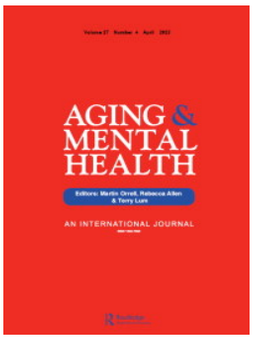

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Spousal loss and cognitive function: the importance of gender and multiple dimensions of marital quality

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ABSTRACT

Objectives: Research suggests that the death of a spouse has an adverse effect on a widow(er)'s cognition. However, little research has examined how the marital context before widowhood and gender influence this association. Guided by the social ambivalence and disease (SAD) model, this study examined the associations between spousal loss and cognition , with moderating effects of gender and pre-loss marital quality.

Method: We analyzed a national longitudinal data, Midlife in the United States (MIDUS), specifically MIDUS 2 (2004-2005) and MIDUS 3 (2013-2014). The analytic sample consisted of (1) 146 participants who experienced the death of their spouse between MIDUS 2 and MIDUS 3 and (2) 144 age- and gender-matched comparison participants who did not lose their spouse during the period.

Results: Adverse influence of widowhood on cognition was more pronounced among bereaved men than bereaved women. Widowed individuals whose relationships with their deceased spouse were ambivalent had poorer cognition than widowed individuals who had aversive relationships with their deceased spouse.

Conclusion: Findings suggest that the influence of spousal death on cognitive functioning depends on gender and pre-loss marital quality, emphasizing the importance of considering pre-loss marital relationship and gender dynamics in developing efficient interventions for the widowed.

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KEYWORDS
Death of spouse; cognition; episodic memory; executive functioning; ambivalence

Introduction

Although researchers have paid extensive attention to the influence of spousal loss on a variety of outcomes, there is still little knowledge about the longitudinal contribution of spousal loss to cognitive function. Research on bereavement has demonstrated that the experience of spousal loss is associated with various physical and mental health outcomes (Carr et al., 2001; Fries, 2001; Siegel et al., 2004; Stroebe et al., 2001; Umberson et al., 1992). Compared to their non-bereaved peers, individuals who have experienced the death of a spouse report a greater prevalence of depressive symptoms, sleep problems, cardiovascular disease, and high cortisol and blood glucose levels (Lee et al., 2014; Min et al., 2018; Richardson et al., 2015; van de Straat & Bracke, 2015; Williams, 2004).

Relative to the research on physical and mental health outcomes, research on cognitive functioning in widowhood is limited. Althouth there is an emerging body of research on the impact of spousal loss on cognitive functioning (Lyu et al., 2019; Mousavi-Nasab et al., 2012; Ward et al., 2007; Wörn et al., 2020; Xavier et al., 2002), the findings regarding the impact of spousal loss on cognitive function over time are mixed; some studies have found that spousal loss is associated with lower levels of cognitive functioning in widowhood (Aartsen et al., 2005; Lyu et al., 2019; Shin et al., 2018; van Gelder et al., 2006; Xu et al., 2021) ; while other studies have found no significant association between spousal loss and cognitive functioning (Karlamangla et al., 2009; Vidarsdottir et al., 2014; Ward et al., 2007). While there are several possible reasons for the mixed findings, taken as a whole, these findings highlight the importance of considering changes over time in both widowhood status and cognitive function. Comparing longitudinal changes in cognitive functioning between widowed and non-widowed individuals does not capture within-person changes in widowhood status. However, comparing cognitive functioning before and after spousal loss requires considering between-person differences in cognitive functions at baseline. Thus, this study examines whether changes in cognitive functioning differ significantly between those who lost their spouse between study waves and those who did not, after controlling for baseline cognitive function.

Mixed findings across studies may also be attributable to different measures of cognition and possible confounding effects of contextual variables, such as gender and pre-loss relationship quality, that contribute to heterogeneity in outcomes following widowhood. Indeed, prior studies have suggested that research on the impact of the death of a spouse should consider the pre-loss context (Carr et al., 2000; 2004; Itzhar-Nabarro & Smoski, 2012; Lee & Carr, 2007). For example, Carr and colleagues (2000) demonstrated that anxiety was higher among those who were highly dependent on their spouse whereas levels of yearning were lower for widowed persons with high levels of marital conflict. In addition, a study of Swedish widowed men found preparedness moderated the association between death of a spouse and health such that those who were less prepared for the death had an increased risk of chronic pain (Ásgeirsdóttir et al., 2013). It is noteworthy

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that relationship quality is an important pre-loss characteristics that predicts mental health of the bereaved individuals (Carr et al., 2000; 2004). The attachment theory posits that people who had close relationship with their spouses face loss of secure attachment figure following the death of a spouse, which might result in psychological pathology such as anxiety (Meier et al., 2013). Research has found that anxiety and grief have an adverse influence on cognition (Bierman et al., 2005), thus pathological responses to the loss of spouse, that can be linked to the assumption of the attachment theory, might be a pathway through which the loss of spouse is resulted in cognitive decline or impairment over time.

However, to the best of our knowledge, there is no research on how pre-loss relationship quality impacts the association between spousal loss and cognitive functioning. This study addresses this gap in the literature by examining the moderating role of relational context (i.e. quality of marital relationships) before the death of a spouse on the association between spousal loss and cognitive functioning.

Specifically, the current study considers the possible moderating effects of multiple dimensions of marital relationship quality based on existing theory. Notably, some studies on the health effects of relationship quality have focused on the complex co-occurrence of positivity and negativity in relationships. For example, Uchino et al. (2012) utilized a combined matrix of positivity and negativity in social relationships, rather than separate measures of positivity and negativity, and examined the associations between this matrix-based measure and various outcomes. Multidimensional assessments of relationship quality have proven efficient in empirical studies, including studies of marital quality. For example, Reblin et al. (2020) found that a multidimensional relationship quality assessment that combined positivity and negativity was an efficient predictor of marital functioning. The multidimensional relationship quality approach has the additional benefit of examining the impact of relationships that are both highly positive and highly negative (or ambivalent), which can be missed if positive and negative relationship quality are considered separately. Indeed, a recent study introduced the social ambivalence and disease (SAD) model and showed that ambivalent relationships are associated with different psychosocial and physiological pathways to disease than supportive and adverse relationships (Holt-Lunstad & Uchino, 2019). It is also found that women with indifferent marital relationship reported worse health outcomes than their counterparts (Liu & Upenieks, 2021). Given the proven links between physical and mental health and cognitive functions (Elderkin-Thompson et al., 2011; Karlamangla et al., 2014;; Kimhy et al., 2013), the current study will utilize the multidimensional relationship quality framework to examine the moderation effects of marital quality prior to the death of a spouse on the association between death of a spouse and cognitive change over time.

In addition to marital relationship quality before spousal loss, the gender of the bereaved individual may have a significant influence on bereavement outcomes.

However, research on gender differences in the association between the marital quality and bereavement outcomes is limited and showed inconsistent findings. Some studies suggested that men were more vulnerable than women to the adverse impact of spousal loss on cognitive functioning (Aartsen et al., 2005; Brown et al., 2021; Liu et al., 2020). One the other hand, some studies found that women's cognitive functioning was more susceptible to the adverse influence of the death of the spouse than men's (Vidarsdottir et al., 2014), while others found no gender differences in cognitive functioning by widowed status (Mousavi-Nasab et a l., 2012). The research on gender differences in the association between widowhood and cognitive functioning might have produced mixed findings because of the influence of potential confounders; for example, the likelihood of experiencing the death of a spouse in later adulthood differs for men and women. Thus, the adjustment to and impact of bereavement might differ for men and women.

To reduce the possibility of bias due to confounding factors that predict both widowhood status and cognitive function, the focal analysis utilizes a comparison group that is matched to the target group (i.e. individuals who experienced the death of a spouse between the baseline at MIDUS 2 and follow-up at MIDUS 3) on both age and gender. That is, because the possibility of both losing a spouse and experiencing cognitive decline increase with age, and during later years women are more likely than men to experience spousal loss while also having different levels of cognitive functioning than men, the study uses a comparison subsample (who did not experience spousal loss between study waves) whose gender and age composition mirrors that of the target group (whose members experienced spousal loss). In sum, this study examines the influence of the death of a spouse on cognitive functioning over time among midlife and older adults by analyzing longitudinal data from a nationally representative study, MIDUS, drawn from a subsample of bereaved individual and a non-bereaved comparison group. In addition, the moderation effects of gender and pre-loss marital quality are examined. We hypothesize that the associations between experiencing the death of a spouse and cognitive functioning over time will differ (1) between bereaved men and women and (2) across various types of marital quality at baseline.

Methods

Data and sample

The analyses use data from the Midlife in the United States: A National Longitudinal Study of Health & Well-Being (MIDUS). MIDUS collected information from a national probability sample of non-institutionalized, English-speaking adults. The first wave (MIDUS 1) was fielded in 1995-1996 among adults age 25 to 74; subsequent waves were conducted with the same sample in 2004-2005 (MIDUS 2) and 2013-2014 (MIDUS 3). The mortality-adjusted retention rate from MIDUS 1to MIDUS 2was 75%. In total, of the 7,108 participants in the first wave, 4,963 completed MIDUS 2 and 3,294 completed MIDUS 3 (Kirsch et al., 2019; Radler & Ryff, 2010).

The sample for the current analyses consists of two groups. The first group includes those participants who experienced the death of the spouse between MIDUS 2 and MIDUS 3 (i.e. were married at MIDUS 2 but widowed at MIDUS 3). A total of 146 respondents who completed both MIDUS 2 and MIDUS 3 interviews and the cognitive battery tests and had valid marital quality information at MIDUS 2 were included in the first group. The second group includes individuals who (1) completed both MIDUS 2 and MIDUS 3 interviews and the cognitive battery test and had valid marital quality information at MIDUS 2 and (2) did not experience the death of the spouse during the same period (i.e. were continuously married to the same spouse between the two surveys). An initial group of 2,021 respondents met these criteria. We used stratified random sampling to select

a matched comparison group from these respondents. Specifically, we used stratified random sampling to select a matched comparison group. Gender and age were used as stratification variables. We used the distributions of the bereaved group on these variables to identify strata, then we randomly selected, from within each stratum of the comparison pool, the same proportion of comparison group individuals as bereaved individuals in that stratum. In this way, the comparison group had equal representation with the target widowed group across all strata. The final analytic sample included 146 participants who experienced the death of a spouse between MIDUS 2 and MIDUS 3 and 144 age- and gender-matched comparison cases who were continuously married to the same spouse and thus did not experience the death of a spouse during this period.

Measures

Cognitive functioning

Measures of cognitive functioning were collected during telephone interview. The Brief Test of Adult Cognition by Telephone (BTACT) was developed for administration via telephone and consists of seven components evaluating verbal memory (immediate and delayed), verbal fluency, processing speed, inductive reasoning, and working memory span, and attention switching (Lachman et al., 2014). Studies comparing the results of the telephone test and the standard in-person test have confirmed the validity of BTACT; these studies have shown no significant effect of mode of testing on test scores and have found significant correlations between BTACT and standardized in-person tests (Lachman et al., 2014; Lachman & Tun, 2008; Tun & Lachman, 2006).

Verbal memory, immediate and delayed, was measured by word-list recall. For the assessment of *immediate memory*, participants were instructed to listen to a list of 15 words and recall as many as possible. Participants were also asked to recall the same word list at the end of the session for the assessment of *delayed memory*. *Verbal fluency* was assessed by a test of category fluency that directed participants to list as many items as possible in one minute from the category "animals." *Working memory* was measured by a backward digit span test. Participants heard increasingly longer series of digits (ranging from two to eight digits) and were asked to repeat them in reverse order. *Processing speed* was assessed by a backward counting task. Participants were asked to count backward from 100 by ones as quickly as possible during 30 s. *Inductive reasoning* was measured by a number series completion task. Participants were given a series of numbers and were asked to respond with the number that best continued the series. A total of five number sets were provided in the task. *Attention switching and inhibitory control* was measured by the Stop & Go Switch Task (SGST), which consists of both single-task trials (a normal condition task and a reverse condition task) and mixed-task trials. The normal-condition task required participants to say "stop" when the interviewer said "red," and "go" when the interviewer said "green." The reverse-condition task asked participants to provide the reverse response and therefore inhibit the familiar response. In mixed-task trials, the alternating condition included occasional cues for participants to switch between the two conditions, which allowed researchers to assess task-switching ability. Participants' responses were scored on both accuracy and latency and for the factor solution; latencies for the means of the switch and non-switch trials were used (Lachman & Tun, 2008).

Based on confirmatory factor analyses (Lachman et al., 2014), two factor scores of cognitive functioning that were computed as standardized means of the z-scored measures loading on the factors were utilized in the current study: episodic memory and executive functioning. Episodic memory was measured by the mean of the standardized scores for immediate verbal memory and delayed verbal memory. Executive functioning was measured by the mean of the standardized scores for verbal fluency, processing speed, inductive reasoning, working memory, and the mean of the switch and non-switch trials from the attention switching and inhibitory control task. Composite cognition score was created by adding the two factor scores, episodic memory and executive functioning.

Bereavement status

Bereavement status was coded as a dichotomous variable (1 = experienced death of spouse between MIDUS 2 and MIDUS 3; 0 = continuously married to same spouse during the focal period).

Marital quality

Marital quality at baseline (MIDUS 2, prior to the loss of spouse for the widowed) was assessed on both positive and negative dimensions, specifically, support from and strain related to the spouse. Marital support was assessed by six items asking how much the respondent's spouse really cared about the respondent, understood the way the respondent felt about things, and appreciated the respondent; how much the respondent relied on the spouse for help if they had a serious problem; how much the respondent could open up to the spouse if they needed to talk about their worries; and how much the respondent could relax and be themselves around the spouse (1 = a lot to 4 = not at all) (Cronbach's alpha = .91). Marital strain was measured by six items asking how often the spouse made too many demands, argued with the respondent, made the respondent feel tense, criticized the respondent, let the respondent down when they were counting on the spouse, and got on the respondent's nerves (1 = often to 4 = never) (Cronbach's alpha = .89). Items were reverse-coded so that higher scores reflected higher levels of support/strain. Scales were constructed by averaging the scores for all items in each scale. Utilizing the mean values for each scale (support and strain) as cutoff points, we formulated high and low levels of positivity and negativity in marital relationships and then created four combined groups based on the multidimensional relationship quality approach (Holt-Lunstad & Uchino, 2019; Uchino et al., 2012): high positivity and high negativity (ambivalent), high positivity and low negativity (supportive), low positivity and high negativity (aversive), and low positivity and low negativity (indifferent).

Covariates

Several variables that previous research has shown to be associated with cognitive functioning were included as controls, including age, education, physical health, and depressed affect (Alley, Suthers, & Crimmins, 2007; Elderkin-Thompson et al., 2011; Karlamangla et al., 2014;; Kimhy et al., 2013; Salthouse, 2009). Physical health was measured by a single item asking about overall health; respondents could answer on a 5-point scale (1 = excellent, 5 = poor, reverse-coded in the analysis). Numerous studies have demonstrated the validity of this single item as a significant predictor of both morbidity and mortality (e.g. Lorem et al., 2020).

Depression was assessed by CIDI-SF (Composite International Diagnostic Interview, Short Form) (Kessler et al., 2004). The respondent was identified as having a depression if he/she ever had a time when he/she felt sad, blue, or depressed for two weeks or more in a row during the past 12 months, every day or almost every day, for all day long or most of the day, and had any associated symptoms (e.g. lost interest in most things, feel more tired out or low on energy than is usual, lose/gain appetite, have more trouble falling asleep than you usually do, have a lot more trouble concentrating than usual, feel down on himself/herself, and think a lot about death) (1 = having major depression, 0 = not having major depression).

Support from family and friends was measured by eight items asking: 1) how much members of the respondents' family [friends] really cared about them, 2) how much family members [friends] understood the way the respondent felt about things, 3) how much the respondent could rely on them for help if they had a serious problem, and 4) how much the respondent opened up to them if they needed to talk about worries (1 = a lot to 4 = not at all). In addition, the respondent's race (1 = non-Hispanic white, 0 = others) was controlled as in previous studies (e.g. Agrigoroaei & Lachman, 2011; Seeman & Sloan, 2013).

Statistical analyses

Multiple regression analysis was used to examine the effect of the death of a spouse on cognitive functioning and to determine whether gender and pre-loss marital quality moderated this relationship. First, we examined the effect of experiencing the death of a spouse

On widow's cognitive functioning; in this step, models included demographic variables (age, gender, race, education), physical health, depressive affect, social support from family and friends, and the key independent variable of widowhood status (experienced death of spouse vs. continuously married). In the second step, a variable measuring the interaction between widowhood status and gender was added to the model. In the third step, marital relationship quality at baseline and the interaction between marital relationship quality and widowhood status were added to the model. The proportion of respondents with missing data ranged from 0% to 8% for the analytic variables (8% for support from friends, 7% for support from family, and none for the most variables). The flag indicating those missing on the support variables were included in the analysis and '-1' was assigned to the missing cases.

Results

Table 1 presents the descriptive statistics for the analytic sample. The participants were 65 years old at baseline, on average, and 72% were female. Those who experienced the death of a spouse between the two time points (MIDUS 2 [2004-2005] and MIDUS 3 [2013-2014]) and the age- and gender-matched comparison cases who did not experience the death of a spouse were comparable for most characteristics. Cognitive functioning, assessed by episodic memory, executive functioning, and composite scores combining the two dimensions, did not differ significantly between widowed and non-widowed respondents. With regard to sociodemographic and health characteristics, the widowed group and the comparison group did not differ significantly in racial/ethnic distribution, educational attainment, self-rated health, depression, support from family and friends, or marital relationship quality at baseline. Both groups had a mean of slightly over 14 years of education. Approximately 93-94% of the participants were non-Hispanic white. The levels of support from family and friends were also comparable between the widowed and non-widowed comparison group. With regard to marital quality at baseline, the distribution of positivity/negativity categories (ambivalent, supportive, aversive, indifferent) did not differ significantly across the two groups. Specifically, at baseline, approximately one half of participants reported having a relationship with "high positivity

Table 1. Descriptive statistics for the analytic sample by bereavement status.

	Transitioned to Widowhood Married (M2) – Widowed (M3)	Continuously Married Married (M2) – Married (M3)	
	M (SD) or %	M (SD) or %	
Cognitive functioning (M2, M3)	−.35 (.68)	−.29 (.66)	ns
Cognitive functioning: composite score (M3)			
Cognitive functioning: episodic memory (M3)	-.41 (.96)	-.38 (.98)	ns
Cognitive functioning: executive function (M3)	-.57 (.68)	-.40 (.68)	*
Cognitive functioning: composite score (M2)	-.18 (.92)	-.01 (.94)	ns
Cognitive functioning: episodic memory (m2)	-.08 (.91)	.16 (1.1)	*
Cognitive functioning: executive function (m2)	-.17 (.83)	.00 (.85)	+
Demographics & marital quality at baseline (M2)			
Age	65.3 (9.2)	64.1 (10.3)	Matched
Female, %	74.0	70.8	Matched
Non-hispanic white, %	97.3	92.4	+
Education	14.4 (2.3)	14.6 (2.4)	ns
Mq: high positivity & high negativity, %	14.4	11.1	ns
Mq: high positivity & low negativity, %	49.3	48.6	ns
Mq: low positivity & high negativity, %	24.7	28.5	ns
Mq: low positivity & low negativity, %	11.6	10.8	ns
Health & social support at follow-up (M3)			
Family support	3.7 (0.4)	3.7 (0.4)	ns
Friends support	3.4 (0.6)	3.3 (0.6)	ns
Self-rated health	3.4 (1.1)	3.2 (1.1)	ns
Depression, %	24.0	14.5	*
N	146	144	

Note: M2 = MIDUS 2 (2004-2006), M3 = MIDUS 3 (2013-2014). MQ = Marital quality. Matched indicates that the non-bereaved sample (i.e. continuously married group) was created based on the distribution of the specific characteristic among the bereaved participants. * $p \leq .05$, + $p \leq .10$, ns = non-significant.

Table 2. Regression models of the association between widowhood status and cognitive functioning: composite cognition score.

	Cognitive functioning: composite score (M3)					
	Model 1		**Model 2**		**Model 3**	
	b	**se**	**b**	**se**	**b**	**se**
Cognitive functioning: composite score (M2)	.430***	.038	.429***	.037	.424***	.038
Age (M2)	-.022***	.003	-.022***	.003	-.021***	.003
Gender (1 = female)	.078	.064	-.044	.086	.085	.064
Race (1 = non-Hispanic White)	-.035	.134	-.046	.133	-.005	.134
Education	.007	.014	.010	.014	.008	.014
Self-rated health (M3)	.055+	.030	.052+	.029	.057+	.030
Depression (M3)	.005	.077	.003	.076	.002	.077
Family support (M3)	-.045	.080	-.049	.079	-.037	.080
Friends support (M3)	-.010	.053	.001	.052	-.013	.053
MQ: High positivity & high negativity (M2)	—	—	—	—	.043	.087
MQ: High positivity & low negativity (M2)	—	—	—	—	.055	.063
MQ: Low positivity & low negativity (M2)	—	—	—	—	-.126	.082
MQ: Low positivity & high negativity (reference) (M2)	—	—	—	—		
Death of spouse (between M2 and M3)	.089	.058	-.093	.104	.194*	.091
death of spouse × gender	—	—	.258*	.123	—	—
Death of spouse × MQ: high positivity & high negativity	—	—	—	—	-.362*	.172
Death of spouse × MQ: high positivity & low negativity	—	—	—	—	-.165	.116
Death of spouse × MQ: low positivity & low negativity	—	—	—	—	-.017	.167
Constant	1.163**	.423	1.198**	.420	1.017*	.430
R^2	.649		.656		.665	

Note: M2 = MIDUS 2, M3 = MIDUS 3. MQ = Marital quality.
+$p \leq .10$.
*$p \leq .05$.
**$p \leq .01$.
***$p \leq .001$.

and low negativity (supportive)," while about one quarter reported having a relationship with "low positivity and high negativity (aversive)." The percentage of participants who described their marital relationships as either "high positivity and high negativity (ambivalent)" or "low positivity and low negativity (indifferent)" ranged from 11-12%

Table 2 presents the results of the regression analysis modeling the effect of widowhood status on cognitive functioning as well as the moderating effects of the participant's gender and marital quality at baseline. As shown in the results for Model 1, individuals who were younger and who had a higher cognition score at baseline showed better cognitive performance in the second wave (MIDUS 3). The interaction between widowhood status and gender had a significant effect on the composite cognition score (see Table 2, Model 2 and Figure 1).

Specifically, gender differences in overall cognitive functioning were more pronounced among the widowed than among non-widowed comparison individuals. Figure 1 shows that widowed men had significantly lower levels of overall cognitive functioning than widowed women, while women's and men's levels of cognitive functioning were rather comparable in the non-bereaved group.

Model 3 in Table 2 and Figure 2a show that the interaction of widowhood status and marital quality prior to bereavement had a significant effect on overall cognitive functioning. Specifically, widowed respondents whose relationships with the deceased spouse were ambivalent (high positivity and high negativity) had much poorer overall cognitive functioning than widowed respondents who had aversive relationships with the deceased spouse (low positivity and high negativity), even after controlling for pre-loss cognitive functioning, physical and mental health, sociodemographic characteristics, and support from family and friends after bereavement. In contrast, among non-bereaved respondents, baseline marital quality did not significantly influence overall cognitive functioning over time.

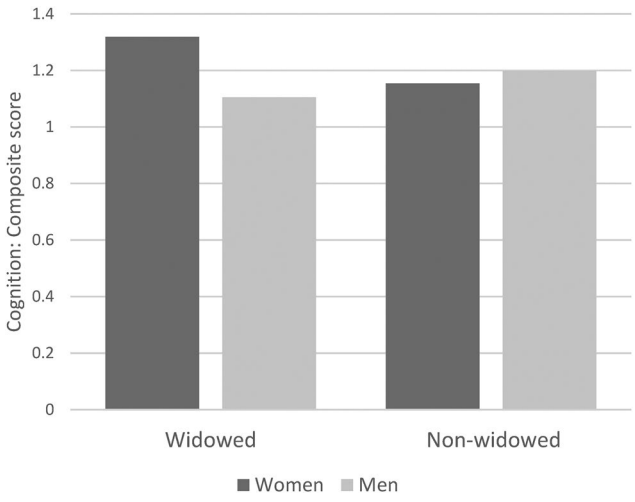

Figure 1. Predicted Composite Score of Cognitive Functioning by Widow Status and Gender.

Table 3 presents the results of the regression analyses modeling the effect of widowhood status on episodic memory as well as the moderating influence of gender and marital quality at baseline. The results of Model 1 show that individuals who had better episodic memory at baseline, were younger, and had better physical health showed better episodic memory performance. Further, women had better episodic memory than men and non-Hispanic whites had better episodic memory than non-whites. The results of Model 2 show that the interaction between widowhood status and gender was not statistically significant. However, in Model 3 the interaction between widowhood status and pre-loss marital quality was statistically significant.

As shown in Figure 2b, among the widowed, levels of episodic memory differed across the pre-loss marital quality groups, while among their non-widowed counterparts, levels of episodic

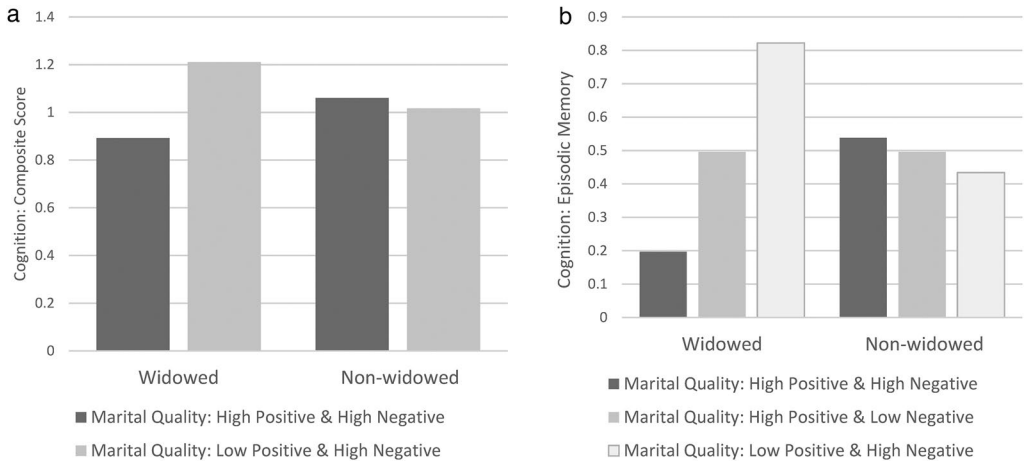

Figure 2. **a**. Predicted Composite Score of Cognitive Functioning by Widow Status and Pre-loss Marital Quality; **b**. Predicted Episodic Memory by Widow Status and Pre-loss Marital Quality.

Table 3. Regression models of the associations between widowhood status and cognitive functioning: episodic memory.

	Cognitive functioning: episodic memory (M3)					
	Model 1		**Model 2**		**Model 3**	
	b	**se**	**b**	**se**	**b**	**se**
Cognitive functioning: episodic memory (M2)	.404***	.051	.410***	.051	.387***	.051
Age (M2)	-.032***	.005	-.032***	.005	-.030***	.005
Gender (1 = female)	.293**	.108	.152	.145	.276**	.107
Race (1 = Non-Hispanic White)	.471*	.216	.467*	.215	.507*	.215
Education	.010	.020	.011	.020	.012	.020
Self-Rated Health (M3)	.127**	.048	.124**	.048	.151**	.048
Depression (M3)	.117	.123	.115	.123	.135	.123
Family support (M3)	-.109	.135	-.114	.135	-.141	.135
Friends support (M3)	.133	.086	.145+	.087	.150+	.087
MQ: High positivity & high negativity (M2)	——	—	—	—	.104	.140
MQ: High positivity & low negativity (M2)	—	—	—	—	.062	.102
MQ: Low positivity & low negativity (M2)	—	—	—	—	-.122	.139
MQ: Low positivity & high negativity (reference) (M2)	—	—	—	—	—	—
Death of spouse (between M2 and M3)	.049	.095	-.159	.173	.388**	.155
Death of spouse × gender	—	—	.293	.203	—	—
Death of spouse × MQ: high positivity & high negativity	—	—	—	—	-.729**	.267
Death of spouse × MQ: high positivity & low negativity	—	—	—	—	-.388*	.194
Death of spouse × MQ: low positivity & low negativity	—	—	—	—	-.378	.269
constant	.668	.672	.725	.672	.434	.674
R^2	.491		.495		.514	

Note: M2 = MIDUS 2, M3 = MIDUS 3. MQ = Marital quality.
+$p \leq .10$.
*$p \leq .05$.
**$p \leq .01$.
***$p \leq .001$.

memory were comparable across marital quality groups. Widowed participants who had either an ambivalent relationship (high positivity and high negativity) or a supportive relationship (high positivity and low negativity) with their deceased spouse had significantly lower levels of episodic memory than widowed participants who had an aversive marital relationship (low positivity and high negativity). In contrast, among non-widowed adults, the level of episodic memory did not differ by marital quality. For executive functioning, neither the main effect of widowhood status nor the moderating effects of gender and marital quality were statistically significant (see Table 4).

Discussion

The purpose of this study was to investigate differences in longitudinal changes in cognitive functioning between bereaved and non-bereaved midlife and older adults in the United States using a nationally representative longitudinal dataset. In addition, this study assessed the moderating effects of gender and multidimensional pre-loss marital quality on the association between death of a spouse and cognitive functioning. The study examined gender differences with consideration of both within-person changes in widowhood status and between-person differences in cognitive functioning. Given the mixed findings in prior research on the gender effect and the dearth of longitudinal quantitative studies examining the role of pre-loss marital quality in the focal association, the current study is uniquely situated to shed light on how gender and pre-loss marital quality influence adaptation in the aftermath of spousal loss.

Gender differences

The regression analysis revealed no statistically significant differences in changes of cognitive functioning between those

Table 4. Regression models of the associations between widowhood status and cognitive functioning: executive functioning.

	Cognitive functioning: executive functioning (M3)					
	Model 1		**Model 2**		**Model 3**	
	b	**se**	**b**	**se**	**b**	**se**
Cognitive functioning: executive functioning (M2)	.484***	.043	.483***	.043	.468***	.043
Age (M2)	-.018***	.003	-.018***	.003	-.019***	.003
Gender (1 = female)	-.004	.006	-.036	.090	.005	.006
Race (1 = Non-Hispanic White)	-.106	.136	-.107	.136	-.087	.137
Education	-.016	.015	-.015	.015	-.016	.015
Self-Rated Health (M3)	.062*	.030	.062*	.030	.059+	.031
Depression (M3)	-.007	.079	-.006	.079	-.032	.079
Family support (M3)	-.041	.086	-.042	.086	-.040	.086
Friends support (M3)	.007	.054	.010	.055	.000	.055
MQ: high positivity & high negativity (M2)	—	—	—	—	.104	.140
MQ: high positivity & low negativity (M2)	—	—	—	—	.062	.102
MQ: low positivity & low negativity (M2)	—	—	—	—	-.122	.139
MQ: low positivity & high negativity (reference) (M2)	—	—	—	—	—	—
Death of spouse (between M2 and M3)	-.001	.060	-.051	.111	.027	.098
Death of spouse × gender	—	—	.068	.129	—	—
Death of spouse × MQ: high positivity & high negativity	—	—	—	—	.079	.089
Death of spouse × MQ: high positivity & low negativity	—	—	—	—	.023	.065
Death of spouse × MQ: low positivity & low negativity	—	—	—	—	-.135	.089
Constant	1.208	.426	1.217	.427	1.256	.431
R^2	.561		.562		.575	

Note: M2 = MIDUS 2, M3 = MIDUS 3. MQ = Marital quality.
+$p \leq .10$.
$p \leq .05$.
*$p \leq .01$.
**$p \leq .001$.

who experienced spousal loss and those who did not. While there was no main effect, the results did reveal that gender had a statistically significant moderating effect on the relationship between spousal loss and overall cognitive functioning (a combined measure of episodic memory and executive functioning). Specifically, the findings suggest that men were more vulnerable than women to the adverse impact of spousal loss on cognitive functioning. The result is consistent with some findings in the literature (Aartsen et al., 2005; Brown et al., 2021; Liu et al., 2020), but incongruent with earlier studies that found no gender differences (Mousavi-Nasab et al., 2012) or found that women's cognitive functioning was more susceptible than men's cognitive functioning to the adverse impact of spousal loss (Vable et al., 2015; Vidarsdottir et al., 2014). The mixed findings across studies may be partly attributable to heterogeneous age ranges in the studies. Because of the gender differences in life expectancy, prevalence of the death of a spouse differs in for men and women—spousal loss is less common experience among men than women as they usually have shorter live expectancy than their wives, especially in advancing age groups. The present study compared bereaved and non-bereaved groups that were comparable with respect to gender and age, which is a unique strength and contribution for the topic.

Notably, the significant gender difference we found for overall cognitive function did not appear when we modeled episodic memory and executive functioning scores separately. This pattern of results highlights the importance of considering both overall and distinct dimensions of cognitive functioning in studies of bereavement (Mousavi-Nasab et al., 2012). Family, friends, and service providers who interact and work with bereaved men who have lost their partners should pay special attention to changes in their cognitive functioning after the death of their wives.

Pre-loss marital quality

Prior studies of stressful major life transitions have suggested the importance of accounting for the role of the pre-loss relationship quality with spouse in the process of bereavement (Carr, 2004). Further, longitudinal data is important for examining the impact of pre-loss relationship, in part because such data prevents meaning reconstruction among bereaved individuals in response to grief after loss (Coleman & Neimeyer, 2010). However, empirical evidence based on longitudinal data remains very limited, with the exception of a small number of qualitative studies. A search of the extant research indicates that the present study is one of the first to examine the impact of pre-loss marital quality on the relationship between widowhood and cognition using nationally representative quantitative data in the United States.

We observed that widowed individuals whose relationships with their deceased spouse were ambivalent (high positivity and high negativity) had much poorer overall cognitive functioning than widowed individuals who had aversive (low positivity and high negativity) relationships with their deceased spouse.

The same pattern emerged for episodic memory. Notably, for episodic memory, scores were lower among widowed individuals who had an ambivalent relationship (high positivity and high negativity) with their deceased spouse than among widowed individuals whose relationship with their deceased spouse was supportive (high positivity and low negativity). The findings corroborated the conclusion of previous research that pre-loss relationship quality matters for the adaptation process of bereavement (Pruchno et al., 2009). Research has shown that stress response systems may be one of the mechanisms driving the association between bereavement and cognitive functions. For example, Ong and colleagues (2012) found that spousal

loss was linked to HPA axis dysregulation. Given the empirical evidence suggesting the links between HPA axis dysregulation and increased risk of morbidity (Rosmond & Björntorp, 2000; Xiong & Zhang, 2013) and the links between physical/mental health and cognitive functions (Elderkin-Thompson et al., 2011; Karlamangla et al., 2014;; Kimhy et al., 2013), this recent evidence of endocrinal stress responses following bereavement provides an explanation of the increased risk in cognitive functioning after spousal loss.

This pattern of results—spousal loss having a stronger negative impact on episodic memory for those who had an ambivalent relationship than for those who had an aversive relationship or even a supportive relationship—can be understood within the framework of ambivalence theory (Connidis & McMullin, 2002). This theoretical perspective acknowledges that people may simultaneously have positive and negative feelings toward someone such as an intimate partner or relative. Further, previous studies have found that those who have close intimate relationships are more likely to provide care to their partners (Collins et al., 2010; Min et al., 2020), but providing care takes a physical and emotional toll in the form of a caregiving burden (Khalaila & Cohen, 2016). Thus, it is likely that spousal loss may be more impactful for those who had a close relationship than for those who had negative relationship (Schulz et al., 2001). The current findings are also congruent with the SAD approach, which posits that ambivalent relationships have adverse health impacts (Holt-Lunstad & Uchino, 2019), which underlines the importance of considering multidimensionality of marital quality in terms of its influence on health. In addition, the assumption of attachment theory suggest a possible pathway through which marital quality prior to the death of the spouse functions as a precursor of the cognitive functioning after spousal loss, with the sequential link of spousal loss or loss of attachment figure, psychological pathology, and cognitive decline or impairment.

Future studies that examine the association between caregiving status and relationship quality prior to spousal death and biomarkers following the experience of spousal bereavement would improve understanding about the dynamics of the associations between the death of spouse and cognitive outcomes over time. Clinicians and family members should take care to provide support not only to those who had supportive relationship with their partners but also to those who had ambivalent feelings toward their spouses prior to the loss.

Limitations and future research

Certain limitations of this study should be acknowledged. First, although the study controlled the baseline cognition score, which allow us to examine differences in changes in cognition over time among widowed and non-widowed adults (before and after spousal loss for the former group), the study utilized only two time points with a 9-year gap, on average. Thus, the study does not capture the trajectory of cognitive functioning between these two time points. Future research using data from multiple time points could mitigate this limitation and enhance the scholarly understanding of the association between spousal loss and changes in cognitive functioning. Second, as noted above, we did not consider the caregiving status of respondents, which may play a role in the association between pre-loss relationship quality and changes in cognitive functioning for those who experienced the death of their spouses. Future studies investigating the dynamics of relationship quality and caregiving trajectories before spousal loss may shed light on the associations between relationship quality, widowhood, and cognition. Third, because we used secondary data from MIDUS, we could not examine the potential moderation effects of characteristics of spousal death, including cause of death. Given the impact of such characteristics on the outcomes of bereaved individuals, future studies should include measures of such characteristics.

Conclusion

Previous research found that intervention programs targeting specifically vulnerable groups were efficient and beneficial to the bereaved, whereas interventions targeting bereaved persons in general had fewer benefits (Schut et al., 2001). The findings of the present study add two characteristics to the list of risk factors for cognitive decline after spousal loss - being a men and having ambivalent relationships with the spouse (i.e. high positivity and high negativity simultaneously) prior to the widowhood. Interventions designed to focus on these particularly vulnerable groups with the goal of improving cognitive functioning would be beneficial.

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