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Marital Status, Marital Quality, and Heart Rate Variability in the MIDUS Cohort

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Abstract

Previous research has shown marital status and marital quality are consistent predictors of health outcomes, including cardiovascular disease and mortality. To better understand the relationship between marital status, marital quality, and cardiovascular health, we examined how marital status and marital quality were associated with an early indicator of deteriorating cardiovascular health, high-frequency heart rate variability (HF-HRV). This study uses data from the National Survey of Midlife in the United States (MIDUS) Biomarker Sub-study ($n = 907$) to examine differences in HF-HRV by traditional marital status categories (married, divorced, widowed, and never married), as well as further differentiating between the continuously married and remarried. In addition, links were also examined between HF-HRV and changes in marital quality (marital satisfaction, support, strain), among individuals in long-term marriages. No significant differences in HF-HRV were observed between married persons and those widowed, divorced, and never married. However, continuously married individuals had higher HF-HRV than remarried adults. Increases in marital satisfaction and support over 10 years were associated with higher HF-HRV, while increased marital strain over 10 years was associated with lower HF-HRV. Higher HF-HRV among the continuously married compared to the remarried suggests previous marital disruptions may have lasting effects on cardiovascular health, or that there may be other differences between the remarried versus those who remain married to the same person. Associations between marital quality and HF-HRV suggest variations in the quality of one's marriage may affect cardiovascular health.

Keywords

Marriage; Marital Quality; Heart Rate Variability; HRV; MIDUS

There is clear evidence linking marital status to cardiovascular disease (CVD) and mortality, with married individuals living longer than their non-married counterparts (e.g., Johnson, Backlund, Sorlie, & Loveless, 2000; Molloy, Stamatakis, Randall, & Hamer, 2009; Rendall, Weden, Favreault, & Waldron, 2011). However, despite the apparent health benefits of marriage, the state of being married may not always confer better health. For example, less supportive and satisfying marriages may potentially serve to undermine health (Seeman, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Although less supportive or higher conflict marriages may be expected to be short-lived, many people remain in low-quality marriages for many years, which could contribute to stress-related wear-and-tear on physiological systems (McEwen & Seeman, 1999). For example, low marital quality has been found to be a risk factor for myocardial infarction and heart failure (Coyne et al., 2001; De Vogli, Chandola, & Marmot, 2007; Orth-Gomer et al., 2000). The present study examines the association between marital status, marital quality, and heart rate variability, an important measure of neural regulation of the heart that has been associated with numerous cardiovascular health outcomes. We analyze data from the National Survey of Midlife in the United States (MIDUS), a sample of US midlife and older adults.

Despite strong associations of marital status and marital quality to disease endpoints, specific mechanisms linking marital status and marital quality to coronary events are largely unknown. Research has examined the association between marriage and resting measures of cardiovascular health such as blood lipids, blood pressure, atherosclerosis, and the metabolic syndrome (Gallo et al., 2003; Gallo, Troxel, Matthews, & Kuller, 2003; Troxel, Matthews, Gallo, & Kuller, 2005), as well as experimentally manipulated (e.g., stress induced) measures of cardiovascular reactivity and recovery such as changes in blood pressure, heart rate, and heart rate variability (Smith et al., 2009). Findings from this research indicate that individuals high in marital satisfaction have lower risk of developing metabolic syndrome, lower trajectories of cardiovascular risk over time, less atherosclerotic burden, and reduced cardiovascular reactivity during marital conflict.

One physiological mechanism that may be an important link between marriage and cardiovascular health is heart rate variability (HRV), a measure of neural regulation of the heart. HRV is a particularly important biomarker because it is a valuable early indicator of cardiovascular health and a robust predictor of atherosclerosis, congestive heart failure, myocardial infarction, cardiac death, and mortality (see Thayer, Yamamoto, & Brosschot, 2010 for a review). HRV may be an important physiological link between marital quality and health due to shared neurological mechanisms regulating both HRV and social behavior and emotion (Porges, 2007; Thayer & Lane, 2009). Resting HRV has been described as a measure of self-regulatory capacity, or an indicator of one's ability to socially engage and attend to stimuli. For example, adults with higher HRV report greater emotion regulation and decreased negative emotional arousal when exposed to stress (Fabes & Eisenberg, 1997). Resting HRV is malleable and can be increased by behaviors such as exercise, and has shown to be decreased after long-term disruptions to social relationships and chronic stress. For instance, negative marital interactions were associated with decreases in resting HRV, while increases were observed after a positive interaction, although these effects were only observed among women (Smith et al., 2011). Work stress and chronic worry have both shown associations with lower resting indices of HRV (Brosschot, Van Dijk, & Thayer,

2007; Loerbroks et al., 2010; Uusitalo et al., 2011), however, in some cases associations with work strain or effort-reward imbalance were only observed among women (Uusitalo et al., 2011), or midlife adults ages 35-44 (Loerbroks et al., 2010). Taken together, HRV appears to be a potent indicator of cardiovascular health that is affected by social stressors. When these stressors are chronic, as they frequently are in bad marriages, they may have long-term implications for regulation of the heart.

To date, only one study has evaluated the association between marital quality and HRV at rest, and this study found marital quality to be associated with baseline resting HRV (Smith et al., 2011). In this study, positive marital characteristics at baseline were associated with higher HRV among women; however, among men, negative characteristics at baseline were associated with lower HRV and positive characteristics were associated with higher HRV. This study consisted of 114 young married couples, most of whom were married 1-3 years and were recruited to participate in a laboratory disagreement with their spouse. Previous research has indicated a substantial percentage of married participants refuse to participate after learning a study includes discussion of a current marital problem (Miller, Dopp, Myers, Stevens, & Fahey, 1999). Thus, it is critical to understand whether marital quality is associated with HRV in a sample of US midlife and older adults in long-term marriages.

The present study examines marital status, marital quality, and changes in marital quality over 10 years, and their associations with HRV, in a large prospective study of US adults. The first aim of this study is to examine the association between HRV and marital status among all participants, hypothesizing that married individuals have higher HRV than their non-married counterparts. The second aim of this study is to examine differences in HRV between the continuously married and the remarried, hypothesizing that the continuously married will have higher HRV than those who are currently married but experienced a previous disruption from divorce or widowhood. The third aim of this study is to understand the long-term effects of marital quality and changes in marital quality and how these affect HRV over a 10-year period. We hypothesize that individuals high in satisfaction and support will have higher HRV and that increases in marital satisfaction and support over 10 years will be associated with higher HRV, and that individuals high in marital strain will have lower HRV. For the third study aim, associations between marital quality and HRV will only be examined among individuals married to the same person for 10 or more years.

Method

We analyzed data from the MIDUS Biomarker Study. The original MIDUS sample was a national probability sample of midlife and older adults (age range = 25-74), along with siblings of a subset of respondents, and an additional sample of twins identified from an ongoing database (Ryff et al., 2006). Participants were asked to participate in a telephone interview and subsequent postal survey in 1995-1996 and were asked to complete a second nearly identical telephone interview and survey in 2006-2008, an average of 9.2 years later. Participants who completed the second phone interview and survey were asked to participate in the Biomarker Study. The Biomarker Study involved an overnight hospital stay including a detailed health interview, a physical health examination, the collection of biological specimens (e.g., blood, urine, saliva), and an electrocardiograph recording. From the 1996

survey to the 2006 survey, there was greater follow-up participation among non-Hispanic Whites, women, and married individuals, as well as those with better health and more education (Radler & Ryff, 2010). The MIDUS Biomarker sample was not significantly different from the 2006 survey sample on age, sex, race, marital status, or income; however, they had higher educational attainment (Dienberg Love et al., 2010). Participants in the Biomarker Study were also similar to the overall 2006 survey sample in health conditions and behaviors, with the exception being less likely to smoke.

Marital status was assessed during the 1996 and 2006 study periods, as well as during the biomarker collection. In this study, differences in HRV are examined across various marital status categories, and then restricted to individuals who were married at the time of the Biomarker Study and who had been married to the same person since the initial interview. This allowed for the examination of health differences associated with marital quality for individuals in long-term marriages. Descriptive characteristics of the final analytic sample ($n = 907$) analyzed by marital status and gender are presented in Table 1. In addition, marital quality characteristics are described for those in long-term marriages.

Measures

Marital Status—Marital status categories indicate the participant's self-reported marital status during the Biomarker Study. Classifications included married, separated/divorced, widowed, and never married. Using data on current marital status and the number of times an individual was married, two sub-categories were created to indicate whether a participant was married continuously to his/her first spouse (continuously married), or if the participant had a previous marital disruption and was currently remarried.

Marital Quality—Marital quality was measured in MIDUS 1 (1996) and MIDUS II (2006) with a set of measures indicating marital satisfaction, support, and strain. Global marital satisfaction was measured with a single item: (1) How would you rate your marriage these days (a scale of 0 [worst] to 10 [best])? Spousal support ($\alpha = .88$) was assessed using the mean of six items rated on a 4-point Likert scale from not at all to a lot. Questions included feelings of being cared for, understood, and appreciated, as well as being able to rely on and relax around one's spouse. Spousal strain ($\alpha = .86$) was assessed using the mean of six items tapping feelings of criticism, demands, tension, and arguments, using a 4-point Likert scale from not at all to a lot.

Heart Rate Variability (HRV)—We present a commonly used measure of HRV, high frequency HRV (HF-HRV) also known as respiratory sinus arrhythmia. HF-HRV captures variance in the normal RR intervals within a specific frequency band (.15 - .50 Hz) that included the typical resting respiratory rate. Pharmacological blockade studies indicate HF-HRV is driven almost exclusively by parasympathetically driven cardiac vagal control (Pomeranz et al., 1985).

HF-HRV was obtained using electrocardiograph (ECG) records, analyzed according to established guidelines (Task Force, 1996). During an 11-minute seated resting period, the analog ECG signal was digitized at 500 Hz and collected by a microcomputer. R waves were detected using event detection software, were visually inspected to correct for any

errors, and files of RR intervals were generated. These files were submitted to Fourier based spectral analysis and power in the HF band (.15 - .50 Hz) was computed in 300-second epochs. If a 300-second duration was not obtainable, 60-second decreases were made until a continuous epoch could be examined. If the duration of the epoch was shorter than 180 seconds, the observation was omitted. If two measurements were obtained, the two measurements were averaged. Greater detail is provided elsewhere (Ryff et al., 2006).

Health, Behavioral, and Psychosocial Variables—Exercise was coded with 1 indicating 20 minutes of light, moderate, or vigorous activity three times/week or more, and 0 indicating fewer than three times/week. Race and ethnicity were collapsed into ‘non-Hispanic White’ and ‘other’ because of the small number of sample members reporting other races or ethnicities. Current smoking status was coded as a dummy variable (0 = nonsmoker, 1 = smoker). Height and weight were both measured by clinical staff. Body mass index (BMI), was calculated using weight in kilograms divided by squared height in meters. Education was dichotomized into two categories, indicating whether a person graduated from a 4-5 year college or not.

Participants were asked to bring in all current prescription, over-the-counter, and alternative medications in their original bottles. Two dummy variables were created to identify participants using medications determined to increase HF-HRV or decrease HF-HRV in at least 10% of individuals taking these medications, based on previous literature. Medications determined to increase HF-HRV included beta-blockers and dioxin drugs. Medications determined to decrease HF-HRV included anticholinergic drugs and drugs with anticholinergic side effects, sedatives, selective serotonin reuptake inhibitors, antipsychotics, and GABA-acting analgesics. Physician diagnosed heart disease was self-reported during the clinical interview by asking the participant, “Have you ever had any of the following conditions or illnesses? If yes, was it diagnosed by a physician?” If the participant answered yes to both, they were categorized as having physician diagnosed heart disease.

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale ($\alpha = .89$; Radloff, 1977). The scale contains 20 items tapping feelings of depression (e.g., sad, lonely), absence of positive affect (e.g., happy, joyful), somatic symptoms (e.g., restless, poor appetite), and interpersonal difficulties (e.g., feeling disliked, people were unfriendly) over the past week. Items were rated on a 4-point Likert scale ranging from rarely or none of the time to most or all of the time, and the sum of the 20 items was used.

Data Analysis

We examined associations between HF-HRV and marital status among all individuals in the MIDUS biomarker study ($n = 907$), and examined marital quality at baseline and change in marital quality between the 1996 survey and the 2006 survey among individuals married for 10 years or more ($n = 533$) in order to capture marital quality at both time points within the same marriage, as well as to examine marital quality over the course of a 10-year period. We subtracted marital quality scores in 1996 from scores in 2006. Thus, higher change scores for satisfaction and support indicate a marriage becoming more positive, whereas higher

change scores for strain indicate a marriage becoming more strained. To specifically examine the effect of each marital characteristic, the three indicators of marital quality were examined separately. The first model in each analysis contained only covariates age, gender, education, smoking status, physical activity, BMI, medication use, self-reported physician diagnosed heart disease, and depressive symptoms. In the first set of models of the entire sample (Table 2), marital status was added to the model, followed by marital status differentiating between continuously married and remarried. In the second set of models (Table 3), marital quality variables were examined among the sample restricted to being married for 10 or more years, additionally controlling for individuals being continuously married or remarried. Interactions of marital status and marital quality with gender and age were tested and there were no significant interactions between marital status or the marital quality indicators.

We used OLS regression with an Eicker-White cluster robust covariance matrix to provide correct standard errors when accounting for the non-independence of the twin and sibling pairs. HF-HRV was natural-log transformed to normalize the distribution, a standard practice in the analysis of HRV (Task Force, 1996). Linear models with natural-log transformed dependent variables yield estimates that, when multiplied by 100, are interpreted as percent change in the dependent variable with a one-unit increase in the independent variable, when all other covariates are held constant. All statistical analyses were performed using Stata 11.1 (StataCorp., College Station, TX).

Results

Table 2 presents the regression of HF-HRV on selected covariates and marital status. The results of the analysis for traditional marital status categories indicate there are no significant differences between married and unmarried individuals. However, when the continuously married and remarried were analyzed separately, the results indicate the remarried have lower HF-HRV compared to the continuously married, after controlling for important covariates ($b = -.26, p = .02$).

Among individuals married for 10 years or more, the three marital quality variables (satisfaction, support, and strain) at baseline were correlated between $-.66$ and $.78$, while the correlations among the same measures (i.e., strain in 1996 and strain in 2006) from baseline to follow-up ranged between $.51$ and $.59$. Changes in marital quality from baseline to follow-up were small, with average absolute changes in satisfaction, support, and strain being 1.07 , $.26$, and $.38$ for each measure, respectively. Table 3 presents the regression of HF-HRV on important covariates, followed by the examination of the three marital quality indicators at baseline, change in these indicators from baseline to 2006 among individuals married to the same person during the entire study period, and whether they were remarried or in their first marriage. Each unit increase in satisfaction over the 10-year period was associated with 9% higher HF-HRV ($b = .09, p = .01$), while each unit increase in support was associated with 28% higher HF-HRV ($b = .28, p = .04$). Increases in marital strain were associated with lower HRV, with a one-unit increase in marital strain being associated with 26% lower HF-HRV over the 10-year period ($b = -.26, p = .03$). In all models of marital quality, being remarried compared to continuously married, was associated with 37% lower

heart rate variability. Examining overall variance accounted for, the marital quality variables accounted for between 2.1-2.6% of the variance in HF-HRV.

Discussion

This is the first study to examine the association between marital status, marital quality, and HF-HRV in a sample of US midlife and older adults. The significant associations observed between marital status, multiple domains of marital quality, and HF-HRV in this study provide a plausible physiological mechanism linking both marital disruption and the quality of one's marriage to a proximal indicator of cardiovascular health.

We first examined differences in HRV by marital status. Surprisingly, significant differences in HF-HRV between married and unmarried adults were not observed. The lack of difference in HRV between the married and unmarried suggests HRV may not be a physiological mechanism contributing to health differences observed between married and unmarried adults. However, when differentiating between continuously married and remarried adults, the results indicate remarried individuals have lower HF-HRV than continuously married individuals. The lower heart rate variability observed among the remarried compared to the continuously married – even among individuals remarried to another person for 10 or more years - suggests previous marital disruptions from divorce or widowhood may have lasting effects on cardiovascular health, or that there may be inherent differences (e.g., socioeconomic status, social support networks, personal characteristics) between continuously married individuals versus those that experience a divorce or death of a spouse and remarry. We also examined whether there were differences between the remarried and the divorced but not remarried, in order to assess whether disruptions may have lasting effects that would be equal between these two groups. This analysis found no difference in HF-HRV between the remarried and the divorced ($p = .24$), indicating that indeed disruptions may have lasting effects on health among those previously divorced or widowed.

We observed associations between marital quality and HF-HRV, with increases in marital satisfaction and support over the 10-year study period being associated with higher HF-HRV, and increases in marital strain associated with lower HF-HRV. This suggests that even in relatively stable, long-term marriages, small variations and change in the quality of one's marriage are associated with cardiovascular health. Baseline marital quality was not a significant predictor of HF-HRV in models that included change in marital quality, which indicates that change in marital quality over a 10-year period may be a more important predictor of HF-HRV.

This study has a number of strengths, including the use of a large sample of US residents and multiple measures of marital quality, capturing both positive and negative dimensions of marriage. However, there are also several notable limitations. The study population was primarily Caucasian adults with relatively high educational attainment, limiting the generalizability of these findings to the broader population. Second, causal direction cannot be inferred and it is possible that declines in vagal control (indexed by HF-HRV) could contribute to poor emotion regulation, thus resulting in poor marital quality - although this

seems unlikely given that age was associated with both lower HF-HRV and higher ratings of marital quality. In addition, marriage is only one source of social support; therefore, marital quality should also be examined in the context of other social relationships, such as friendships and relationships with other family members. There is some evidence that although marriage may be an important relationship for adults, it may not always be a primary source of emotional support. Thus, if emotional support is met from other social relationships, then changes in marital quality may not have as strong of an effect on more distal outcomes such as mortality.

In sum, these findings suggest HRV is a plausible physiological pathway linking marital quality to long-term health and highlights this as a potentially modifiable factor, suggesting that increasing marital quality, possibly through interventions, could improve neural regulation of the heart. However, while it is clear that higher HRV is beneficial for cardiovascular health; the quantity of increase that would be protective and the ways in which these increases should be achieved (e.g., medications, exercise, stress reduction) has yet to be determined (Task Force, 1996).

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Table 1

Descriptive characteristics of the MIDUS analytic sample by gender (n = 907)

	Male (<i>n</i> = 410)	Female (<i>n</i> = 497)
	<u>Mean (SD)</u>	<u>Mean (SD)</u>
Age (years)	58.0 (11.7)	57.0 (11.0)
Body Mass Index (kg/m ²)	29.6 (5.2)	28.6 (6.3)
Heart Rate Variability ^a		
High Frequency (.15-.50 Hz)	4.7 (1.2)	4.8 (1.2)
Baseline Marital Quality ^b		
Satisfaction (0-10)	8.3 (1.7)	8.18 (1.58)
Support (1-4)	3.7 (.4)	3.59 (.49)
Strain (1-4)	2.2 (.5)	2.19 (.58)
Depression (CES-D)	7.4 (6.9)	8.0 (8.0)
	<u><i>n</i> (%)</u>	<u><i>n</i> (%)</u>
Marital Status		
Continuously Married	245 (60%)	228 (46%)
Remarried	85 (21%)	96 (19%)
Divorced/Separated	44 (11%)	94 (19%)
Widowed	5 (1%)	48 (10%)
Never Married	31 (8%)	31 (6%)
College Degree	214 (52%)	221 (44%)
Current Smoker	44 (11%)	56 (11%)
Physical Activity 3 times/week	314 (83%)	399 (80%)
Medications		
Activating	60 (15%)	70 (14%)
Deactivating	74 (18%)	122 (25%)
Heart Disease Diagnosis	57 (14%)	31 (6%)

^a natural-log transformed in models^b Individuals married 10 or more years

Table 2

Regression coefficients (95% confidence intervals) for high frequency heart rate variability on marital status (n = 907)

	Covariates Only	Marital Status	Marital Status with Remarried
Marital Status			
Married	ref.	ref.	ref.
Remarried	-	-	-.26* (-.49, -.04)
Divorced/ Separated		.14 (-.08, .36)	.06 (-.17, .29)
Widowed		-.05 (-.38, .28)	-.14 (-.48, .20)
Never Married		.07 (-.27, .41)	.01 (-.34, .35)
Age	-.03*** (-.04, -.02)	-.03*** (-.04, -.02)	-.03*** (-.04, -.02)
Gender	.08 (-.08, .24)	.05 (-.13, .22)	.09 (-.08, .25)
Race/Ethnicity	.20 (-.13, .52)	.08 (-.09, .24)	.17 (-.15, .48)
College	.04 (-.12, .21)	.04 (-.13, .20)	.01 (-.16, .17)
Smoker	.33* (.07, .58)	.31* (.06, .57)	.34** (.09, .60)
Exercise	.05 (-.14, .24)	.06 (-.13, .25)	.05 (-.14, .25)
BMI (kg/m ²)	-.02** (-.03, -.01)	-.02** (-.04, -.01)	-.02** (-.03, -.01)
Medication (increase)	.38*** (.14, .61)	.39*** (.15, .62)	.39*** (.16, .62)
Medication (decrease)	-.34** (-.54, -.12)	-.33** (-.54, -.12)	-.33** (-.55, -.12)
Depressive Symptoms	-.00 (-.01, .01)	-.00 (-.02, .00)	-.00 (-.01, .01)
Heart Disease	.06 (-.23, .36)	.06 (-.24, .35)	.09 (-.20, .40)
<i>R</i> ²	.117	.118	.125

*
p .05

**
p .01

p .001

Table 3

Regression coefficients (95% confidence intervals) for high frequency heart rate variability on marital quality measures among individuals married for 10 or more years (n=533)

	Covariates Only	Satisfaction	Support	Strain
Baseline Marital Quality		.03 (-.03 , .10)	.10 (-.12 , .35)	-.06 (-.26 , .14)
Marital Quality Change		.09** (.02 , .16)	.28* (.01 , .55)	-.26* (-.48 , -.03)
Remarried		-.37** (-.64 , -.10)	-.37** (-.64 , -.09)	-.37** (-.64 , -.10)
Age	-.03*** (-.04 , -.02)	-.04*** (-.05 , -.03)	-.03*** (-.05 , -.02)	-.04*** (-.05 , -.03)
Gender	.08 (-.08 , .24)	.11 (-.10 , .31)	.13 (-.08 , .34)	.10 (-.10 , .30)
Race/Ethnicity	.20 (-.13 , .52)	.06 (-.42 , .54)	.05 (-.42 , .51)	.07 (-.39 , .53)
College	.04 (-.12 , .21)	-.02 (-.22 , .19)	-.01 (-.21 , .19)	-.03 (-.23 , .18)
Smoking	.33* (.07 , .58)	.20 (-.19 , .60)	.21 (-.18 , .61)	.21 (-.18 , .60)
Exercise	.05 (-.14 , .24)	.01 (-.24 , .26)	.00 (-.25 , .25)	.02 (-.24 , .27)
BMI (kg/m ²)	-.02** (-.03 , -.01)	-.02 (-.04 , .00)	-.02 (-.04 , .00)	-.02 (-.04 , .00)
Medication (increase)	.38*** (.14 , .61)	.24* (-.05 , .53)	.26 (.04 , .55)	.24* (.05 , .53)
Medication (decrease)	-.34** (-.54 , -.12)	-.37**	-.36** (-.61 , -.10)	-.33** (-.58 , -.08)
Depressive Symptoms	-.00 (-.01 , .01)	-.00 (-.02 , .01)	-.01 (-.02 , .01)	.01 (-.02 , .01)
Heart Disease	.06 (-.23 , .36)	.19 (-.17 , .55)	.17 (-.19 , .53)	.16 (-.21 , .53)
<i>R</i> ²	.117	.143	.138	.140

*
p .05

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p .01

p .001