($P=0.004$) or ≥2 ($P\leq0.001$) marital loss(es) had significantly lower rates of survival than adults with no marital loss. Further details of the characteristics of study participants are provided by marital group in Table S1.

Table 2 presents the sociodemographically adjusted HRs for the associations between marital status (model 1) and marital losses (model 2) and the risk of dying after a stroke. Results from model 1 showed that risks were higher in adults who never married (HR, 1.71; 95% CI, 1.31–2.24), remarried (HR, 1.23; 95% CI, 1.06–1.44), divorced (HR, 1.23; 95% CI, 1.01–1.49), and widowed (HR, 1.25; 95% CI, 1.10–1.43) relative to those who remained continuously married. Model 2 showed that one lifetime marital loss was significantly associated with dying after a stroke (HR, 1.20; 95% CI, 1.06–1.35) and a history of ≥2 marital losses was associated with significantly greater risks (HR, 1.41; 95% CI, 1.19–1.66) after accounting for differences in age at onset, sex, race, ethnicity, proxy interview, and geographic region. Model 3 further disaggregated the participants' history of marital losses with their current marital status. Results showed that being never married or having a history of marital instability was significantly associated with increases in one's risk of dying after a stroke; furthermore, having multiple marital losses is especially detrimental to survival regardless of one's current marital status.

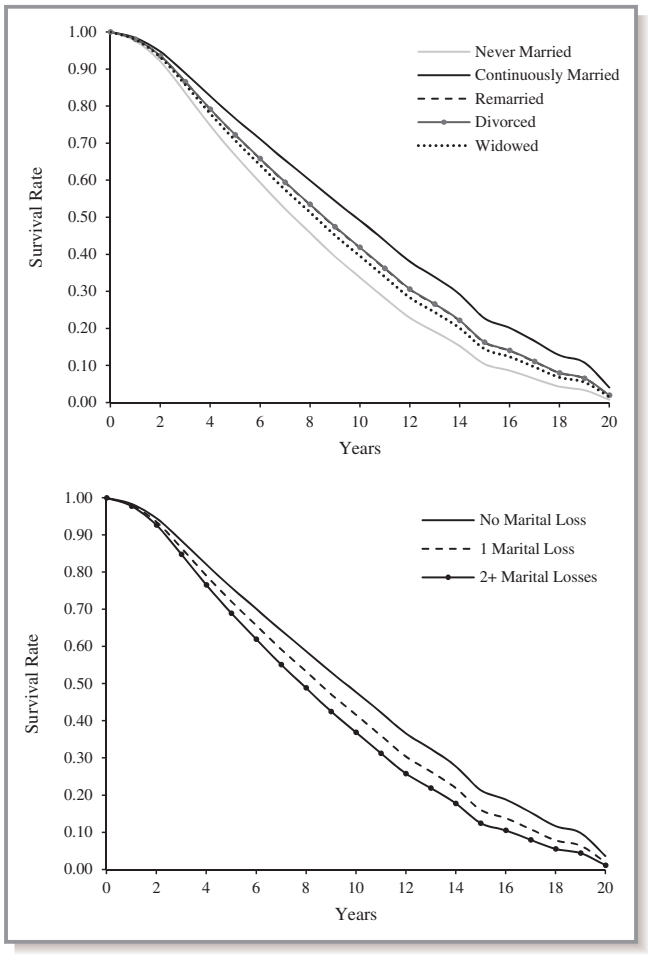

Figure 1. Age-adjusted survival rates after stroke by marital history. Differences are statistically significant for marital status ($P\leq0.05$) and marital losses ($P\leq0.01$). Also note that survival rates are nearly identical for persons divorced and remarried.

Figure 2 presents the sociodemographically adjusted HRs from model 3 and the fully adjusted model that accounts for socioeconomic, psychosocial, behavioral, and physiological factors that may have contributed to marital differences in mortality following a stroke. Overall, we found that adults who never married and those who were unmarried after one divorce or widowhood in their lifetime were not significantly different from continuously married adults after taking into account differences in more than a dozen explanatory variables. However, we found that adults with more than one marital loss remained significantly more likely to die regardless of their current marital status.

Reductions in HRs and estimated Akaike information criteria values indicated that each category of covariates had comparable levels of explanatory power (Table 3). Physiological factors had the greatest overall model fit for estimating the risk of dying after a stroke—and largely attenuated the survival differences among the widowed. Psychosocial factors had the largest reduction in risks for adults who never married, and socioeconomic factors had the largest reduction in risks for divorced adults with multiple marital losses. Supplementary analyses were also conducted to examine whether the associations varied for men and women or by race/ethnicity. Of the multiple interactions that were tested, there was no evidence that the key findings significantly differed by sex or race/ethnicity.

Discussion

This study provides the first evidence of how current and past marital experiences are associated with survival after a stroke in US older adults. Compared with adults who were continuously married, we found that those who never married or

Table 2. Hazard Ratios for Dying After Stroke Associated With Marital Status and Marital Losses

	Hazard Ratio (95% CI)		
	Model 1	Model 2	Model 3
Marital status			
Continuously married	1.00	1.00	1.00
Never married	1.71 (1.31–2.24)	1.71 (1.30–2.24)	1.71 (1.30–2.24)
Remarried	1.23 (1.06–1.44)		
Divorced	1.23 (1.01–1.49)		
Widowed	1.25 (1.10–1.43)		
Marital loss(es)			
1 marital loss		1.20 (1.06–1.35)	
2+ marital losses		1.41 (1.19–1.66)	
Marital status and marital loss(es)			
Remarried			
1 marital loss			1.18 (1.01–1.40)
2+ marital losses			1.44 (1.10–1.88)
Divorced			
1 marital loss			1.15 (0.91–1.44)
2+ marital losses			1.39 (1.04–1.86)
Widowed			
1 marital loss			1.22 (1.06–1.40)
2+ marital losses			1.40 (1.13–1.74)

All models adjusted for age at stroke onset, sex, race, ethnicity, proxy interview, and geographic region. The reference group is continuously married. Marital loss includes the number of divorces and/or widowhoods.

experienced a marital dissolution were significantly more likely to die following a stroke. The risks associated with multiple marital losses were especially high and were not reduced with remarriage. Furthermore, we found that adjustments for multiple socioeconomic, psychosocial, behavioral, and physiological factors helped to explain some of the associations.

Previous studies have shown associations between marital status and multiple health outcomes.[16,33,34] The current study builds on this literature and is the first to demonstrate an association between marital history and prospective survival after the onset of a stroke. For adults who never married, we found that the risks of dying after a stroke were 71% greater than adults who were continuously married. Results from multivariate models suggested that these risks were largely attenuated by differences in psychosocial factors—including the lack of children, limited social support, and depressive symptoms—that may have inhibited recovery. We also found that the mortality risks associated with divorce and widowhood were 23% and 25% greater, respectively, than adults who were continuously married. These risks were especially pronounced in those with multiple marital losses (39% and 40%, respectively), and although these increased risks were attenuated most by socioeconomic factors—such as household income and health insurance—the study did not fully account for the 25% to 50% increase in death for these older adults relative to their continuously married counterparts. It may be that more detailed measures of social support and/or psychological distress are needed to better account for how a history of marital instability is detrimental to survival after the onset of a major illness. Therefore, we encourage future studies to consider additional factors that may be contributing to these findings.

Two notable findings warrant comment. First, we found that the mortality risks in adults who were divorced once were not significantly different from adults who were continuously married. Further analysis also showed that the increased risks in divorced adults with multiple marital losses were partially attributable to the risks of a prior widowhood. These findings are not entirely unexpected and are consistent with previous studies showing that the risks associated with divorce diminish over time.[16,35] In the current study of stroke survivors, we expect that marital loss due to widowhood is more contemporaneous with the occurrence of stroke at older ages and, subsequently, more salient to the risks associated with mortality. A second notable finding was that remarried

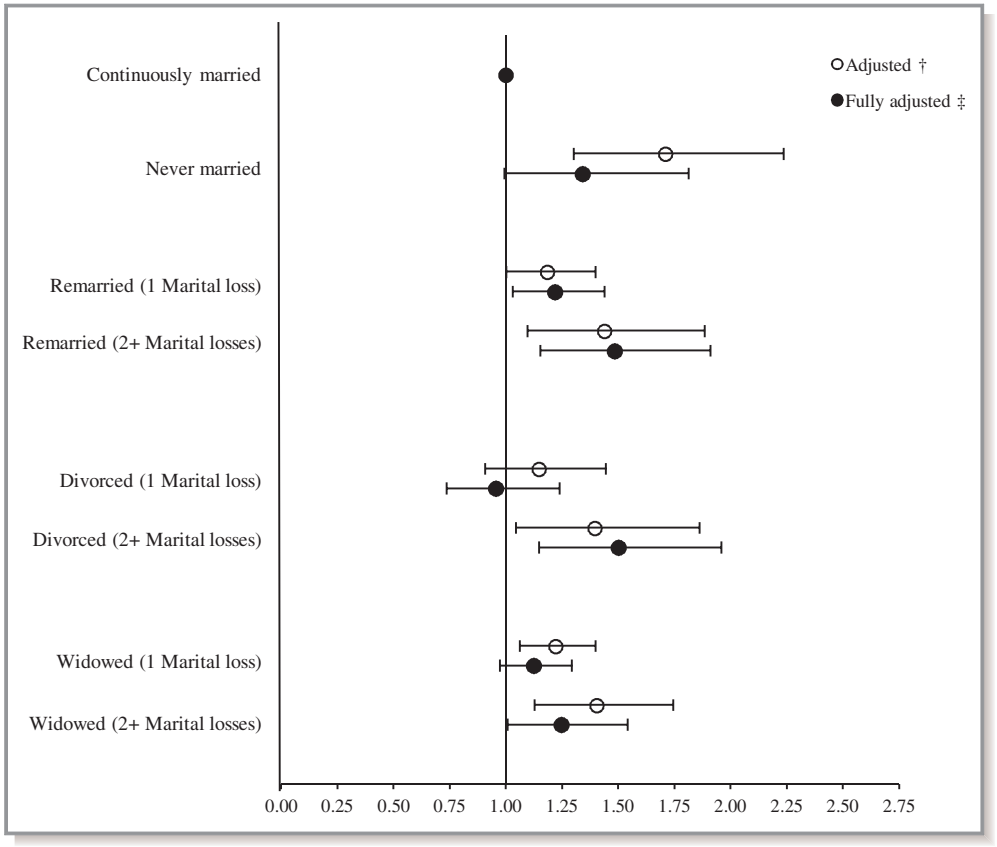

Figure 2. Adjusted hazard ratios of dying after stroke associated with marital status and marital losses. †Adjusted for age at stroke onset, sex, race, ethnicity, proxy interview, and geographic region. ‡Adjusted for age at stroke onset, sex, race, ethnicity, proxy interview, geographic region, education level, household income, health insurance, any children, nearby friends/relatives, religious attendance, depressive symptoms, smoking, alcohol use, physical exercise, hypertension medication use, body mass index, functional disability, other diagnosed chronic illness, and recurrent stroke. Error bars denote 95% CIs.

adults were significantly more likely to die following a stroke relative to continuously married adults. We found that remarried adults with more than one marital loss had mortality risks that were nearly equivalent in magnitude to their divorced counterparts (HRs 1.48 versus 1.50, respectively). Although counterintuitive to the generally ascribed benefits of marriage, there is evidence for this finding in related research. For example, studies have shown that remarried adults have significantly greater levels of physical and psychological illness than adults who are continuously married.[20,33,36] Alternatively, continuous marriages have been shown to provide stable socioeconomic, behavioral, and psychosocial resources that accumulate and solidify over time.[18,36,37] Faced with a stroke, we suspect that those with stable marriages draw from these protracted resources to better manage disease and prolong survival after experiencing a life-threatening event. The present findings corroborate this association to suggest that remarriage after divorce or widowhood may not confer the same health benefits for those who remained stably married.

An important area for future research will be to investigate the mechanisms underlying the findings from this study and to identify possible interventions to reduce these risks. The prevailing argument is that marital instability is negatively associated with the economic, behavioral, and psychosocial well-being of individuals that reduces their ability to prevent and treat illness.[18,38–40] Contrary to expectations and existing literature, we found that factors such as income, health insurance, depressive symptoms, alcohol use, and smoking did not account for the excess risks associated with a history of marital loss. We suspect that the acute and chronic stress associated with marital loss(es) may have played an important role in our findings—particularly as it related to widowhood in older ages.[41–43] Indeed, recent studies have identified possible biological mechanisms (eg, blood pressure reactivity, elevated cortisol, and hemoglobin A_{1c}) related to the stress of marital loss that warrant additional investigation as they relate to increased risk for mortality after a stroke.[34,43,44] Relatedly, we also suspect that a history of marital dissolution may have had negative consequences on one's medication

Table 3. Adjusted Hazard Ratios for Dying After a Stroke Associated With Marital History

	Hazard Ratio (95% CI)					
	Model 1: Demographic Factors	Model 2: Socioeconomic Factors	Model 3: Psychosocial Factors	Model 4: Behavioral Factors	Model 5: Physiological Factors	Model 6: Full Model
Marital history						
Continuously married	1.00	1.00	1.00	1.00	1.00	1.00
Never married	1.71 (1.30–2.24)	1.66 (1.26–2.18)	1.51 (1.11–2.05)	1.68 (1.28–2.20)	1.52 (1.17–1.99)	1.34 (0.99–1.81)
Remarried						
1 marital loss	1.18 (1.01–1.40)	1.18 (1.01–1.40)	1.19 (1.00–1.41)	1.20 (1.02–1.42)	1.19 (1.01–1.41)	1.22 (1.03–1.44)
2+ marital losses	1.44 (1.20–1.88)	1.43 (1.09–1.87)	1.44 (1.09–1.89)	1.42 (1.09–1.85)	1.45 (1.13–1.86)	1.48 (1.15–1.91)
Divorced						
1 marital loss	1.15 (0.91–1.44)	1.11 (0.88–1.40)	1.12 (0.89–1.42)	1.12 (0.89–1.41)	0.98 (0.76–1.27)	0.96 (0.74–1.24)
2+ marital losses	1.39 (1.04–1.86)	1.35 (1.01–1.81)	1.42 (1.07–1.89)	1.41 (1.07–1.86)	1.47 (1.13–1.92)	1.50 (1.15–1.96)
Widowed						
1 marital loss	1.22 (1.06–1.40)	1.18 (1.03–1.36)	1.20 (1.05–1.38)	1.22 (1.06–1.39)	1.13 (0.98–1.30)	1.12 (0.97–1.29)
2+ marital losses	1.40 (1.13–1.74)	1.37 (1.10–1.70)	1.39 (1.11–1.72)	1.34 (1.10–1.66)	1.29 (1.04–1.60)	1.25 (1.01–1.54)
AIC value	18 433.13	18 458.11	18 457.52	18 420.74	18 255.53	18 321.63

The reference group is continuously married. Marital loss includes the number of divorces and/or widowhoods. Model 1 adjusted for age at stroke onset, sex, race, ethnicity, proxy interview, and geographic region. Model 2 adjusted for model 1 covariates and included education level, household income, and health insurance. Model 3 adjusted for model 1 covariates and included any children, nearby friends/relatives, religious attendance, and depressive symptoms. Model 4 adjusted for model 1 covariates and included smoking, alcohol use, physical exercise, and hypertension medication use. Model 5 adjusted for model 1 covariates and included body mass index, functional disability, other diagnosed chronic illness, and recurrent stroke. Model 6 adjusted for all covariates. AIC indicates Akaike information criteria.

adherence, healthcare utilization, and other behaviors for disease management that may have accelerated their health decline.[5,6,38] Accordingly, studies have shown that spouses encourage concordant health behaviors—such as proper diet, exercise, and medication compliance—that promote cardiovascular health and prolong survival.[18,45,46] Therefore, we encourage future studies to explore these mechanisms to help better explain how repeated exposure to marital loss is associated with increasing risks for mortality following a stroke.

Study Limitations

The results of this study are not without limitations. First, we recognize that the analyses are based on self-reported diagnoses of strokes that were not formally adjudicated. Although studies have shown consistency between diagnostic reports of strokes from survey respondents and those from medical evaluations, we acknowledge that the HRS may have unreported cases of stroke that were not included in the study.[26,47,48] Therefore, future studies may be warranted to validate these findings with formal clinical events classification. Second, and relatedly, the study was limited to adults who survive to hospital discharge, and we cannot rule out potential selection bias related to those who died shortly after experiencing a stroke. Likewise, it is possible that selection played a role in the likelihood of entering/exiting marriage, as well as contributing to underlying risks for mortality in adults who experienced a stroke. Third, although the data were rich in the number and breadth of measured covariates, it is possible that additional unmeasured factors may have contributed to the findings. For example, direct measures were not available for the severity or type of stroke, the treatment/control of hypertension and diabetes, or other clinical factors (eg, rehabilitation) that are associated with survival after an acute cerebrovascular event. We also could not identify the duration or quality of past marriages or the circumstances of marital loss. Likewise, we lacked direct measures of stress and anxiety that follow a stroke—and marital loss—which may have contributed to the associations. Finally, this is an observational study based on a selective subsample of HRS respondents (stroke survivors) and we recognize that the results do not indicate causality and may not be generalizable to other populations.

Conclusions

The results from this observational study provide new evidence that has the potential to inform health policy and practice. Although marital events are not amenable to medical intervention or treatment, knowledge about the risks associated with marital life may be useful for personalizing care and

improving prognoses for those who experience a stroke. Greater recognition and understanding of these associations may enable healthcare providers to better identify and treat older adults with illness who are at potentially high risk of dying, as well as provide older adults a greater awareness of the risks associated with their marital status and background. Future studies are needed to further examine the mechanisms contributing to these associations and to assess how such information can be used to aggressively treat vulnerable segments of the population.

Acknowledgments

The National Institute on Aging had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Sources of Funding

Support for this study was provided by the National Institute on Aging grant R03AG042712.

Disclosures

None.

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SUPPLEMENTAL MATERIAL

Table S1. Characteristics of Study Participants from the Health and Retirement Study at Baseline

	Continuously Married	Never Married	Remarried (n=443)	Divorced (n=259)	Widowed (n=743)	*P* Value
Background Characteristics						
Age, median (IQR), y	70.5 (16.0)	68.0 (16.0)	68.0 (15.0)	65.0 (14.0)	82.0 (12.0)	<.001
Male	59.5	47.3	58.9	42.1	19.4	<.001
Non-Hispanic black	13.5	40.5	14.0	31.3	19.4	<.001
Non-Hispanic other race	1.9	4.1	2.0	2.3	1.6	.673
Hispanic	9.0	8.1	9.0	11.2	6.1	.071
Proxy interview	17.1	13.5	17.2	11.6	25.8	<.001
Lives in the South	44.7	35.1	45.2	44.4	46.0	.511
Socioeconomic Factors						
Years of education, mean (SD)	11.8 (3.3)	11.0 (3.6)	11.8 (3.2)	11.4 (3.4)	10.7 (3.5)	<.001
Median household income (IQR)	33.0 (34.3)	9.8 (14.9)	33.0 (34.9)	14.2 (18.6)	13.2 (13.2)	<.001
No health insurance	5.4	9.5	4.7	11.2	3.2	<.001
Psychosocial Factors						
No children	4.1	70.3	3.6	10.4	9.4	<.001
No nearby friends and/or relatives	19.1	24.3	23.5	30.9	21.4	.002
Never attends religious services	20.3	23.0	32.1	31.3	24.5	<.001
CES-D depressive symptoms (SD)	1.9 (2.1)	2.5 (2.2)	2.0 (2.2)	2.7 (2.5)	2.5 (2.2)	<.001
Behavioral Factors						
Current or former smoker	62.0	67.6	74.5	74.9	50.1	<.001
Drinks alcohol in excess	12.7	18.9	14.9	22.4	12.0	<.001
No vigorous exercise	77.6	86.5	75.2	81.1	86.0	<.001
Does not take HTN medication	13.1	8.1 `	12.4	13.9	11.0	.489
Physiological Factors						
Underweight, BMI < 18.5	1.3	4.1	3.6	2.3	5.4	<.001
Overweight or obese, BMI ≥ 25.0	64.1	54.1	63.4	62.6	49.8	<.001
ADL limitations (SD)	1.0 (1.6)	1.2 (1.6)	0.9 (1.5)	0.9 (1.4)	1.5 (1.8)	<.001
Diagnosed chronic illness	75.7	79.7	81.5	80.7	82.8	.009
Recurrent stroke	13.5	8.1	17.2	15.4	14.5	.211
Died during study period	50.5	64.9	55.5	47.5	70.7	<.001

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; HTN, hypertension; BMI, body mass index.