

# Investigating Heterogeneity in the Relationship Between Marital Satisfaction and Cognitive Health by Gender and Across the Cognitive Function Distribution

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Decision Editor: Steven M. Albert, PhD MS, FGSA

## Abstract

**Background and Objectives:** Marital satisfaction has been established as an essential factor for promoting health and well-being in older adults. However, it is unclear whether marital satisfaction is also associated with cognitive health in this population. This study aimed to investigate the longitudinal association between marital satisfaction and cognitive function, while also exploring variations in this relationship by gender and across the cognitive function distribution.

**Research Design and Methods:** This study used 6 waves of the Korean Longitudinal Study of Ageing (KLoSA) and employed gender-stratified unconditional quantile regression (UQR) models with fixed effects (FE) to estimate the association between marital satisfaction and cognitive function across different quantiles of the cognitive function distribution. FE models controlled for unobserved individual-level confounders such as genetics, cognitive and noncognitive skills, and early childhood social and cultural background.

**Results:** The results of this study revealed that marital satisfaction was positively associated with cognitive function ( $b = 0.305$ ), and this association was stronger in older men than in older women ( $b = 0.392$  for older men vs  $b = 0.181$  for older women). The UQR-FE models suggested that stronger association between marital satisfaction and cognitive function was observed among older men with lower cognitive function ( $b = 0.817$  for 10th percentile vs  $b = 0.118$  for 90th percentile). Among older women, no clear patterns of heterogeneity were found across the cognitive function distribution.

**Discussion and Implications:** The findings of this study highlight a significant degree of heterogeneity in the relationship between marital satisfaction and cognitive function among older men, with stronger associations observed in the lower percentiles of the cognitive function distribution. Interventions aimed at improving marital quality could be an effective strategy for promoting cognitive health in older adults, with an approach tailored to the individual's characteristics.

**Translational Significance:** There is a scarcity of empirical evidence regarding the relationship between marital satisfaction and cognitive health in older adults. The results of this study reveal a positive association between marital satisfaction and cognitive function, with the strongest association observed in older men with lower cognitive function. These findings highlight the potential importance of targeting marital quality in efforts to improve the cognitive health of older adults, particularly older men with cognitive impairment.

**Keywords:** Cognitive function, Fixed effects model, Gender, Marital satisfaction, Quantile regression

## Background and Objectives

The social integration theory explains how macro-social factors, such as the degree of social cohesion and integration, can influence the suicide and mortality rates of a country (Berkman et al., 2000). Social interactions and relationships are essential for health and well-being, and their effects are long-lasting and cumulative throughout life (Berkman et al., 2000). Recent studies have focused on the influence of relationship quality on health, moving beyond the structural aspects of social networks, such as marital status and network size (Antonucci et al., 2014). For instance, qualitative aspects of network ties, such as satisfaction with relationships, have

shown significant associations with the risk of subsequent dementia (Amieva et al., 2010). The context of relationship quality is crucial for older adults, who prioritize emotional satisfaction and therefore limit their social interactions to close partners or relatives (Carstensen, 1992). Likewise, as people age, spousal relationships and the perceived quality of marriage may become more influential in determining health and well-being than other network ties (Carr et al., 2014; Yoon et al., 2022).

Cognitive aging, which can occur via pathological and non-pathological trajectories, is a prevalent health concern among older adults (Salhouse, 2019). Certain cognitive functions

Received: April 27 2023; Editorial Decision Date: July 15 2023.

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may decline with age, and chronic exposure to cognitive impairment risks may promote pathological conditions such as dementia (Glymour & Manly, 2008; Salthouse, 2019). With a growing body of research uncovering the social determinants of cognitive health (i.e., attributes of social networks; Nie et al., 2021), understanding how marital relationships may influence cognitive function has become crucial for preventing the onset of dementia in older adults. A recent longitudinal study demonstrated that marital quality predicts cognitive health (Liu et al., 2021). This study found that initial positive and negative marital quality were associated with better and worse initial cognition of older men and women, respectively, although the rate of cognitive decline was significant only among men. Although marital satisfaction is a global evaluation of marriage, little research has examined its association with cognitive function. As low marital satisfaction is the final common pathway through which marital maladjustment is expressed (Fincham & Bradbury, 1987), it is essential to investigate how it is associated with cognitive function in older adults in relation to various individual characteristics.

Several mechanisms have been proposed to explain the association between marital satisfaction and cognitive function. First, low marital satisfaction tends to create chronic and adverse stress, which may increase the risk of cognitive impairments and susceptibility to Alzheimer's disease (Kiecolt-Glaser & Newton, 2001; Rothman & Mattson, 2010). Similarly, unpleasant emotional states that may result from low marital satisfaction can impair working memory capacity, which is related to daily information processing tasks (Figueira et al., 2017). Moreover, older adults with marital problems and low marital satisfaction are more likely to adopt poorer health behaviors (Whisman et al., 2006). For instance, increased alcohol consumption can damage the fronto-cerebellar circuit of the brain, which is responsible for regulating and controlling cognitive function (Hayes et al., 2016). In addition, lower marital satisfaction may limit spousal interaction, which is associated with cognitive stimulating behaviors. Marital satisfaction is found to be a significant predictor of spousal interactions, such as enjoying leisure activities and participating in social events together (White, 1983). Couples who are dissatisfied with their marriage are less likely to spend time together and communicate (Reissman et al., 1993), thereby increasing the risk of declines in cognitive function.

The association between marital satisfaction and cognitive function may vary along different levels of cognitive ability. The cognitive reserve theory posits that the rate and pattern of cognitive declines depend on the brain's capacity to resist neural damage (Stern, 2002). Individuals with high cognitive reserve maintain normal cognitive function despite the presence of dementia pathology, whereas those with low cognitive reserve display a stronger association between brain volume and cognitive function (Ince, 2001; Perry et al., 2022). Social determinants of cognitive reserve include education, occupational complexity, leisure and physical activities, and social network (Perry et al., 2022; Stern et al., 2020). Therefore, older adults with lower cognitive reserve tend to have lower educational levels or small network ties that limit access to diverse social stimuli. They may be more sensitive to changes in marital satisfaction as they become more dependent on their spouses and lack independent coping abilities to sustain marital distress (Jennings et al., 2022). In contrast, the effects

may be less pronounced in older adults with higher cognitive reserves, possibly due to their greater resistance to marital dissatisfaction or the presence of a ceiling effect. Similarly, the stress and coping literature suggests that the positive effects of marital satisfaction may be most pronounced when individuals are dealing with higher levels of cognitive impairment because social resources tend to have a particularly significant impact during times of heightened distress (Folkman & Moskowitz, 2004).

Research on the relationship between marital quality and health has produced conflicting findings regarding gender differences. According to Kiecolt-Glaser and Newton (2001), men typically display greater hormonal responses to stressors, although women are more sensitive to marital distress due to their interdependent self-construal and greater attunement to emotional changes in dyadic relationships. However, other studies testing gender moderation subsequently found the gender difference to be small or insignificant, albeit in the direction of greater magnitude for women (Robles et al., 2014). These conflicting findings suggest that gender heterogeneity may result from complex interactions between biological traits and social roles for both men and women (Robles et al., 2014). In South Korea (hereafter, Korea), where institutionalized forms of marriage are still prevalent, women typically provide emotional support and monitor their husbands' health as family caregivers (Kim & Woo, 2022). As a result, men's health and well-being may be more dependent on the support of their wives, and an increase in marital dissatisfaction may be more detrimental to men. In addition, men tend to have a smaller circle of intimate relationships, although women have access to a larger network of support that can mitigate the negative effects of marital dissatisfaction (Antonucci et al., 2014). Hence, in the context of Korea, the association between marital satisfaction and cognitive health may be greater for older men than for older women.

Using seven waves (spanning 12 years) of the Korean Longitudinal Study of Ageing (KLoSA), the present study examines the longitudinal relationship between marital satisfaction and cognitive function among older adults. To control for time-invariant individual heterogeneity, this study uses fixed effects (FE) models to estimate the within-subject change in cognitive function associated with the within-subject change in marital satisfaction. This allows us to obtain a more credible estimate of the association between marital satisfaction and cognitive function. Gender-stratified FE models are employed to examine potential gender differences in the association between marital satisfaction and cognitive function. This analysis will expand on previous research that did not consider gender differences when examining the cognitive health consequences of marital quality. In addition, to explore the possibility that the effects of marital satisfaction on cognitive function vary across the cognitive function distribution, this study uses UQR models. These models estimate the effects of marital satisfaction in different quantiles of cognitive function. This analysis will support interventions that offer personalized services to individuals with diverse needs, particularly those who are at a high risk of cognitive decline.

## Research Design and Methods

### Data

The data come from the Korean Longitudinal Study of Ageing (KLoSA), a longitudinal, nationally representative

study of adults in Korea aged 45 or older. Since 2006, the survey has been conducted biennially to gather data on various factors such as socioeconomic status, mental health, and physical health among older adults. The sampling frame for the KLoSA was constructed based on enumeration districts obtained from the Population and Housing Census of Korea Statistics. Survey participants were recruited through a multi-stage stratified sampling process that considered their housing type (apartment or regular housing) and geographical location (urban or rural). The current study used longitudinal data collected over a period of 12 years, spanning from 2006 (Wave 1) to 2018 (Wave 7).

Out of a total of 11,844 observations across seven waves for those who were 65 years or older and currently married, 598 observations with missing values on cognitive function (5%) were excluded. Additionally, 13 observations were dropped due to missing values on independent and control variables used in the study. Consequently, 11,233 observations were used for analysis (2,539 participants for Wave 1, 2,075 for Wave 2, 1,740 for Wave 3, 1,542 for Wave 4, 1,316 for Wave 5, 1,108 for Wave 6, and 913 for Wave 7). Due to the unbalanced panel data structure, the final analytic sample size was 2,573 (1,550 men and 1,023 women). All participants provided informed consent, and the data were anonymized prior to being uploaded to a publicly accessible database. The study was granted exemption from ethical approval as it relied on secondary analysis of publicly available data (KUIRB-2020-0194-01).

## Measures

### Dependent variable

Cognitive function was evaluated using K-MMSE, a measure that has been validated by prior research (Kim et al., 2010). This assessment tool covers various domains of cognitive function, such as memory recall, attention, and visual construction, and the scores range from 0 to 30. In supplementary analyses, we also used cognitive impairment as a criterion, defined as a K-MMSE score of 23 or lower (Kukull et al., 1994), and obtained results that were substantially similar to those presented in this study (Supplementary Table 1).

### Independent variable

Marital satisfaction was assessed using a single-item measure derived from the following question (Choi, 2021): "In general, how satisfied are you with your marriage?" Respondents were required to rate their level of marital satisfaction on a scale from 0 to 100, with a 10-point range. Higher scores indicated greater marital satisfaction. To make interpretation easier, the score of marital satisfaction was standardized to have a mean of zero and a standard deviation (SD) of 1.

### Control variables

A comprehensive set of control variables were used in the study. Time-constant covariates included gender, educational attainment (divided into four categories: elementary or lower, middle school, high school, and college or higher), and the number of children. Time-varying covariates included age, age squared, household size, household income (divided into quartiles), homeownership (determined by living in owner-occupied or privately rented housing), economic activity (determined by whether the respondent was economically active), region of residence (divided into three categories: large city,

small city, and rural area), the number of chronic diseases (measured by the sum of 10 doctor-diagnosed chronic diseases including hypertension, diabetes mellitus, cancer or a malignant tumor, chronic lung disease, liver disease, heart disease, cerebrovascular disease, psychological disease, arthritis or rheumatoid arthritis, and prostatic disease), and activities of daily living score (determined by whether the respondent reported needing assistance to perform at least one of the following seven activities: dressing oneself, washing one's face, bathing oneself, eating, going out of the room, using a toilet, and regulating urine and bowel movements).

## Statistical Analysis

When examining the relationship between marital satisfaction and cognitive function, conventional pooled ordinary least squares (OLS) models may produce biased estimates due to unobserved individual heterogeneity. For example, individual-level characteristics such as genetics, cognitive and noncognitive abilities, and early childhood background, which are associated with the quality of marriage, may also predict cognitive function. To account for potential bias resulting from confounders and selection processes, this study used longitudinal data to estimate FE regression models. FE models eliminate observed and unobserved time-constant confounding factors at the individual level that may affect both marital satisfaction and cognitive function. The FE models can be expressed in the following form:

$$Y_{it} = \beta_0 + \beta_1 MS_{it} + Z_{it}\delta + \varphi_t + \nu_i + \varepsilon_{it} \quad (1)$$

where the dependent variable, represented by  $Y_{it}$ , is the cognitive function of the individual  $i$  at time  $t$ . The main explanatory variable is marital satisfaction, denoted by  $MS_{it}$ . The regression coefficient  $\beta_1$  estimates the within-individual difference in cognitive function associated with marital satisfaction. The set of time-varying control variable is represented by  $Z_i$ . To account for potential year-specific effects, year FE (represented by  $\varphi_t$ ) are controlled. In FE models, the individual-specific, time-invariant error term,  $\nu_i$ , is treated as a fixed constant, and thus, all between-person variance is omitted from the models (Vaisey & Miles, 2017). The idiosyncratic error term that varies with people and time is represented by  $\varepsilon_{it}$ . Robust standard errors were used in FE models.

RE models, an alternative to FE models, assume that  $\nu_i$  is drawn from a random variable with constant variance. In other words, these models assume that the unobserved person-specific differences are uncorrelated with the regressors in the model. However, using the Hausman test (1978), we found evidence that the assumption of the RE model was violated. Therefore, FE models are preferred ( $p < .001$ ). That said, we present estimates from both OLS and RE models alongside FE estimates for comparison (Morgan & Winship, 2007). This comparison allows us to evaluate the extent to which unobserved time-constant confounding variables may bias the estimates.

To investigate the heterogeneity in the relationship between marital satisfaction and cognitive function across the cognitive function distribution, we estimate UQR models using an individual FE approach to account for individual-level heterogeneity (Borgen, 2016; Kim & Park, 2023b). This method provides consistent estimates of the effect of marital satisfaction on cognitive function at virtually any quantile of the unconditional distribution, and can help reveal heterogeneity that may be obscured by conventional FE models. To estimate

**Table 1.** Descriptive Statistics, Korean Longitudinal Study of Ageing (KLoSA), 2006

Variable	Total		Min	Max	Women	Men	Gender diff.
	M or prop.	SD			M or prop.	M or prop.	p-value
Dependent variable							
Cognitive function (K-MMSE)	24.002	5.546	0.0	30.0	22.607	24.915	*
Independent variable							
Marital satisfaction	69.537	20.926	0.0	100.0	66.096	71.810	*
Control variables							
Age	71.398	5.183	65.0	93.0	70.515	71.981	*
Women	0.398		0.0	1.0	1.000	0.000	
Education							
Elementary or lower	0.639		0.0	1.0	0.808	0.527	
Middle school	0.120		0.0	1.0	0.091	0.140	
High school	0.166		0.0	1.0	0.086	0.219	
College or higher	0.074		0.0	1.0	0.015	0.114	
Number of children	3.936	1.527	0.0	9.0	4.135	3.805	*
Household size	2.713	1.268	1.0	9.0	2.739	2.696	
Household income							
Q1	0.340		0.0	1.0	0.364	0.324	
Q2	0.309		0.0	1.0	0.296	0.317	
Q3	0.183		0.0	1.0	0.160	0.198	
Q4	0.072		0.0	1.0	0.074	0.070	
Missing	0.096		0.0	1.0	0.106	0.090	
Homeownership	0.801		0.0	1.0	0.800	0.803	
Economic activity	0.230		0.0	1.0	0.129	0.297	*
Place of residence							
Large city	0.407		0.0	1.0	0.406	0.407	
Small city	0.287		0.0	1.0	0.287	0.287	
Rural area	0.306		0.0	1.0	0.307	0.306	
Number of chronic diseases	1.044	1.037	0.0	6.0	1.169	0.961	*
ADLs	0.071	0.257	0.0	1.0	0.064	0.076	
N	2,573				1,023	1,550	

Notes. ADLs = activities of daily living; M = Mean; SD = standard deviation. Summary statistics are based on the 2006 data (Wave 1). Chi-squared tests for categorical variables and *t* tests for continuous variables were performed.

\*Differences between women and men are statistically significant,  $p < .05$ .

UQR, we replaced the outcome variable in the regression model with the recentered influence function (Firpo et al., 2009):

$$\text{RIF}(Y; q_\tau, F_\tau) = \frac{\tau - 1 \{Y \leq q_\tau\}}{f_Y(q_\tau)} \quad (2)$$

where  $q_\tau$  represents the value of the dependent variable,  $Y$ , at the  $\tau$  quantile.  $f_Y$  refers to the cumulative distribution function of  $Y$ , and  $f_Y(q_\tau)$  represents the density of  $Y$  at  $q_\tau$ . The indicator function,  $1 \{Y \leq q_\tau\}$ , determines whether the individual's value of the dependent variable,  $Y$ , is below  $q_\tau$ . The UQR framework enables us to provide estimates of the effect of marital satisfaction at different levels of cognitive function, as indicated by quantiles of the unconditional grip strength distribution. In other words, it explicitly accounts for the possibility that the influence of marital satisfaction on cognitive function for those who are at, say, the 25<sup>th</sup> percentile of the distribution may significantly differ from the influence for those at the 90<sup>th</sup> percentile.

## Results

Table 1 displays the characteristics of the sample, which consisted of 2,573 participants from Wave 1, separately by gender. About 39.8% of respondents were female, with a mean age of 71.398. The majority of respondents (63.9%) had an elementary education or lower. The mean cognitive function score was 24.002 with an *SD* of 5.546, although the mean (unstandardized) marital satisfaction score was 69.537 with a *SD* of 20.926. Significant gender differences were observed in some key measures of the study. Men demonstrated higher cognitive function (24.915 vs 22.607) and higher marital satisfaction (71.810 vs 66.096). Men also tended to be more advantaged socioeconomically than women, reporting higher educational attainment and household income. Moreover, women reported a higher number of doctor-diagnosed chronic diseases than men.

In Table 2, we present estimates of the association between marital satisfaction and cognitive function. We first present POLS estimates in Column 1, followed by RE and FE models

**Table 2.** Regression Models of Cognitive Function on Marital Satisfaction, by Gender

Variable	(1)	(2)	(3)	(4)	(5)
	Cognitive function	Cognitive function	Cognitive function	Cognitive function	Cognitive function
Sample	Total	Total	Total	Women	Men
Estimation model	POLS	RE	FE	FE	FE
Time-constant controls	Yes	Yes	No	No	No
Time-varying controls	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Marital satisfaction	0.691*** [0.605,0.777]	0.433*** [0.340,0.526]	0.305*** [0.202,0.408]	0.181* [0.019,0.343]	0.392*** [0.259,0.524]
N (Observations)	11,233	11,233	11,233	4,346	6,887
N (Individuals)	2,573	2,573	2,573	1,023	1,550

Notes: The 95% confidence intervals are in brackets. Robust standard errors were used. Time-constant controls include gender, education, and number of children. Time-varying controls include age (linear and squared), household size, household income, homeownership, economic activity, region of residence, number of chronic diseases, and ADLs. FE = fixed effect; POLS = pooled ordinary least squares; RE = random effect.

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

in Column 2 and Column 3, respectively. To explore possible gender differences, we estimate separate models for each gender in Column 4 for women and Column 5 for men.

In Column 1, the results of POLS estimates show that marital satisfaction is associated with an increase in cognitive function ( $b = 0.691$ ), even after adjusting for a set of time-constant and time-varying covariates. Similarly, RE estimates produce very comparable results ( $b = 0.433$ ), although the estimated coefficient is somewhat reduced. The preferred FE estimates indicate that the positive association between marital satisfaction and cognitive function is robust when accounting for unobserved individual-level heterogeneity ( $b = 0.305$ ). However, it is important to note that accounting for unobserved individual-level heterogeneity attenuates the observed association by approximately 56% ( $[0.691 - 0.305]/0.691$ ). This suggests that over half of the association between marital satisfaction and cognitive function may be driven by unobserved confounding factors.

Gender-stratified models suggest that the association between marital satisfaction and cognitive function is more pronounced among men than women ( $b = 0.392$  vs  $b = 0.181$ ), and this gender difference is statistically significant ( $p < .05$ ). To interpret, a one-SD increase in marital satisfaction is associated with about 3% of a one-SD increase in cognitive function (i.e.,  $0.181/5.546$ ) for women and 7% of a one-SD increase in cognitive function (i.e.,  $0.392/5.546$ ) for men.

Similar to many longitudinal studies involving older participants, the KLoSA dataset is also prone to attrition due to various reasons, including mortality and loss to follow-up. To assess the potential impact of attrition-related selection bias on the estimated relationship between marital satisfaction and cognitive function, we conducted a sensitivity analysis using inverse probability weighting (IPW). By using IPW to adjust for attrition bias, we determined that our results remain robust (Supplementary Table 2).

Table 3 presents the results from UQR models with FE for the 10th, 30th, 50th (median), 70th, and 90th percentiles in the cognitive function distribution by gender (Panel A for the total, Panel B for women, and Panel C for men). In the total sample (Panel A), a more substantial positive association was found between marital satisfaction and cognitive function at the lower percentiles in the cognitive function distribution;

marital satisfaction is associated with an increase in cognitive function by 0.543 (10th), 0.321 (30th), 0.179 (50th), 0.206 (70th), and 0.090 (90th). In Panel B, no association was found between marital satisfaction and cognitive function for women at any point in the cognitive function distribution, except for the 50th percentile ( $b = 0.271$ ). Similar to the total sample, for men, the positive association between marital satisfaction and cognitive function was more significant at the lower percentiles in the cognitive function distribution: 0.817 (10th), 0.497 (30th), 0.193 (50th), 0.262 (70th), and 0.118 (90th).

To illustrate the results about gender differences, we plotted the estimates for marital satisfaction along multiple points across the cognitive function distribution, separately for women and men (Figure 1). The black line and gray shaded region depict the estimates from the UQR models and their corresponding 95% confidence intervals. The dashed line represents the FE mean model estimates. The plot for women reveals no discernable patterns in the association between marital satisfaction and cognitive function based on the cognitive function distribution. For men, the plot suggests a downward trend: significant positive associations are present at the lower end of the distribution and diminish towards the null as percentile levels rise.

## Discussion and Implications

This study aimed to investigate the association between marital satisfaction and cognitive function in older adults, with a focus on examining potential gender differences. The FE estimates indicate a positive association between marital satisfaction and cognitive function, even after accounting for unobserved individual-level confounders. In other words, older adults with lower marital satisfaction tend to have less advanced cognitive function than those with higher marital satisfaction. However, the results show a significantly stronger association among older men with lower cognitive function, suggesting that the effects of marital satisfaction on cognitive function may vary by gender and across the cognitive function distribution. Overall, this study contributes to the existing literature on marital quality and cognitive health by investigating the association between marital satisfaction and cognitive function while examining heterogeneous effects.

**Table 3.** Unconditional Quantile Regression Models of Cognitive Function on Marital Satisfaction, By Gender

Variable	(1)	(2)	(3)	(4)	(5)
	Cognitive function	Cognitive function	Cognitive function	Cognitive function	Cognitive function
Estimation model	FE	FE	FE	FE	FE
Time-constant controls	No	No	No	No	No
Time-varying controls	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Percentile	10 <sup>th</sup>	30 <sup>th</sup>	50 <sup>th</sup>	70 <sup>th</sup>	90 <sup>th</sup>
<i>Panel A. Total</i>					
Marital satisfaction	0.543 <sup>***</sup> [0.270,0.817]	0.321 <sup>***</sup> [0.163,0.479]	0.179 <sup>**</sup> [0.048,0.310]	0.206 <sup>***</sup> [0.099,0.313]	0.090 <sup>*</sup> [0.003,0.178]
N (observations)	11,233	11,233	11,233	11,233	11,233
N (individuals)	2,573	2,573	2,573	2,573	2,573
<i>Panel B. Women</i>					
Marital satisfaction	0.274 [-0.121,0.668]	0.111 [-0.142,0.363]	0.271 <sup>*</sup> [0.052,0.489]	0.091 [-0.120,0.301]	0.028 [-0.145,0.202]
N (observations)	4,346	4,346	4,346	4,346	4,346
N (individuals)	1,023	1,023	1,023	1,023	1,023
<i>Panel C. Men</i>					
Marital satisfaction	0.817 <sup>***</sup> [0.375,1.259]	0.497 <sup>***</sup> [0.297,0.696]	0.193 <sup>**</sup> [0.052,0.334]	0.262 <sup>***</sup> [0.139,0.385]	0.118 <sup>*</sup> [0.018,0.218]
N (observations)	6,887	6,887	6,887	6,887	6,887
N (individuals)	1,550	1,550	1,550	1,550	1,550

Notes: The 95% confidence intervals are in brackets. Robust standard errors were used. Time-constant controls include gender, education, and number of children. Time-varying controls include age (linear and squared), household size, household income, homeownership, economic activity, region of residence, number of chronic diseases, and ADLs. FE = fixed effect.

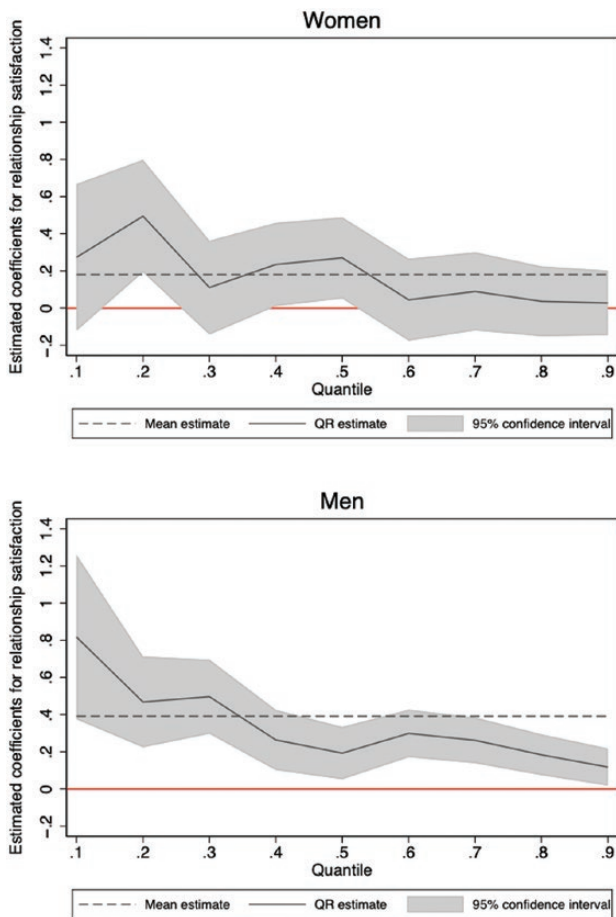
\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

The findings of our study draw on underlying biological and behavioral mechanisms that link marital satisfaction to cognitive function. Low marital satisfaction may generate significant risk factors for cognitive impairment, including depressive symptoms, chronic stress, and generalized anxiety disorder (Bielak et al., 2011; Dew et al., 2007; Kiecolt-Glaser & Newton, 2001; Rothman & Mattson, 2010; Whisman, 2007). Chronic negative stress activates the hypothalamic-pituitary-adrenocortical axis, resulting in an increase in the release of steroid hormones that impair memory function (Rothman & Mattson, 2010). In addition to these biological mechanisms, low marital satisfaction may lead to behavioral problems that exacerbate cognitive impairment. Although some studies have demonstrated that conflicts between couples may stimulate cognitive function, our findings suggest that individuals who are dissatisfied with their marriage are more likely to adopt behaviors that adversely affect cognitive function. For instance, a dissatisfying marriage may lead to a higher prevalence of substance use disorders, especially alcohol use, which may induce brain damage (Hayes et al., 2016; Whisman, 2007). Furthermore, people with low marital satisfaction may engage in fewer interactive behaviors, which may limit their social and cognitive activities and exacerbate declines in cognitive function (Brown et al., 2016; Kirchier, 1988).

In this study, we observed a positive association between marital satisfaction and cognitive functions, with varying impacts across different levels of cognitive ability. Specifically, the results from the UQR model indicated that older adults with lower cognitive ability were most significantly affected

by changes in marital satisfaction. For the total sample, the estimated coefficient for marital satisfaction was highest among those in the lowest percentile (10<sup>th</sup>) of cognitive ability, indicating that individuals with lower cognitive ability were more vulnerable to the adverse effects of marital dissatisfaction than those with higher cognitive ability. This heterogeneity can be explained by the cognitive reserve theory, which emphasizes the combined role of brain and social capacity in mitigating neural damage (Perry et al., 2022; Stern, 2002). Previous research has suggested that cognitive reserve and social capital can offset the detrimental effects of psychological stress on cognitive function (Ihle, 2018). In addition, the stress and coping literature suggests that the positive effects of marital satisfaction on cognitive function may be particularly significant for individuals who are at a heightened risk of cognitive impairment due to their greater need for assistance, such as emotional support, practical help, companionship, and cognitive stimulation (Folkman & Moskowitz, 2004). Therefore, as suggested by our results, the role of marital satisfaction on the cognitive function of older adults is more consequential for those with lower cognitive reserve.

After applying gender stratification to our UQR model, we found that heterogeneous effects across the cognitive function distribution are largely driven by older men, rather than older women. This gender difference may reflect the fact that positive aspects of marriage, such as support and companionship, have a stronger effect on marital satisfaction for men compared with women (Boerner et al., 2014). Particularly for older men, who tend to rely more heavily on their marital relationship for emotional support and companionship, the



**Figure 1.** Unconditional quantile and mean estimates of the association between marital satisfaction and cognitive function, by gender.

positive aspects of marriage, such as marital satisfaction, may have a more substantial impact on their cognitive function. Especially in the social context of Korea, older men tend to depend more on their wives for emotional and social support, as they are the major kin-keepers and caregivers of the family (Ermer & Proulx, 2020; A. Kim & Woo, 2022). Previous studies have also shown that older men rely more on their spouses for access to social networks and benefit more from family support compared with older women (Antonucci et al., 2014; Ermer & Proulx, 2020). Consequently, the results of this study suggest that older men are more susceptible to changes in marital quality, such as marital satisfaction, due to their reliance on their relationship with their spouses (Kim & Park, 2023a; Yoon et al., 2022).

This study has some limitations that must be acknowledged. First, marital satisfaction ratings were used as the sole measure of marital quality. Future studies may include additional dimensions of marital quality to determine which aspects of marriage have significant associations with health (Fincham & Bradbury, 1987). Second, the restriction of our sample to community-dwelling older adults may limit the generalizability of our study's findings. This is because older adults who are hospitalized or residing in care facilities might be lost to follow-up, which could potentially impact the results. Excluding institutionalized individuals from our analysis may result in an underestimation of the effects of marital satisfaction on cognitive function because they are more likely to

have lower cognitive function. Consequently, our estimates could be considered conservative.

Third, although FE models can effectively control for time-constant confounders, both observed and unobserved, the presence of time-varying confounders can still bias FE estimates (Wooldridge, 2010). Although we controlled for a set of time-varying covariates in our study, this approach cannot fully address the problem because it cannot account for unobserved time-varying confounders. Indeed, there may be time-varying characteristics that could confound the association between marital satisfaction and cognitive function. For example, depressive symptoms are likely to be linked with cognition and can also impact one's perception of marital satisfaction. Although controlling for depressive symptoms can help reduce concerns regarding omitted variable bias, it is crucial to recognize the lack of clear temporal ordering between marital satisfaction and depressive symptoms. It is plausible that depressive symptoms may mediate, rather than confound, the effect of marital satisfaction on cognitive function. Individuals with lower levels of marital satisfaction may be more prone to experiencing depressive symptoms, which could subsequently lead to a decline in cognitive function. In this context, including depressive symptoms as an additional covariate may introduce overcontrol bias (Elwert & Winship, 2014). Although our supplementary analyses indicate the robustness of our results when controlling for depressive symptoms (Supplementary Tables 3 and 4), given the ambiguity in the temporal ordering of variables, we opted for a parsimonious set of plausibly exogenous covariates in this study. Future research may consider employing a cross-lagged panel model to better investigate the bidirectional relationship between marital satisfaction, depressive symptoms, and cognitive function.

Despite these limitations, this study has several strengths that contribute to the existing literature on marital satisfaction and health. First, we used cognitive function as an indicator of older adults' health, thereby expanding the health consequences of marital satisfaction beyond physical and mental health outcomes, which has been a focus of prior research. Given the growing prevalence of dementia in many aging societies, our findings on the significance of marital satisfaction in cognitive health could serve as evidence to inform policies for promoting healthy aging. Second, the use of FE models to eliminate unobserved time-invariant individual-level heterogeneity increases the reliability and robustness of our findings. This adds rigor to the existing literature on the relationship between marital satisfaction and health. Third, our study utilized theoretical frameworks to elucidate the heterogeneity in the effects of marital satisfaction on cognitive function across the cognitive function distribution and by gender, thus enhancing the interpretation of our findings. Fourth, this study relied on data that were nationally representative of older adults in Korea and collected over a period of 12 years. This allowed us to apply our findings to the general population and enhances the generalizability of our results.

The study's findings provide several policy implications. Overall, the positive association between marital satisfaction and cognitive function underscores the need to improve the quality of marriage for both genders. To improve marital satisfaction, it is crucial to enhance interpersonal processes, such as spouses' behaviors and expressions, and create social environments that foster emotionally

supportive marital relationships (Bradbury et al., 2000). In addition, considering the heterogeneity in the association by gender and cognitive ability, special attention should be paid to older men with low cognitive ability. Research has shown that older men in Korea who transitioned to the role of caregivers reported increased marital satisfaction in later life (Choi, 2021). This suggests that providing care may increase men's autonomy and independence in relationships, making them more resilient to changes in marital quality. Moreover, assisting older men with low cognitive functioning by providing communication or interpersonal skills training or marital counseling can also be crucial in helping them improve their relationship with their wives. Social isolation among men must not be overlooked, as it can lead to boredom, loneliness, and depression, which increase the risk of cognitive decline and susceptibility to marital dissatisfaction (Farina et al., 2018; Kim & Park, 2023c). Therefore, integrated efforts to increase positive interaction between spouses may be more effective and beneficial for enhancing men's cognitive reserve and marital satisfaction simultaneously.

In conclusion, our study provides valuable insights into the relationship between marital satisfaction and cognitive function among older adults, contributing to the existing body of knowledge on marriage and health. Our results demonstrate that the positive association between marital satisfaction and cognitive function is more pronounced among older men than older women. Additionally, we have documented a substantial degree of heterogeneity in this relationship among older men, with the strongest associations observed in the lower percentiles of the cognitive function distribution. Hence, these findings suggest that interventions aimed at enhancing marital quality may be an effective strategy for improving cognitive health in older adults, with the specific approach tailored to the characteristics of the individual.

## Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

## Funding

None.

## Conflict of Interest

None.

## Data Availability

The KLoSA data are available at <https://survey.keis.or.kr/eng/klosa/klosa01.jsp> with the permission of the Korea employment Information Service.

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