Health Psychology
2003, Vol. 22, No. 5, 453–463

0278-6133/03/$12.00 DOI: 10.1037/0278-6133.22.5.453

Marital Status and Quality in Middle-Aged Women: Associations With Levels and Trajectories of Cardiovascular Risk Factors

Linda C. Gallo
San Diego State University

Wendy M. Troxel
University of Pittsburgh

Karen A. Matthews
University of Pittsburgh School of Medicine

Lewis H. Kuller
University of Pittsburgh

The current study compared cardiovascular risk profiles and trajectories (i.e., within-person changes) of women who were married or cohabitating and who had high relationship satisfaction with those of women with moderate or low satisfaction and with those of women who were single, divorced, and widowed. Participants were 493 women from the Healthy Women Study, a prospective investigation of health during and after the menopausal transition. Risk factors were measured across more than 5 occasions and 13 years, on average. Data were analyzed using a multilevel modeling technique. Overall, women in relationships with high satisfaction had lower levels of biological, lifestyle, and psychosocial risk factors when compared with the other groups. In some cases, women in satisfying marriages also showed a lower risk trajectory on risk factors relative to other women. Hence, marriage appears to confer health benefits for women, but only when marital satisfaction is high.

Key words: cardiovascular diseases, marriage, psychosocial, interpersonal stress, risk factors

Higher levels of social integration and support have been linked with a number of health benefits (e.g., House, Landis, & Umberson, 1988; Seeman, 1996), including protection against cardiovascular morbidity and mortality (e.g., Berkman, 1995; Hazuda, 1994; Orth-Gomér, 1994). The marital relationship is a primary source of support for many adults. Thus, some research has examined whether being married confers health-protective effects (e.g., Johnson, Backlund, Sorlie, & Loveless, 2000).

Married men and women may be at a health advantage relative to their unmarried counterparts, for a number of reasons. First, as a primary source of social support, marriage may protect against the well-documented risks associated with social isolation (e.g., Berkman, 1995; Berkman & Glass, 2000; Brummett et al., 2001). Second, positive spousal influence and involvement may encourage health-promoting behaviors and deter health-compromising behaviors (e.g., Rook, 1990; Umberson, 1987, 1992). Finally, married persons, particularly women, may be at a health advantage relative to their unmarried counterparts, through the increased availability of socioeconomic resources (Johnson et al., 2000). However, the findings concerning marital status and health have generally been less consistent for women than for men (see reviews by Litwak & Messeri, 1989; Ross, Mirowsky, & Goldsteen, 1990). These inconsistencies may reflect the failure of previous studies to consider the quality of the marriage as well as marital status.

Indeed, some research suggests that women may be more sensitive to negative aspects of relationships than are men (Notarius, Benson, Sloane, Vanzetti, & Hornyak, 1989)—an assertion that is consistent with overarching theories of gender-linked traits, motives, and goals (e.g., Cross & Madson, 1997; Helgeson, 1994; Taylor et al., 2000). For instance, in a sample of male and female coronary heart disease (CHD) patients, Coyne et al. (2001) found that poor marital quality was a more robust predictor of mortality in women than in men. Previous research also suggests that women display more pronounced physiological responses to marital conflict or disagreement when compared with men (e.g., Ewart, Taylor, Kraemer, & Agras, 1991; Kiecolt-Glaser et al., 1997; Mayne, O'Leary, McCrady, Contrada, & Labouvie, 1997; Smith, Gallo, Goble, Gnu, & Stark, 1998). These trends may help explain why, overall, women show an inconsistent health benefit from marriage. That is, the positive effects of supportive marriages may be obscured in studies that assess marital status, due to the marked, negative impact of discordant marriages.

To date, research examining marital relationship quality and cardiovascular health is limited, and the results are equivocal. Marital quality failed to predict incident angina and myocardial infarction (MI) in the Framingham study (Haynes, Feinleib, & Kannel, 1980), although marital disagreements were positively

Linda C. Gallo, San Diego State University/University of California (SDSU/UCSD) Joint Doctoral Program in Clinical Psychology, San Diego State University; Wendy M. Troxel, Department of Psychology, University of Pittsburgh; Karen A. Matthews, Department of Psychiatry, University of Pittsburgh School of Medicine; Lewis H. Kuller, Graduate School of Public Health, University of Pittsburgh.

This research was supported by National Heart, Lung, and Blood Institute Grant HL28266, by Pittsburgh Mind-Body Center Grants HL65111 and HL65112, by National Institutes of Health Training Grant HL07560, and by National Institute of Mental Health Grant MH6610101.

Correspondence concerning this article should be addressed to Karen A. Matthews, Department of Psychiatry, University of Pittsburgh School of Medicine, 3811 O'Hara Street, Pittsburgh, Pennsylvania 15213. E-mail: matthewska@msx.upmc.edu

correlated with diastolic blood pressure among men in the cohort (Haynes, Levine, Scotch, Feinleib, & Kannel, 1978). A recent prospective study of patients with mild hypertension found an inverse association between marital adjustment and rate of left-ventricular mass increase, a risk factor for cardiovascular morbidity and mortality (Baker et al., 2000). Additional research suggests that both positive and negative aspects of marital quality predict outcomes in cardiac patient populations (e.g., Coyne et al., 2001; Helgeson, 1991; Orth-Gomér et al., 2000). Thus, preliminary evidence suggests that marital quality is important to cardiac health, but additional research is warranted.

How Might Marital Quality Influence Cardiovascular Health?

Several direct and indirect paths have been proposed to link marital quality with health (Burman & Margolin, 1992; Kiecolt-Glaser & Newton, 2001). First, marital stress is associated with lifestyle risk factors and nonadherence to medical regimens (for a review, see Kiecolt-Glaser & Newton, 2001). For example, Trevino, Young, Groff, and Jono (1990) found that higher marital adjustment predicted better adherence to an antihypertensive medication regimen. In a longitudinal study of men, positive marital interaction predicted a reduced likelihood of risky health habits (e.g., poor dietary habits, substance use, and inadequate sleep), which, in turn, predicted worse health outcomes (Wickrama, Conger, & Lorenz, 1995).

Poor marital quality is also linked with psychosocial factors, including depression, hostility, and anger—variables that are themselves risk factors for CHD (e.g., Rozanski, Blumenthal, & Kaplan, 1999). Finally, marital distress could influence CHD risk through physiological pathways (Seeman, Berkman, Blazer, & Rowe, 1994; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Marital quality relates inversely to cardiovascular responses in the laboratory (e.g., Broadwell & Light, 1999; Ewart et al., 1991) and to ambulatory blood pressure levels (e.g., Baker et al., 1999; Carels, Sherwood, Szczepanski, & Blumethal, 2000). In turn, cardiovascular stress responses have been shown to predict future elevated blood pressure (Markovitz, Raczynski, Wallace, Chettur, & Chesney, 1998; Matthews, Woodall, & Allen, 1993; Stewart & France, 2001) and carotid atherosclerosis (Matthews et al., 1998), and ambulatory blood pressure measures are strong predictors of cardiovascular morbidity and mortality (e.g., Verdecchia, 2000). Physiological stress responses also predict more atherogenic plasma lipid profiles (e.g., Burker, Fredrikson, Rifai, Siegel, & Blumenthal, 1994; Stoney, Bausserman, Niaura, Marcus, & Flynn, 1999), probably consequential to cortisol elevations (e.g., McCann et al., 1996), and higher levels of stress or daily hassles are associated with altered blood glucose modulation in diabetic (e.g., Hanson, Henggeler, & Burghen, 1987; Peyrot & McMurry, 1985) and nondiabetic samples (Cesana et al., 1985; Vitaliano, Scanlan, Krenz, & Fujimoto, 1996). Thus, marital status and quality could influence metabolic risk factors and acute stress responses, which in turn predict cardiovascular morbidity and mortality.

The Current Study

The current study expanded on previous research in several respects. First, prior studies have tended to assess the health effects of marital status and quality separately. As a result, it is unclear if women in happy marriages experience a health advantage relative to those in distressed marriages *and* to unmarried women. The current study compared cardiovascular risk profiles of married or cohabitating women with high levels of marital satisfaction with those of women with moderate or low satisfaction and with those of women with no partner (i.e., who reported their marital status as single, divorced, or widowed). Second, whereas previous research has tended to examine marital status and relationship quality on a single occasion, we assessed these variables at two time points. This approach allowed us to examine the impact of persistent satisfaction and dissatisfaction rather than the immediate effects of marital discord. Finally, in addition to examining differences in levels of risk factors among the marital groups, we examined risk factor trajectories (i.e., intraindividual change) during a period of increasing risk for women: middle age and the menopausal transition.

Participants were from the University of Pittsburgh's Healthy Women Study (HWS; Matthews et al., 1989), a longitudinal study that includes multiple assessments of risk factors. Data were analyzed through hierarchical linear modeling (HLM), which facilitates examining intraindividual changes (Bryk & Raudenbush, 1992). We predicted that women in highly satisfying marriages would show a less atherogenic profile in terms of average level and trajectories on biological, lifestyle, and psychosocial cardiovascular risk factors when compared with (a) cohabitating or married women describing their marriages as moderate or (b) low in satisfaction and women who reported (c) single, (d) divorced, or (e) widowed marital status. We predicted that women reporting high marital quality would show a relative advantage over women reporting low marital quality, given previous research implicating both positive and negative aspects of social relationships in women's health (e.g., Coyne et al., 2001; Orth-Gomér et al., 2000). We further expected women in high-quality marriages to show an advantage over unmarried women in general, owing to the increased social and economic resources associated with marriage. As noted below, the number of women in each of the unmarried comparison groups was small; however, we did expect a trend for divorced and perhaps widowed women to be at a relative disadvantage, given the greater interpersonal stress and fewer resources they might have experienced.

Method

Participants

Participants were 493 women from the HWS, a prospective investigation of cardiovascular risk factor changes during menopause. As presented in detail elsewhere (Matthews et al., 1989), the HWS cohort consists of 541 healthy women (490 White, 48 African American, 2 Asian American, and 1 Other) recruited between 1983 and 1985 from a random sample living in Allegheny County, PA, with addresses obtained from driver's license lists. Women were screened for eligibility criteria including age 42–50 years, menstrual bleeding within the last 3 months, no surgical menopause, diastolic blood pressure < 100 mmHg, no use of hormone replacement therapy (HRT), and no reliance on medications known to influence biological risk factors. Of women contacted, 89% agreed to the screening, and 60% of those eligible agreed to participate. To date, 12 women have been lost from the study to mortality (2.2%), and 57 women have dropped out of the study (11%).

The current study excludes women who were seen only for the baseline visit ($n = 14$) and women who were missing data for relationship status or satisfaction at one or both of the assessment points for marital status and satisfaction (i.e., baseline and 3-year follow-up; $n = 4$). In addition, we excluded women who experienced a marital status change ($n = 23$) and women who showed a large marital satisfaction change (i.e., change scores at least 3 *SD* higher than the sample mean change score; $n = 7$) between the baseline and 3-year follow-up. We excluded women with a change in status or a large change in satisfaction because we were interested in investigating the effects of a stable relationship on cardiovascular health, given the prolonged etiology of atherosclerosis. We could not separately evaluate the impact of experiencing a status or quality transition because these occurrences were uncommon in this cohort. Further, women who did experience a status or quality change varied in the direction (i.e., losing a partner versus gaining a partner; increasing versus decreasing in marital quality) or cause (e.g., divorce versus widowhood) for the change.

Procedure

Women were seen for a baseline visit and a series of follow-up visits, the first of which occurred after 12-months cessation of menses or use of HRT. In the initial study phase (i.e., 1983–1987), postmenopausal visits were conducted yearly, so that some women were also seen 2 and 3 years postmenopause. In addition, a follow-up visit was conducted for all women 3 years after the baseline (i.e., 3-year follow-up), regardless of menopausal status. Thus, some women had more than one premenopausal assessment. After the initial phase, visits were scheduled at approximately 3-year intervals, or 5, 8, and 11–12 years postmenopause. The current study therefore includes participants with varied numbers and spacing of assessments, depending on when they became menopausal. On average, the participants were seen for 5.52 visits ($SD = 1.74$, with a minimum of 2 and maximum of 8) over a period of 13.22 years ($SD = 3.87$, with a minimum of 2.57 and a maximum of 17.90). Each visit included a fasting blood draw, blood pressure evaluation, body-size measurements, and assessment of health behaviors and psychosocial characteristics. However, the latest visits (i.e., 11–12 years postmenopausal follow-up) do not include assessments of psychosocial factors.

Biological and lifestyle risk factors. Biological risk factors examined in the current study included systolic and diastolic blood pressure (SBP and DBP), high- and low-density-lipoprotein cholesterol (HDL-c and LDL-c), triglycerides, and fasting glucose. Lifestyle factors included body mass index (BMI), smoking, and exercise. Assays were conducted at laboratories meeting standards set forth by the Centers for Disease Control and the National Heart, Lung, and Blood Institute. Technicians certified by the Multiple Risk Factor Intervention Trial protocol (Dischinger & DuChene, 1986) measured blood pressure with two random zero-muddler readings (Garrow, 1963), which were then averaged. Plasma glucose was measured via enzymatic assay (Yellow Springs glucose analyzer, Yellow Springs Instruments, Yellow Springs, OH). Triglycerides (Bucolo & David, 1973), serum cholesterol (Allain, Poon, Chan, Richmond, & Fu, 1974), and total HDL-c (Warnick & Albers, 1978) were also assayed, and total LDL-c was estimated through the Friedewald equation (Friedewald, Levy, & Fredrickson, 1972). Height and weight were measured to allow calculation of BMI. At each visit, participants also self-reported their current smoking status and kilocalories expended in leisure-time physical activity during the previous week (Physical Activity Index; Paffenbarger, Wing, & Hyde, 1978).

Psychosocial risk factors. Psychosocial risk factors examined in the current study included depression, anxiety, anger, anger expression style, perceived social support, and stress. Depression was measured with the Beck Depression Inventory (BDI; Beck & Beamesderfer, 1974), a 21-item measure of symptoms, which has proved reliable and valid in substantial previous research (e.g., Beck, Steer, & Garbin, 1988). Anxiety was measured with the 10-item Trait version of the Spielberger State–Trait Anxiety Inventory, an assessment of the propensity to experience situations as threatening or dangerous. The 10-item Trait Anger scale and the 12-item Anger-On and Anger-Out scales assessed the disposition to experience angry emotion, and the tendency to suppress or express anger, respectively. The Spielberger scales are widely used and demonstrate good psychometric properties (Spielberger, Sydeman, Owen, & Marsh, 1999). Administration of the Anger Expression scales was discontinued in 1992, so these analyses are based on fewer data points. Perceived social support was measured with the 10-item Appraisal (i.e., emotional) support subscale of the Interpersonal Support Evaluation List (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). Finally, participants completed the 4-item Perceived Stress Scale, a measure of generalized perceptions of stress, which is reliable and valid (Cohen, 1988; Cohen, Kamarck, & Mermelstein, 1983).

Relationship Grouping

Relationship groups were formed on the basis of information provided at the baseline and 3-year follow-up assessments. Participants reported their marital status, and those who were married or cohabitating completed a 7-item measure of marital quality. The scale assessed satisfaction with: amount of time spent together, communication, sexual activity, agreement on financial matters, and similarity of interests, lifestyle, and temperament, on a 4-point Likert-type scale. Items were summed to yield scores ranging from 0 to 21, with higher scores indicating greater satisfaction. The scale showed good internal consistency at both the baseline and 3-year visits ($\alpha = .87$ at each visit), and scores at the two time points were highly correlated, $r(375) = .78$, $p < .01$.

The distribution of scores was negatively skewed at both time points, with most women describing their relationships in positive terms. On the basis of the distribution of marital satisfaction scores, the lower third was chosen as a cutoff for *low satisfied* (i.e., at this point the distribution began to flatten out and decrease more gradually). Thus, a satisfied group consisted of married or cohabitating women who scored in the upper two thirds of the distribution on the relationship satisfaction measure at both assessments ($n = 217$). A moderately satisfied group consisted of married or cohabitating women who scored in the lower third of the distribution at one of the two assessments ($n = 63$). A low-satisfied group consisted of married or cohabitating women who scored in the lower third of the distribution on both occasions ($n = 95$). Additional groups represented women who reported single ($n = 39$), divorced or separated ($n = 60$), or widowed ($n = 19$) marital status at both time points. Table 1 contains the relationship satisfaction scores for the married or cohabitating groups. As would be expected given the group definitions, relationship satisfaction differed across groups at both time points. On average, the moderately satisfied women had levels of satisfaction that fell between the other groups. That is, rather than necessarily experiencing a marked change between assessments, these women typically had satisfaction scores somewhere near the cutoff, with minor fluctuations placing them at one side of the cutoff versus the other at alternative time points. The groups did not differ on change in satisfaction between the time points, with all groups showing a small decrease in relationship satisfaction, on average. Further, the groups did not differ in number of visits or years of follow-up (*ps* .35; data not shown).

Results

Characteristics of Relationship Groups

Table 2 summarizes the analyses of the relationship group differences on sociodemographic factors reported at baseline. Although the majority of the HWS cohort is White (490 White, 48 African American, 2 Asian American, and 1 Other), the groups varied significantly on ethnicity. The chi-square analysis showed that the satisfied and single groups were most likely to report

Table 1
Descriptive Statistics and One-Way ANOVAs Characterizing the Baseline and 3-Year Follow-Up Relationship Satisfaction Scores for the Married or Cohabitating Groups

	Satisfied (n = 217)		Moderately satisfied (n = 95)		Low satisfied (n = 63)		
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	One-way ANOVA
Baseline relationship satisfaction	17.93_a	2.09	13.49_b	2.80	9.59_c	3.02	$F(2, 372) = 333.93$**
3-year follow-up relationship satisfaction	17.76_a	2.18	12.90_b	2.94	9.14_c	3.04	$F(2, 372) = 395.51$**
Relationship satisfaction change	−0.17	1.92	−0.59	4.91	−0.45	3.08	$F(2, 372) = 0.66$

Note. Means with differing subscripts are significantly different according to Tukey's honestly significant difference test for pairwise comparisons, at $p < .01$. ANOVA = analysis of variance.
** $p < .01$.

White ethnicity. The divorced group was least likely to report White ethnicity and most likely to report African American ethnicity. The groups did not differ on educational attainment but did differ significantly on family income. Individuals with no partner (e.g., single, divorced, or widowed) tended to report lower incomes—likely a function of not having a second earner in the household. The groups varied in probability of having children and of no surprise, single women were least likely to have children.

Risk Factor Levels and Trajectories

Primary analytic strategy. Risk factor trajectories were examined through HLM (Bryk & Raudenbush, 1992; HLM Version 5.04, Raudenbush, Bryk, Cheong, & Congdon, 2000), a method for modeling intraindividual change in outcomes measured on repeated occasions. (The analysis for smoking used a logistic [Bernoulli model] version of this same procedure.) In HLM, multiple observations on each individual are viewed as nested within person rather than as the same for all participants, as occurs in multivariate repeated measures or structural equation modeling. This allows unequal numbers and increments of observations across participants. Analysis of change within HLM proceeds in levels and in the current study involved two levels. At the first, within-person level, repeated observations from each participant were regressed against time. Time was expressed as age at visit,

Table 2
Summary of Chi-Square Analysis Comparing the Relationship Groups on Sociodemographic Characteristics Reported at Baseline

	Satisfied (n = 217)		Moderately satisfied (n = 63)		Low satisfied (n = 95)		Single (n = 39)		Divorced (n = 60)		Widowed (n = 19)	
Variable	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Mean age at baseline (years)[a]	47.69 (1.66)		47.68 (1.60)		47.70 (1.62)		47.08 (1.89)		47.63 (1.51)		48.08 (1.64)	
Ethnicity (n = 493)[b]												
White	210	96.8	56	88.9	83	87.4	38	97.4	45	75.0	16	84.2
African American	6	2.8	6	9.5	12	12.6	1	2.6	14	23.3	3	15.8
Asian American	1	0.5	1	1.6	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	1	1.7	0	0
Education (n = 493)[c]												
High school or less	55	25.3	19	30.2	38	40.0	5	12.8	19	31.7	7	36.8
Some college	51	23.5	14	22.2	17	17.9	8	20.5	13	21.7	6	31.6
4-year degree	50	23.0	14	22.2	23	24.2	13	33.3	15	25.0	4	21.1
Advanced degree	61	28.1	16	25.4	17	17.9	13	33.3	13	21.7	2	10.5
Family income (n = 403)[d]												
< $30,000	17	9.8	5	10.0	18	22.8	18	58.1	39	69.6	9	64.3
$30,000–$49,999	45	26.0	14	28.0	27	34.2	12	38.7	14	25.0	4	28.6
$50,000–$69,999	40	23.1	9	18.0	15	19.0	1	3.2	3	5.4	1	7.1
≥ $70,000	71	41.0	22	44.0	19	24.1	0	0.0	0	0.0	0	0.0
Have any children (n = 493)[e]	204	94.0	62	98.4	92	96.8	6	15.4	54	90.0	19	100.0

Note. Values below mean years are standard deviations.
[a] $F(5, 492) = 1.24, p > .1$. [b] $\chi^2(15) = 41.85, p < .01$. [c] $\chi^2(15) = 18.25, p > .1$. [d] $\chi^2(15) = 142.23, p < .01$. [e] $\chi^2(5) = 228.94, p < .01$.

and the age slope, therefore, represented the change in the risk factor for a 1-year increment in age. Age was centered about the individual mean, and the intercept, therefore, represented the average level of the risk factor across all visits for that individual. Hence, the Level 1 model produced estimates of the intercept (i.e., average risk factor level) and slope (i.e., change per year) for each person.

At the second stage of analysis, or Level 2, the person-specific intercepts and slope parameters served as outcomes predicted by the between-subjects factor relationship grouping. Relationship grouping was represented with five dummy codes that compared the satisfied group with the (a) moderately satisfied, (b) low-satisfied, (c) single, (d) divorced, and (e) widowed groups. For all contrasts, the satisfied group was coded as 0, and each comparison group was coded as 1. Hence, the intercepts in the Level 2 equation predicting the within-person intercepts and slopes represented the average level of and the annual rate of change, respectively, in the risk factors for the satisfied group. The coefficients of the dummy variables in the Level 2 equation predicting the within-person intercepts reflected the differences, relative to the satisfied group, in average levels of the risk factors for the five other groups. Finally, the coefficients of the dummy variables in the Level 2 equation predicting within-person slopes indicated the difference in the average annual rate of change for each of the five comparison groups, relative to the average annual rate of change for the satisfied group.

Chi-square tests were used to examine whether the model fit was significantly improved with the addition of the marital group contrasts, relative to the covariates-only model. R^2 values provided an estimate of the amount of variance in each parameter (i.e., intercept, slope) explained by the aggregate marital status–quality group contrasts and were calculated according to the following formula: unrestricted model error variance (in this case, variance for covariates-only model) − restricted model variance/unrestricted model error variance (Bryk & Raudenbush, 1992).

Covariate selection and covariates-only analyses. Before we examined between-groups differences, we calculated initial models that included only age and all possible covariates. To reduce model complexity, variables that did not predict the outcome at $p < .10$ were excluded from further analyses. Covariate-selection models for biological variables included menopausal status, use of HRT, and outcome-specific medications (i.e., antihypertensives for blood pressure analyses, diabetic medications for glucose, lipid-lowering drugs for HDL-c, LDL-c, and triglycerides) as possible time-varying covariates at Level 1. Time-varying covariates were person centered before entry and were treated as fixed, because the impact of the covariates was not expected to vary randomly across individuals. Variables included as covariates at Level 1 might still contribute to between-group effects on slope and intercept outcomes if the groups varied in average levels of exposure to these covariates (Hedeker, in press). In this case, between-person mean covariate levels should be included in the Level 2 equation. One-way analyses of variance showed that the marital groups differed marginally on the proportion of visits with use of HRT, $F(5, 487) = 1.96$, $p = .08$, but did not differ in proportion of visits reflecting use of outcome-specific medications or in the proportion of postmenopausal visits (all ps $> .30$). Hence, the proportion of visits with HRT for each participant was included as a possible covariate at Level 2. Ethnicity was also included as a possible covariate at Level 2, given the group differences on this variable and because ethnicity often predicts cardiovascular outcomes. Income could not be considered as a covariate because of missing data (20%). Furthermore, we considered income a plausible mediator (rather than a confound) of marital group differences, as a measure of access to resources. Level 2 covariates were included in the equations for both the intercept and slope outcomes and were centered about the sample mean before entry. Only ethnicity was included as a possible covariate in the analyses concerning lifestyle and psychosocial risk factors, because hormonal factors were not expected to affect these outcomes beyond the effects of age. Covariates selected for each analysis are noted in Tables 3 and 4.

We next used models that included only those covariates related to outcomes at $p < .10$, to test for the presence of residual interindividual heterogeneity for random effects (i.e., intercepts and slopes) and to ensure that intercept and slope parameters could be estimated with at least minimal reliability (i.e., .05; Bryk & Raudenbush, 1992). Coefficients with minimal interindividual variability or inadequate reliabilities were treated as fixed effects, and the marital group contrasts were not entered for these outcomes. In the analyses for the biological outcomes, chi-square tests indicated substantial remaining interindividual variability in average levels and trajectories of all risk factors (ps $< .01$), after controlling for the covariates. Reliabilities for the intercept coefficients ranged from .86 (fasting glucose) to .94 (HDL-c), and reliabilities for slope coefficients ranged from .16 (fasting glucose) to .50 (SBP). The analyses for lifestyle factors suggested substantial residual interindividual variability in the average risk factor levels for all outcomes and in changes for BMI and exercise (all ps $< .01$). The analysis for smoking showed that although the cohort was less likely to smoke as they aged overall, little variability existed among individuals. Thus, the slope parameter was treated as fixed in the marital group analysis for smoking. Reliabilities for the random coefficients from the lifestyle factor models ranged between .57 (smoking) to .99 (BMI) for intercepts and between .21 (exercise) to .62 (BMI) for slopes. Analyses for psychosocial factors showed substantial residual interindividual variance in intercept parameters for all outcomes and in slope parameters for Depression, Anger-In, and Anger-Out (ps $< .01$). Analyses for Trait Anger and Anxiety, Stress, and Social Support suggested little interindividual variance and low reliabilities for slope coefficients, and these parameters were, therefore, treated as fixed in the marital group analyses. Across the sample, women showed a significant decrease in Anger, Anxiety, and Stress and a significant increase in Support with age. Among the random coefficients in the psychosocial risk factor models, intercept reliabilities ranged from .75 (Stress) to .87 (Depression, Anxiety), and slope reliabilities ranged from .15 (Depression) to .25 (Anger-Out).

Biological and Lifestyle Risk Factors

Table 3 summarizes the analyses concerning the differences among the marital status and satisfaction groups in the levels and trajectories of biological and lifestyle risk factors. Addition of the marital grouping variables resulted in a significant improvement in model fit, relative to covariates-only models, for SBP ($p < .10$), DBP, HDL, BMI, and physical inactivity. The marital grouping

Table 3
Prediction of the Level 1 Effects for the Biological and Lifestyle Risk Factors, Comparing the Satisfied Group With All Other Groups at Level 2

	Satisfied		Moderately satisfied		Low satisfied		Single		Divorced		Widowed			
Variable	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	R^2	$\chi^2(10)$[i]
SBP (mm/Hg)[a,b,c]														17.45†
Intercept[d]	114.44	0.90	−1.74	1.73	1.04	1.68	2.63	2.29	−4.09*	1.86	1.96	2.60	.02	
Slope[c]	1.54	0.10	0.06	0.18	−0.13	0.14	0.43†	0.24	−0.11	0.20	0.40	0.35	.03	
DBP (mm/Hg)[b,c]														22.06**
Intercept[d,e]	72.71	0.50	−0.54	1.07	0.00	0.98	1.34	1.31	−2.10†	1.11	0.80	1.77	.02	
Slope	−0.12	0.04	0.06	0.09	−0.02	0.08	0.34*	0.13	0.05	0.11	0.50*	0.20	.10	
HDL-c (mg/dl)[a,b]														20.84*
Intercept[d]	61.13	0.90	−0.10	1.80	−3.42*	1.71	−3.48	2.33	−4.33*	1.78	1.57	3.55	.02	
Slope	0.03	0.08	−0.09	0.16	−0.22†	0.11	−0.09	0.14	−0.48**	0.14	0.21	0.19	.07	
LDL-c (mg/dl)[a,b,c]														12.12
Intercept	119.46	1.82	3.32	3.57	7.57*	3.64	3.89	3.78	0.51	4.39	−3.88	6.43	.01	
Slope	1.20	0.17	0.16	0.27	−0.14	0.25	0.33	0.36	0.56	0.35	0.24	0.65	.06	
Triglycerides (mg/dl)[a,b,c,f,g]														9.26
Intercept[e]	101.21	3.68	−4.75	6.38	12.06*	6.88	1.42	7.57	2.35	7.08	−10.81	9.85	.02	
Slope	2.87	0.31	−0.20	0.68	0.40	0.58	0.12	0.74	−0.17	0.70	−0.82	0.69	.01	
Fasting glucose (mg/dl)[f,g,h]														15.50
Intercept	88.20	0.65	0.09	1.17	1.72	1.27	−1.21	1.07	0.78	1.49	−1.61	1.25	.01	
Slope	1.35	0.06	0.18	0.14	0.27*	0.12	0.06	0.13	0.32**	0.12	−0.19	0.16	.09	
BMI (kg/m^2)[f,g]														23.91**
Intercept[c]	25.76	0.31	0.47	0.74	0.94†	0.59	1.78†	1.10	−0.01	0.63	0.75	1.06	.01	
Slope[e]	0.16	0.01	0.06†	0.03	0.02	0.03	0.08†	0.06	0.09**	0.04	0.17**	0.06	.05	
Exercise (kcal past week)[g]														35.59**
Intercept[e]	1,802.31	77.53	−187.67	143.54	−323.15**	130.76	−689.23**	161.61	−338.29*	157.41	−322.36	277.29	.06	
Slope	59.96	10.43	−35.25	21.04	−27.62	20.96	−43.23	16.85	−56.78	29.76	−48.09*	24.10	.07	

Note. Age and Level 1 covariates were centered about the person's mean. Level 2 covariates were centered about the sample mean. SBP = systolic blood pressure; DBP = diastolic blood pressure; HDL-c = high-density-lipoprotein cholesterol; LDL-C = low-density-lipoprotein cholesterol; BMI = body mass index.
[a] Analysis controlled for menopausal status at Level 1. [b] Analysis controlled for hormone replacement therapy (HRT) use at Level 1. [c] Analysis controlled for outcome-specific medication use at Level 1. [d] Analysis controlled for proportions of visits with HRT use at Level 2. [e] Analysis controlled for ethnicity at Level 2. [f] Analyses and significance levels are based on log-transformed data. To facilitate interpretation, coefficients and standard errors are from nontransformed analyses. [g] R^2 values are from nontransformed analyses. Accurate R^2 estimates could not be calculated from log-transformed data because variance components were extremely small. [h] Outliers greater than four standard deviations from the mean were removed before analysis to normalize the distribution. [i] For SBP, $N = 473$ (overall $N = 493$); for DBP, $N = 473$ (overall $N = 493$); for HDL-c, $N = 470$ (overall $N = 492$); for LDL-c, $N = 470$ (overall $N = 492$); for triglycerides, $N = 470$ (overall $N = 492$); for fasting glucose, $N = 468$ (overall $N = 491$); for BMI, $N = 489$ (overall $N = 493$); for exercise, $N = 490$ (overall $N = 492$).
† $p < .10$. * $p < .05$. ** $p < .01$.

Table 4
Prediction of the Level 1 Effect for the Psychosocial Risk Factors, Comparing the Satisfied Group With All Other Groups at Level 2

	Satisfied		Moderately satisfied		Low satisfied		Single		Divorced		Widowed			
Variable	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	γ	*SE*	R^2	$\chi^2(10)$[c]
Depression[a]													.16	84.74**
Intercept	3.44	0.19	1.20*	0.52	4.29**	0.57	1.46**	0.61	2.79**	0.67	1.52	0.73		
Slope	0.08	0.02	0.12	0.06	−0.02	0.06	0.03	0.06	−0.05†	0.05	0.17†	0.12	.14	
Trait anxiety														57.68**
Intercept	16.04	0.23	1.36**	0.52	3.60**	0.53	1.98**	0.69	1.88**	0.59	2.07*	1.02	.13	
Trait anger														25.97**
Intercept	16.88	0.22	0.09	0.47	1.98**	0.44	0.66	0.50	0.79†	0.47	1.51†	0.80	.06	
Anger-in														31.57**
Intercept[b]	14.04	0.20	0.85†	0.45	1.69**	0.40	1.84**	0.63	0.77	0.49	1.30†	0.76	.06	
Slope	−0.02	0.05	0.19†	0.11	−0.13	0.11	−0.13	0.12	−0.02	0.12	0.09	0.13	.11	
Anger-out														19.18**
Intercept	14.21	0.18	−0.56	0.37	0.87*	0.38	−0.89*	0.37	0.22	0.39	−0.46	0.74	.04	
Slope[b]	−0.18	0.04	−0.02	0.12	0.10	0.08	0.01	0.08	−0.02	0.10	−0.01	0.18	.00	
Appraisal support[a]														40.53**
Intercept[b]	8.39	0.09	−0.49**	0.19	−1.48**	0.26	−0.91**	0.31	−0.48†	0.26	−0.76†	0.46	.10	
Perceived stress														
Intercept[b]	10.64	0.17	1.22**	0.37	2.50**	0.35	1.28**	0.44	1.90**	0.40	1.30†	0.71	.15	63.34**

Note. Age was centered about the person's mean. When included, ethnicity was centered about the sample mean.
[a] Analyses and significance levels are based on log-transformed data. To facilitate interpretation, coefficients and standard errors are from nontransformed analyses. [b] Analysis controlled for ethnicity at Level 2. [c] For depression, $N = 493$ (overall $N = 493$); for trait anxiety, $N = 493$ (overall $N = 493$); for trait anger, $N = 493$ (overall $N = 493$); for anger-in, $N = 490$ (overall $N = 490$); for anger-out, $N = 490$ (overall $N = 493$); for appraisal support, $N = 493$ (overall $N = 493$); for perceived stress, $N = 493$ (overall $N = 493$).
† $p < .10$. * $p < .05$. ** $p < .01$.

variables did not make a significant contribution to model fit for LDL-c, trigylcerides, or fasting glucose, although some specific between-group differences emerged.

Pairwise contrasts revealed that relative to the satisfied group, the moderately satisfied women tended to have larger increases in BMI over time ($p < .10$). The low-satisfied women had higher BMIs, and lower exercise and HDL-c levels on average, and they also tended to show a higher risk trajectory on HDL-c (i.e., decreasing over time; $p < .10$), when compared with the satisfied group. Relative to the satisfied group, single women reported less physical activity and a tendency toward higher BMIs ($p < .10$), and they also tended to show increasing risk over time on SBP ($p < .10$), DBP, and BMI ($p < .10$). Divorced women had lower average SBP levels and marginally lower DBP levels across all measures when compared with the satisfied group. They also reported less exercise, had lower HDL-c levels, and showed higher risk trajectories on both BMI and HDL-c. The widowed group showed a higher risk trajectory on DBP, BMI, and exercise behavior, relative to the satisfied group. Finally, with the exception of the widowed women, all comparison groups were more likely to report smoking when compared with the satisfied participants (data not shown in table). The satisfied group showed a .04 probability (95% confidence interval [CI] = 0.03, 0.07) of smoking on average across visits, whereas the probabilities of smoking for the other groups were as follows: For the moderately satisfied group, $p < .13$ (95% CI = 0.06, 0.26); for the low-satisfied group, $p < .15$ (95% CI = 0.08, 0.28); for the single group, $p < .18$ (95% CI = 0.07, 0.39); for the divorced group, $p < .27$ (95% CI = 0.13, 0.48); for the widowed group, $p < .14$ (95% CI = 0.04, 0.41; *ns*).

Psychosocial Risk Factors

As shown in Table 4, addition of the marital grouping variables resulted in a significant improvement in model fit, relative to the covariates-only models, for all psychosocial scales. In aggregate, the between-groups contrasts supported the hypothesis that the satisfied group would show a less risky psychosocial profile relative to the other groups. Analyses that included slope effects were less consistent. The divorced group tended to show a lower risk trajectory (i.e., a smaller increase) and the widowed group tended to show a higher risk trajectory for depressive symptoms when compared with the satisfied group, although both of these differences were only marginally significant. In the analysis for Anger-In, moderately satisfied women showed a marginally higher risk trajectory when compared with satisfied women. The marital contrasts explained negligible variance in Anger-Out trajectories, and the group differences were quite small.

Discussion

The current study demonstrates that when examined in combination, marital status and quality predict the average level of exposure to and, in specific cases, trajectories of cardiovascular risk factors over time, in middle-aged women. In keeping with our hypotheses, women in marriages characterized by high levels of satisfaction showed a health advantage when compared with participants in marriages characterized by low levels of satisfaction and with unmarried participants (i.e., single, widowed, or divorced marital status). To a lesser extent, participants in stable, highly satisfying marriages also showed a health advantage when compared with women in moderately satisfying marriages. Thus, the findings support the approach of examining marital status and quality concurrently (Ross et al., 1990). This may be especially important in studies of women, who seem to show elevated emotional (Whisman, 2000) and physiological responses (Kiecolt-Glaser & Newton, 2001) to marital distress when compared with men. Previous studies that failed to identify a health advantage for married women may have obtained null results because they did not assess marital quality, thereby obscuring the protective effects of supportive relationships.

The higher risk groups displayed differing patterns of elevated levels and trajectories of risk factors. For example, biological risk factor profiles of women in moderately and highly satisfying relationships were quite similar. However, the women in moderately satisfying marriages tended to show relatively adverse psychosocial risk profiles, and these pathways may therefore increase their cardiovascular risk. In contrast, women in relationships characterized by low satisfaction tended to show a more atherogenic biological risk factor profile, particularly on measures of lipids, and they also displayed higher risk on lifestyle and psychosocial factors. Note that with a few exceptions, the low-satisfied married or cohabitating women showed higher levels of cardiovascular risk factors across middle age, rather than showing higher risk trajectories during the follow-up period. Thus, the low-satisfied group may be at higher risk owing to stable exposure to biologic, lifestyle, and psychosocial risk factors, and this is consistent with the pathways hypothesized to link marital distress with cardiovascular morbidity and mortality (Burman & Margolin, 1992; Kiecolt-Glaser & Newton, 2001). On the other hand, given that women were enrolled in the current research during middle age, psychosocial distress could be the antecedent to both low marital quality and biological and lifestyle risk factors. Further research is needed to explore these alternative interpretations with more care, ideally by examining younger women and the dynamic association between marital quality and psychosocial well-being over time.

The analyses revealed comparatively fewer risk differences between the no-partner groups and the maritally satisfied group, owing in part to small sample sizes. Divorced women showed a higher risk profile on measures of HDL-c (average levels and trajectories), BMI (trajectories), and physical activity (average levels), but a lower risk profile on BP (average levels), relative to women in highly satisfying marriages. On the other hand, single and widowed women tended to show higher risk BP, BMI, and physical activity trajectories. Overall, all unmarried groups showed worse lifestyle and psychosocial risk factor profiles when compared with the satisfied group, although again, variations in the patterns and levels of differences occurred.

Note that unmarried women would be expected to show varying levels of risk, due to a number of factors. Some single women (particularly in this relatively high socioeconomic status cohort) are likely to be unmarried by choice and to maintain highly satisfying careers and supportive social networks, whereas others may be at risk due to insufficient financial resources and social isolation. Many of the divorced women may similarly have been exposed to a period of marital stress (similar to the low-satisfied women), but the health implications of this experience could depend on a number of moderating factors, such as the length of the marriage, time since divorce, whether they remarried, and—like the single women—the presence or absence of supplementary financial and social resources. Parallel factors could influence the degree to which widowhood might influence health. Another important question is whether one form of unmarried status results, on average, in higher cardiovascular risk in women, relative to other forms. A recent population-based study by Johnson et al. (2000) suggested that among the unmarried, individuals who are divorced are at especially high risk for cardiovascular mortality compared with their married counterparts, and in the current study, divorced women also seemed to have the highest levels of certain risk factors (e.g., depression, smoking). However, we did not test differences between the unmarried groups statistically, and the pattern of findings lacked consistency across outcomes. Further research, with larger unmarried samples and repeated assessments across time, should more carefully examine the patterns of risk among unmarried groups.

The current study has a number of strengths, including assessing relationship status and satisfaction at two time points to examine the effects of a stable social situation on cardiovascular risk and following an initially healthy cohort and assessing risk factors at multiple time points over more than 13 years, on average. In addition, the study used HLM to facilitate monitoring intraindividual change over time without loss of data due to inconsistent frequency and increment of follow-up visits. Nevertheless, the findings should be interpreted in the light of several limitations.

Monitoring marital satisfaction at all follow-up visits would have been preferable and would have allowed evaluation of the dynamic covariation between marital status–satisfaction and cardiovascular risk factors. Furthermore, the use of a study-specific measure of relationship satisfaction does not permit comparisons of results with data based on standardized scales. Future research should use well-validated scales and might focus concurrently on both positive and negative aspects of marital functioning—factors that are conceptually distinct rather than polar opposites on a single dimension (e.g., Pierce, Sarason, & Sarason, 1991; Ruehlman & Karoly, 1991).

Evaluating risk associated with marital status and satisfaction from an earlier developmental stage would be preferable for studying trajectories. For the most part, the higher risk groups seemed to maintain an elevated level of risk across the entire study, suggesting that by middle age, the cumulative influence of being single, divorced, or widowed or of being in a distressed relationship had already occurred. Research with younger couples would help to identify how and when women in distressed marriages and unmarried women develop higher risk cardiovascular profiles. Longitudinal research would also help disentangle the temporal association between emotional and marital distress, although previous research suggests that these variables are most likely mutually reinforcing and cyclically related across time (Beach, Fincham, & Katz, 1998; Fincham & Beach, 1999).

Given the relatively small sample size of some groups and possible implications for power, we did not adjust the alpha level to protect against Type I error. The number of analyses performed must therefore temper the interpretation of the results. However, the significant findings are notable for their consistency in supporting our a priori hypothesis that satisfied women would show lower risk; in fact, only 3 out of 62 marginal or significant contrasts were contradictory to predictions (i.e., satisfied women had higher average levels of SBP, DBP, and a larger increase in depression over time when compared with divorced women).

Furthermore, although the parameter estimates are specific to our sample, it is instructive to consider their meaning in the light of estimates derived from observational studies. In population studies, a decrease of 1 mg/dl in HDL-c or an increase of 1 mg/dl in LDL-c is associated with a 3% and 2% higher risk, respectively, for coronary disease in women (Gordon et al., 1989). Hence, relative to satisfied women, the low-satisfied women would be predicted to experience a 10.3% higher risk for coronary disease due to group differences in HDL-c and a 15.1% higher risk due to LDL-c. Despite the generally small effect sizes observed across effects, the identified differences may be important at the population level.

Finally, the results should be interpreted in the context of sample characteristics. The HWS cohort includes women who were initially healthier and higher in socioeconomic status, relative to the general population, and the sample was nearly exclusively White (Matthews et al., 1989). These characteristics may limit the generalizability of the findings, and they prevent an examination of potential ethnic or cultural differences. In addition, the cohort includes only women, and future research investigating gender differences in the effects of marital status and quality on cardiovascular risk would be informative.

Conclusion

The current study demonstrates the utility of concurrently examining marital status and satisfaction in relation to women's cardiovascular risk. Relative to women in highly satisfying relationships, women in less satisfying relationships and unmarried women showed higher levels of cardiovascular risk factors across time. In some cases, women in highly satisfying marriages also showed lower risk trajectories relative to women in other groups. The pathways that lead to higher cardiovascular risk for maritally distressed women may differ from those that increase risk for unmarried women. The current findings and remaining unanswered questions suggest a need for a continued focus on marital relationships and cardiovascular health.

References

Allain, C. C., Poon, L. S., Chan, C. S., Richmond, W., & Fu, P. C. (1974). Enzymatic determination of total serum cholesterol. *Clinical Chemistry, 20,* 470–475.

Baker, B., Helmers, K., O'Kelly, B., Sakinofsky, I., Abelsohn, A., & Tobe, S. (1999). Marital cohesion and ambulatory blood pressure in early hypertension. *American Journal of Hypertension, 12,* 227–230.

Baker, B., Paquette, M., Szalai, J. P., Driver, H., Perger, T., Helmers, K., et al. (2000). The influence of marital adjustment on 3-year left ventricular mass and ambulatory blood pressure in mild hypertension. *Archives of Internal Medicine, 160,* 3453–3458.

Beach, S. R. H, Fincham, F. D., & Katz, J. (1998). Marital therapy in the treatment of depression: Toward a third generation of therapy and research. *Clinical Psychology Review, 18,* 635–661.

Beck, A. T., & Beamesderfer, A. (1974). Assessment of depression: The depression inventory. In P. Pinchot (Ed.), *Psychological measurements in psychopharmacology* (pp. 151–169). Basel, Switzerland: Karger Press.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review, 8,* 77–100.

Berkman, L. F. (1995). The role of social relations in health promotion. *Psychosomatic Medicine, 57,* 245–254.

Berkman, L. F., & Glass, T. (2000). Social integration, social networks, social support, and health. In L. F. Berkman & I. Kawachi (Eds.), *Social epidemiology* (pp. 137–173). New York: Oxford.

Broadwell, S. D., & Light, K. C. (1999). Family support and cardiovascular responses in married couples during conflict and other interactions. *International Journal of Behavioral Medicine, 6,* 40–63.

Brummett, B. H., Barefoot, J. C., Siegler, I. C., Clapp-Channing, N. E., Lytle, B. L., Bosworth, H. B., et al. (2001). Characteristics of socially isolated patients with coronary artery disease who are at elevated risk for mortality. *Psychosomatic Medicine, 63,* 267–272.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Applications and data analysis methods*. Newbury Park, CA: Sage.

Bucolo, G., & David, H. (1973). Quantitative determination of serum triglycerides by the use of enzymes. *Clinical Chemistry, 19,* 476–482.

Burker, E. J., Fredrikson, M., Rifai, N., Siegel, W., & Blumenthal, J. A. (1994). Serum lipids, neuroendocrine, and cardiovascular responses to stress in men and women with mild hypertension. *Behavioral Medicine, 19,* 155–161.

Burman, B., & Margolin, G. (1992). Analysis of the association between marital relationships and health problems: An interactional perspective. *Psychological Bulletin, 112,* 39–63.

Carels, R. A., Sherwood, A., Szczepanski, R., & Blumenthal, J. A. (2000). Ambulatory blood pressure and marital distress in employed women. *Behavioral Medicine, 26,* 80–85.

Cesana, G., Panza, G., Ferrario, M., Zanettini, R., Arnoldi, M., & Grieco, A. (1985). Can glycosylated hemoglobin be a job stress parameter? *Journal of Occupational Medicine, 27,* 357–360.

Cohen, S. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan & S. Oskamp (Eds.), *The social psychology of health: The Claremont Symposium on Applied Social Psychology* (pp. 31–67). Thousand Oaks, CA: Sage.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24,* 385–396.

Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. M. (1985). Measuring the functional components of social support. In I. G. Sarason & B. Sarason (Eds.), *Social support: Theory, research and applications* (pp. 73–94). The Hague, the Netherlands: Martinus Nijhoff.

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. *American Journal of Cardiology, 88,* 526–529.

Cross, S. E., & Madson, L. (1997). Models of the self: Self-construals and gender. *Psychological Bulletin, 122,* 5–37.

Dischinger, P., & DuChene, A. G. (1986). Quality control aspects of blood pressure measurements in the Multiple Risk Factor Intervention Trial. *Controlled Clinical Trials, 7,* S137–S157.

Ewart, C. K., Taylor, C. B., Kraemer, H. C., & Agras, W. S. (1991). High blood pressure and marital discord: Not being nasty matters more than being nice. *Health Psychology, 10,* 155–163.

Fincham, F. D., & Beach, S. R. H. (1999). Marriage in the new millennium: Is there a place for social cognition in marital research? *Journal of Social & Personal Relationships, 16,* 685–704.

Friedewald, W. T., Levy, R. I., & Fredrickson, D. S. (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry, 18,* 499–502.

Garrow, J. S. (1963). Zero-muddler for unprejudiced sphygmomanometry. *Lancet, 2,* 1205.

Gordon, D. J., Probstfield, J. L., Garrison, R. J., Neaton, J., Castelli, W. P., Knoke, J. D., et al. (1989). High density lipoprotein cholesterol and cardiovascular disease: Four prospective American studies. *Circulation, 79,* 8–15.

Hanson, C. L., Henggeler, S. W., & Burghen, G. A. (1987). Model of associations between psychosocial variables and health-outcome measures of adolescents with IDDM. *Diabetes Care, 10,* 752–758.

Haynes, S. G., Feinleib, M., & Kannel, W. B. (1980). The relationship of psychosocial factors to coronary heart disease in the Framingham Study: III. Eight-year incidence of coronary heart disease. *American Journal of Epidemiology, 111,* 37–58.

Haynes, S. G., Levine, S., Scotch, N., Feinleib, M., & Kannel, W. B. (1978). The relationship of psychosocial risk factors to coronary heart disease in the Framingham Study: I. Methods and risk factors. *American Journal of Epidemiology, 107,* 362–383.

Hazuda, H. P. (1994). A critical evaluation of U.S. epidemiological evidence and ethnic variation. In S. A. Shumaker & S. M. Czajkowski (Eds.), *Social support and cardiovascular disease* (pp 119–142). New York: Plenum.

Hedeker, D. (in press). An introduction to growth modeling. In D. Kaplan (Ed.), *Quantitative methodology for the social sciences*. Thousand Oaks, CA: Sage.

Helgeson, V. S. (1991). The effects of masculinity and social support on recovery from myocardial infarction. *Psychosomatic Medicine, 53,* 621–633.

Helgeson, V. S. (1994). Relation of agency and communion to well-being: Evidence and potential explanations. *Psychological Bulletin, 116,* 412–428.

House, J. S., Landis, K. R., & Umberson, D. (1988, July 29). Social relationships and health. *Science, 241,* 540–545.

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.

Kiecolt-Glaser, J. K., Glaser, R., Cacioppo, J. T., MacCallum, R. C., Snydersmith, M., Kim, C., & Malarkey, W. B. (1997). Marital conflict in older adults: Endocrinological and immunological correlates. *Psychosomatic Medicine, 59,* 339–349.

Kiecolt-Glaser, J. K., & Newton, N. (2001). Marriage and health: His and hers. *Psychological Bulletin, 127,* 472–503.

Litwak, E., & Messeri, P. (1989). Organizational theory, social supports, and mortality rates: A theoretical convergence. *American Sociological Review, 54,* 49–66.

Markovitz, J. H., Raczynski, J. M., Wallace, D., Chettur, V., & Chesney, M. A. (1998). Cardiovascular reactivity to video game predicts subsequent blood pressure increases in young men: The CARDIA study. *Psychosomatic Medicine, 60,* 186–191.

Matthews, K. A., Meilahn, E., Kuller, L. H., Kelsey, S. F., Caggiula, A. W., & Wing, R. R. (1989). Menopause and risk factors for coronary heart disease. *New England Journal of Medicine, 321,* 641–646.

Matthews, K. A., Owens, J. F., Kuller, L. H., Sutton-Tyrrell, K., Lassila, H. C., & Wolfson, S. K. (1998). Stress-induced pulse pressure change predicts women's carotid atherosclerosis. *Stroke, 29,* 1525–1530.

Matthews, K. A., Woodall, K. L., & Allen, M. T. (1993). Cardiovascular reactivity to stress predicts future blood pressure status. *Hypertension, 22,* 479–485.

Mayne, T. J., O'Leary, A., McCrady, B., Contrada, R., & Labouvie, E. (1997). The differential effects of acute marital distress on emotional, physiological and immune functions in maritally distressed men and women. *Psychology and Health, 12,* 277–288.

McCann, B. S., Benjamin, A. H., Wilkinson, C. W., Carter, J., Retzlaff, B. M., Russo, J., & Knopp, R. H. (1996). Variations in plasma lipid concentrations during examination stress. *International Journal of Behavioral Medicine, 3,* 251–265.

Notarius, C. I., Benson, S., Sloane, D., Vanzetti, N., & Hornyak, L. (1989). Exploring the interface between perception and behavior: An analysis of marital interaction in distressed and nondistressed couples. *Behavioral Assessment, 11,* 39–64.

Orth-Gomér, K. (1994). International epidemiological evidence for a relationship between social support and cardiovascular disease. In S. A. Shumaker & S. M. Czajkowski (Eds.), *Social support and cardiovascular disease* (pp. 97–118). New York: Plenum.

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

Paffenbarger, R. S., Wing, A. L., & Hyde, R. T. (1978). Physical activity as an index of heart attack risk in college alumni. *American Journal of Epidemiology, 108,* 161–175.

Peyrot, M. F., & McMurry, J. F. (1985). Psychosocial factors in diabetes control: Adjustment of insulin-treated adults. *Psychosomatic Medicine, 47,* 542–557.

Pierce, G. R., Sarason, I. G., & Sarason, B. R. (1991). General and relationship-based perceptions of social support: Are two constructs better than one? *Journal of Personality and Social Psychology, 61,* 1028–1039.

Raudenbush, S., Bryk, A., Cheong, Y. F., & Congdon, R. (2000). *HLM 5: Hierarchical linear and nonlinear modeling*. Lincolnwood, IL: Scientific Software International.

Rook, K. S. (1990). Social networks as a source of social control in older adults' lives. In H. Giles, N. Coupland, & J. Wiemann (Eds.), *Communication, health, and the elderly* (pp. 45–63). Manchester, England: University of Manchester Press.

Ross, C. E., Mirowsky, J., & Goldsteen, K. (1990). The impact of the family on health: The decade in review. *Journal of Marriage and the Family, 52,* 1059–1078.

Rozanski, A., Blumenthal, J. A., & Kaplan, J. (1999). Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation, 99,* 2192–2217.

Ruehlman, L. S., & Karoly, P. (1991). With a little flak from my friends: Development and preliminary validation of the test of negative social exchange (TENSE). *Psychological Assessment, 3,* 97–104.

Seeman, T. E. (1996). Social ties and health: The benefits of social integration. *Annals of Epidemiology, 6,* 442–551.

Seeman, T. E., Berkman, L. F., Blazer, D., & Rowe, J. W. (1994). Social ties and support and neuroendocrine function: The MacArthur studies of successful aging. *Annals of Behavioral Medicine, 6,* 95–106.

Smith, T. W., Gallo, L. C., Ngu, L., Goble, L., & Stark, K. A. (1998). Agency, communion, and cardiovascular reactivity during marital interaction. *Health Psychology, 17,* 537–545.

Spielberger, C. D., Sydeman, S. J., Owen, A. E., & Marsh, B. J. (1999). Measuring anxiety and anger with the State–Trait Anxiety Inventory (STAI) and the State–Trait Anger Expression Inventory (STAXI). In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcomes assessment* (2nd ed., pp. 993–1021). Mahwah, NJ: Erlbaum.

Stewart, J. C., & France, C. R. (2001). Cardiovascular recovery from stress predicts longitudinal changes in blood pressure. *Biological Psychology, 58,* 105–120.

Stoney, C. M., Bausserman, L., Niaura, R., Marcus, B., & Flynn, M. (1999). Lipid reactivity to stress: II. Biological and behavioral influences. *Health Psychology, 18,* 251–261.

Taylor, S. E., Klein, L. C., Lewis, B. P., Gruenewald, T. L., Gurung, R. A., & Updegraff, J. A. (2000). Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *Psychological Review, 107,* 411–429.

Trevino, D. B., Young, E. H., Groff, J., & Jono, R. T. (1990). The association between marital adjustment and compliance with antihypertension regimens. *Journal of the American Board of Family Practice, 3,* 17–25.

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.

Umberson, D. (1987). Family status and health behaviors: Social control as a dimension of social integration. *Journal of Health & Social Behavior, 28,* 306–319.

Umberson, D. (1992). Gender, marital status and the social control of health behavior. *Social Science & Medicine, 34,* 907–917.

Verdecchia, P. (2000). Prognostic value of ambulatory blood pressure: Current evidence and clinical implications. *Hypertension, 35,* 844–851.

Vitaliano, P. P., Scanlan, J. M., Krenz, C., & Fujimoto, W. (1996). Insulin and glucose: Relationships with hassles, anger, and hostility in nondiabetic older adults. *Psychosomatic Medicine, 58,* 489–499.

Warnick, G. R., & Albers, J. J. (1978). A comprehensive evaluation of the heparin-manganese precipitation procedure for estimating high density lipoprotein cholesterol. *Journal of Lipid Research, 19,* 65–76.

Whisman, M. A. (2000). The association between depression and marital dissatisfaction. In S. R. H. Beach (Ed.), *Marital and family processes in depression: A scientific foundation for clinical practice* (pp. 3–24). Washington, DC: American Psychological Association.

Wickrama, K., Conger, R. D., & Lorenz, F. O. (1995). Work, marriage, lifestyle, and changes in men's physical health. *Journal of Behavioral Medicine, 18,* 97–111.