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BRIEF REPORT

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

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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 among 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 Substudy ($N = 907$) 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, whereas increased marital strain over 10 years was associated with lower HF-HRV. Higher HF-HRV among the continuously married compared with the remarried suggests that 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 that variations in the quality of one's marriage may affect cardiovascular health.

Keywords: marriage, marital quality, heart rate variability, National Survey of Midlife in the United States

There is clear evidence linking marital status to cardiovascular disease (CVD) and mortality, with married individuals living longer than their nonmarried 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 among marital status, marital quality, and heart rate variability (HRV), 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 U.S. 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

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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 HRV (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 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 because of 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 it 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, whereas 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); however, in some cases associations with work strain or effort-reward imbalance were only observed among women or midlife adults 35–44 years of age (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 who 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 U.S. 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 U.S. 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 nonmarried 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, 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 years), 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 that included a detailed health interview, a physical health examination, the collection of biological specimens (e.g., blood, urine, saliva), and an electrocardiograph (ECG) 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, Seeman, Weinstein, & Ryff, 2010). Participants in the biomarker study were also similar to the overall 2006 survey sample in health conditions and behaviors, with the exception of 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 and Table 2. In addition, marital quality characteristics are described for those in long-term marriages in Table 1.

Table 1
Descriptive Characteristics of the MIDUS Analytic Sample by Gender (N = 907)

Characteristic	Male (n = 410) M (SD)	Female (n = 497) M (SD)
Age (years)	58.0 (11.7)	57.0 (11.0)
BMI (kg/m^2)	29.6 (5.2)	28.6 (6.3)
HRV[a]		
HF-HRV (0.15–0.50 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 (0.4)	3.59 (0.49)
Strain (1–4)	2.2 (0.5)	2.19 (0.58)
Depression (CES-D)	7.4 (6.9)	8.0 (8.0)

Note. CES-D = Center for Epidemiologic Studies Depression scale.
[a] Natural-log transformed in models. [b] Individuals married ≥10 years.

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 subcategories were created to indicate whether a participant was married continuously to his or 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 I (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: How would you rate your marriage these days (a scale of 0 [worst] to 10 [best])? Spousal support (α = .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 (α = .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*.

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 (0.15–0.50 Hz) that included the typical resting respiratory rate. Pharmacological blockade studies indicate that HF-HRV is driven almost exclusively by parasympathetically driven cardiac vagal control (Pomeranz et al., 1985).

HF-HRV was obtained using ECG records, analyzed according to established guidelines (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [Task Force], 1996). During an 11-min 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 high-frequency band (0.15–0.50 Hz) was computed in 300-sec epochs. If a 300-sec duration was not obtainable, then 60-sec decreases were made until a continuous epoch could be examined. If the duration of the epoch was shorter than 180 sec, then the observation was omitted. If two measurements were obtained, then 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 min of light, moderate, or vigorous activity 3 times/week or more and 0 indicating fewer than 3 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- to 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 on the basis of 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, then they were categorized as having physician-diagnosed heart disease.

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (α = .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.

Table 2
Descriptive Characteristics of the MIDUS Analytic Sample by Gender (N = 907)

Characteristic	Male (n = 410) n (%)	Female (n = 497) n (%)
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 or more	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)

Data Analysis

We examined associations between HF-HRV and marital status among all individuals in the MIDUS biomarker study ($N = 907$), and we 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 ($n = 533$) 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 separately examined. The first model in each analysis only contained the 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 (see Table 3), marital status was added to the model, followed by marital status differentiating between continuously married and remarried. In the second set of models (see Table 4), 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 and the marital quality indicators.

We used ordinary least squares regression with an Eicker-Huber-White cluster robust covariance matrix to provide correct standard errors when accounting for the nonindependence 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 percentage 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 3 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 that the remarried have lower HF-HRV compared with 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, whereas 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, 0.26, and 0.38 for each measure, respectively. Table 4 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 ($b = .09$, $p = .01$), whereas 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 with continuously married was associated with 37% lower HRV. Examining overall variance accounted for,

Table 3
Regression Coefficients (95% Confidence Intervals) for HF-HRV on Marital Status (N = 907)

Variable	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)
R^2	.117		.118		.125	

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

Table 4
Regression Coefficients (95% Confidence Intervals) for HF-HRV on Marital Quality Measures Among Individuals Married for ≥10 Years (n = 533)

Variable	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** (−.62, −.12)	−.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)
R^2	.117	.143	.138	.140

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

the marital quality variables accounted for between 2.1% and 2.6% of the variance in HF-HRV.

Discussion

This is the first study to examine the association among marital status, marital quality, and HF-HRV in a sample of U.S. midlife and older adults. The significant associations observed among 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 that 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 that remarried individuals have lower HF-HRV than continuously married individuals. The lower HRV observed among the remarried compared with the continuously married—even among individuals remarried to another person for 10 or more years—suggests that 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 to assess whether disruptions may having 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 several strengths, including the use of a large sample of U.S. 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 summary, these findings suggest that 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, although 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).

References

Brosschot, J. F., Van Dijk, E., & Thayer, J. F. (2007). Daily worry is related to low heart rate variability during waking and the subsequent nocturnal sleep period. *International Journal of Psychophysiology, 63,* 39–47. http://dx.doi.org/10.1016/j.ijpsycho.2006.07.016

Coyne, J. C., Rohrbaugh, M. J., Shoham, V., Sonnega, J. S., Nicklas, J. M., & Cranford, J. A. (2001). Prognostic importance of marital quality for survival of congestive heart failure. *The American Journal of Cardiology, 88,* 526–529. http://dx.doi.org/10.1016/S0002-9149(01)01731-3

De Vogli, R., Chandola, T., & Marmot, M. G. (2007). Negative aspects of close relationships and heart disease. *Archives of Internal Medicine, 167,* 1951–1957. http://dx.doi.org/10.1001/archinte.167.18.1951

Dienberg Love, G., Seeman, T. E., Weinstein, M., & Ryff, C. D. (2010). Bioindicators in the MIDUS national study: Protocol, measures, sample, and comparative context. *Journal of Aging and Health, 22,* 1059–1080. http://dx.doi.org/10.1177/0898264310374355

Fabes, R. A., & Eisenberg, N. (1997). Regulatory control and adults' stress-related responses to daily life events. *Journal of Personality and Social Psychology, 73,* 1107–1117. http://dx.doi.org/10.1037/0022-3514.73.5.1107

Gallo, L. C., Troxel, W. M., Kuller, L. H., Sutton-Tyrrell, K., Edmundowicz, D., & Matthews, K. A. (2003). Marital status, marital quality, and atherosclerotic burden in postmenopausal women. *Psychosomatic Medicine, 65,* 952–962. http://dx.doi.org/10.1097/01.PSY.0000097350.95305.FE

Gallo, L. C., Troxel, W. M., Matthews, K. A., & Kuller, L. H. (2003). Marital status and quality in middle-aged women: Associations with levels and trajectories of cardiovascular risk factors. *Health Psychology, 22,* 453–463. http://dx.doi.org/10.1037/0278-6133.22.5.453

Johnson, N. J., Backlund, E., Sorlie, P. D., & Loveless, C. A. (2000). Marital status and mortality: The national longitudinal mortality study. *Annals of Epidemiology, 10,* 224–238. http://dx.doi.org/10.1016/S1047-2797(99)00052-6

Loerbroks, A., Schilling, O., Haxsen, V., Jarczok, M. N., Thayer, J. F., & Fischer, J. E. (2010). The fruits of ones labor: Effort-reward imbalance but not job strain is related to heart rate variability across the day in 35–44-year-old workers. *Journal of Psychosomatic Research, 69,* 151–159. http://dx.doi.org/10.1016/j.jpsychores.2010.03.004

McEwen, B. S., & Seeman, T. (1999). Protective and damaging effects of mediators of stress. Elaborating and testing the concepts of allostasis and allostatic load. *Annals of the New York Academy of Sciences, 896,* 30–47. http://dx.doi.org/10.1111/j.1749-6632.1999.tb08103.x

Miller, G. E., Dopp, J. M., Myers, H. F., Stevens, S. Y., & Fahey, J. L. (1999). Psychosocial predictors of natural killer cell mobilization during marital conflict. *Health Psychology, 18,* 262–271. http://dx.doi.org/10.1037/0278-6133.18.3.262

Molloy, G. J., Stamatakis, E., Randall, G., & Hamer, M. (2009). Marital status, gender and cardiovascular mortality: Behavioural, psychological distress and metabolic explanations. *Social Science & Medicine, 69,* 223–228.

Orth-Gomér, K., Wamala, S. P., Horsten, M., Schenck-Gustafsson, K., Schneiderman, N., & Mittleman, M. A. (2000). Marital stress worsens prognosis in women with coronary heart disease: The Stockholm Female Coronary Risk Study. *JAMA: Journal of the American Medical Association, 284,* 3008–3014. http://dx.doi.org/10.1001/jama.284.23.3008

Pomeranz, B., Macaulay, R. J. B., Caudill, M. A., Kutz, I., Adam, D., Gordon, D., . . . Benson, H. (1985). Assessment of autonomic function in humans by heart rate spectral analysis. *The American Journal of Physiology, 248,* H151–H153.

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology, 74,* 116–143. http://dx.doi.org/10.1016/j.biopsycho.2006.06.009

Radler, B. T., & Ryff, C. D. (2010). Who participates? Accounting for longitudinal retention in the MIDUS national study of health and well-being. *Journal of Aging and Health, 22,* 307–331. http://dx.doi.org/10.1177/0898264309358617

Radloff, L. S. (1977). The CES-D scale. *Applied Psychological Measurement, 1,* 385–401. http://dx.doi.org/10.1177/014662167700100306

Rendall, M. S., Weden, M. M., Favreault, M. M., & Waldron, H. (2011). The protective effect of marriage for survival: A review and update. *Demography, 48,* 481–506. http://dx.doi.org/10.1007/s13524-011-0032-5

Ryff, C., Almeida, D. M., Ayanian, J. S., Carr, D. S., Cleary, P. D., Coe, C., & Williams, D. (2006). *National Survey of Midlife Development in the United States (MIDUS II).* (No. ICPSR04652-v6). Ann Arbor, MI: Inter-university Consortium for Political and Social Research.

Seeman, T. E. (1996). Social ties and health: The benefits of social integration. *Annals of Epidemiology, 6,* 442–451. http://dx.doi.org/10.1016/S1047-2797(96)00095-6

Smith, T. W., Cribbet, M. R., Nealey-Moore, J. B., Uchino, B. N., Williams, P. G., Mackenzie, J., & Thayer, J. F. (2011). Matters of the variable heart: Respiratory sinus arrhythmia response to marital interaction and associations with marital quality. *Journal of Personality and Social Psychology, 100,* 103–119. http://dx.doi.org/10.1037/a0021136

Smith, T. W., Uchino, B. N., Berg, C. A., Florsheim, P., Pearce, G., Hawkins, M., . . . Olsen-Cerny, C. (2009). Conflict and collaboration in middle-aged and older couples: II. Cardiovascular reactivity during marital interaction. *Psychology and Aging, 24,* 274–286. http://dx.doi.org/10.1037/a0016067

Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. (1996). Heart rate variability: Standards of measurement, physiological interpretation and clinical use. *Circulation, 93,* 1043–1065. http://dx.doi.org/10.1161/01.CIR.93.5.1043

Thayer, J. F., & Lane, R. D. (2009). Claude Bernard and the heart-brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience and Biobehavioral Reviews, 33,* 81–88. http://dx.doi.org/10.1016/j.neubiorev.2008.08.004

Thayer, J. F., Yamamoto, S. S., & Brosschot, J. F. (2010). The relationship of autonomic imbalance, heart rate variability and cardiovascular disease risk factors. *International Journal of Cardiology, 141,* 122–131. http://dx.doi.org/10.1016/j.ijcard.2009.09.543

Troxel, W. M., Matthews, K. A., Gallo, L. C., & Kuller, L. H. (2005). Marital quality and occurrence of the metabolic syndrome in women. *Archives of Internal Medicine, 165,* 1022–1027. http://dx.doi.org/10.1001/archinte.165.9.1022

Uchino, B. N., Cacioppo, J. T., & Kiecolt-Glaser, J. K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119,* 488–531. http://dx.doi.org/10.1037/0033-2909.119.3.488

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