Marital Quality and Occurrence of the Metabolic Syndrome in Women

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Background: Marital status is associated with the early stages and progression of cardiovascular disease, an association that may stem in part from the influence of marital quality on metabolic factors. The objective of this study was to examine whether women reporting marital satisfaction are at reduced risk of developing the metabolic syndrome compared with other women.

Methods: Four hundred thirteen middle-aged women from the Pittsburgh Healthy Women Study completed measures of marital status and marital satisfaction at baseline and 3 years later. Metabolic syndrome (diagnosed according to the criteria of the National Cholesterol Education Program) was assessed at baseline and at the last follow-up visit (an average of 11.5 years later).

Results: Compared with maritally satisfied women, maritally dissatisfied (odds ratio [OR], 3.02; 95% confidence interval [CI], 1.46-6.24), divorced (OR, 2.47; 95% CI, 1.02-5.97), and widowed (OR, 5.82; 95% CI, 1.88-18.03) women were significantly more likely to have the metabolic syndrome at follow-up. The differences between maritally satisfied women and dissatisfied (OR, 3.18; 95% CI, 1.42-7.15) and widowed (OR, 5.69; 95% CI, 1.70-9.04) women remained significant in the full multivariate model. The difference between maritally satisfied women and divorced women (OR, 2.35; 95% CI, 0.89-6.18) was reduced to marginal significance in the full multivariate model. Single (OR, 2.84; 95% CI, 0.84-9.64) and moderately satisfied (OR, 1.06; 95% CI, 0.35-3.21) women did not differ significantly from maritally satisfied women.

Conclusions: Women in high-quality marriages are at lower risk of developing the metabolic syndrome. Social histories of patients should include assessment of marital quality.

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EVIDENCE SUGGESTS THAT marriage is associated with health benefits for men, including decreased cardiovascular morbidity and mortality,[1-3] but the association in women is less consistent or of lesser magnitude.[4] Paradoxically, several lines of evidence suggest that marriage *should* be associated with better health, perhaps particularly in women. Specifically, marriage may protect against the well-documented risks associated with social isolation, promote health-enhancing behaviors and deter health-damaging behaviors,[5,6] and affect health indirectly by increasing socioeconomic resources.[2] In contrast, given the health costs associated with conflictive social relationships and the fact that marriage is the primary social relationship for most adults, being in an unhappy marriage may serve as a potent psychosocial stressor, thereby elevating disease risk.[7,8] In aggregate, these divergent perspectives on the advantages of having a spouse vs the disadvantages of marital discord suggest the utility of examining marital status and marital quality simultaneously. However, few studies to date have adopted this approach.

See also pages 986 and 1016

The research specifically examining the association between marital quality and cardiovascular health is scant and primarily based in patient populations. For instance, marital quality has been linked with prognosis following myocardial infarction[9] and survival time in patients with congestive heart failure.[10] Although intriguing, these results leave open the possibility of reverse causality (ie, poor health negatively influencing marital quality). Another limitation is that most studies assess marital quality only once, despite the fact that marital quality fluctuates over time.[11]

The clustering of cardiovascular risk factors known as the metabolic syndrome provides an important clinical context for examining plausible pathways between marital processes and risk of cardiovascular disease (CVD). The metabolic syndrome includes mild dyslipid-

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emia, central adiposity, hypertension, and insulin resistance/hyperglycemia. Although each of these risk factors is independently associated with increased risk of CVD and type 2 diabetes, the constellation may have greater prognostic value, possibly due to synergistic effects.[12-14] Reported linkages between the metabolic syndrome and psychosocial risk factors[15-17] suggest that perturbations in metabolic processes may represent a pathophysiological link between psychosocial factors and stress-related illness.[17,18]

The purpose of the present study was to examine the association between marital status and marital quality and the risk of developing the metabolic syndrome in the Pittsburgh Healthy Women Study. In this sample, we previously observed that marital quality was related to individual risk factors, including blood pressure, high-density lipoprotein cholesterol levels, and body mass index but not low-density lipoprotein, triglyceride, or fasting glucose levels.[19] In the present analysis, we hypothesized that women in highly satisfying marriages would be at lower risk of developing the metabolic syndrome across 11.5 years compared with women who consistently reported marital dissatisfaction or women who were single, divorced, or widowed. Given strong correlations between marital discord and psychological characteristics such as depression, anxiety, and lack of social support that have been shown to predict CVD morbidity and mortality,[20,21] a secondary purpose was to examine whether marital quality/status is independently associated with the metabolic syndrome.

METHODS

STUDY POPULATION

The participants were 413 women from the Pittsburgh Healthy Women Study, an ongoing prospective investigation of the changes in behavioral, psychosocial, and biological characteristics of women during the perimenopausal and postmenopausal years. Detailed descriptions of the recruitment are available elsewhere.[22] Between 1983 and 1985, 541 participants were recruited from a random sample of licensed drivers in Allegheny County, Pennsylvania. Participants were aged 42 through 50 years at study entry, and 90% were non-Hispanic whites.

The Institutional Review Board at the University of Pittsburgh, Pittsburgh, Pa, approved this project, and all participants gave informed consent. To be eligible, women had to have had a menstrual period in the previous 3 months, could not be taking hormone replacement therapy, had to have a diastolic blood pressure lower than 100 mm Hg, could not be surgically menopausal (no hysterectomy), could not have a diagnosis of diabetes or hypertension, and could not be taking thyroid, lipid-lowering, or psychotropic medications. At the time of this report, 12 women (2.2%) had died and 57 women (10.5%) had dropped out. The current analysis excluded women who were seen only for the baseline visit (n=14), women who were missing metabolic syndrome data at follow-up (n=11), women who were missing data for marital status or satisfaction at baseline or at 3-year follow-up (n=4), women who experienced a marital status change (n=23), and women who showed a large change in marital satisfaction (ie, change score at least 3 SDs greater than the mean sample change score) between the baseline and 3-year follow-up (n=7). Women in the analysis were more physically active, were younger, had higher high-density lipoprotein cholesterol levels, and were less depressed and anxious than women not in the analysis who participated in both the baseline visit and 3-year follow-up ($P<.05$).

PROCEDURE

The participants underwent baseline examinations in which demographic characteristics and biological, behavioral, and psychosocial risk factors were assessed, and they mailed cards monthly to indicate whether they had menstruated. Women returned for a follow-up evaluation after 12 successive months without menstruating and then returned every several years thereafter at approximately 3-year intervals, or 3, 5, 8, and 11 to 12 years postmenopause. In addition, all women attended a clinic visit 3 years after baseline (ie, 3-year follow-up), regardless of menopausal status.

MARITAL STATUS/QUALITY GROUPING

Participants reported their marital status and, if married or cohabitating, completed a study-specific 7-item measure of marital quality. The measure used a 4-point Likert scale to assess satisfaction with amount of time spent together, satisfaction with communication, satisfaction with sexual activity, agreement on financial matters, and similarity of interests, lifestyle, and temperament, with possible scores ranging from 0 to 21. The scale showed good internal consistency at both assessments ($\alpha=0.87$ at the baseline and 3-year follow-up visits), and scores at the two time points were highly correlated ($r_{375}=0.78$, $P<.001$). The scale was also highly correlated with a standardized and well-validated marital quality measure administered 17 years later, the Marital Adjustment Test ($r=0.50$, $P<.001$).[23]

The distribution of scores was negatively skewed at both time points, with most women describing their relationships as satisfying. The lower third (score <13) was chosen as the cutoff point for dissatisfaction, and the following groups were created: a satisfied group consisting of married or cohabitating women who scored in the upper two thirds of the distribution on the relationship satisfaction measure at both assessments (n=187), a moderately satisfied group consisting of married or cohabitating women who scored in the lower third of the distribution at one of the two assessments (n=52), and a dissatisfied group consisting of married or cohabitating women who scored in the lower third of the distribution on both occasions (n=84). On average, the dissatisfied women endorsed being "not too satisfied" in their marriage. The unpartnered groups were single (n=28), divorced or separated (n=48), or widowed (n=17).

METABOLIC SYNDROME

At the baseline and follow-up clinic visits, a blood draw was collected following a 12-hour fast. Glucose levels were analyzed by enzymatic assay (Yellow Springs Glucose Analyzer; Yellow Springs Instruments, Yellow Springs, Ohio). Triglyceride and high-density lipoprotein cholesterol levels were assayed by the Heinz Nutrition Laboratory (Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa), a laboratory certified by the Centers for Disease Control and Prevention (Atlanta, Ga). Waist circumference was measured using a measuring tape at the narrowest point between the iliac crest and the lowest rib. Height and weight were measured to allow calculation of the body mass index.

The primary outcome was the presence or absence of the metabolic syndrome at the latest follow-up visit, as quantified by the guidelines of the National Cholesterol Education Program's Adult Treatment Panel III report[24]; specifically, the presence of 3 or more of the following risk factors: fasting glucose level of 110 mg/dL or greater (≥6.1 mmol/L), triglyceride level

Table 1. Sociodemographic Characteristics and the Metabolic Syndrome at Baseline by Relationship Group in 413 Patients*

Variable	Satisfied (n = 186)	Moderately Satisfied (n = 51)	Dissatisfied (n = 84)	Single (n = 28)	Divorced (n = 47)	Widowed (n = 17)
White†	181 (97)	44 (86)	72 (86)	27 (96)	37 (79)	15 (88)
Education‡						
High school or less	47 (25)	16 (31)	36 (43)	3 (11)	13 (28)	6 (35)
Some college	42 (23)	10 (20)	16 (19)	7 (25)	11 (23)	6 (35)
4-Year degree	43 (23)	11 (22)	18 (21)	9 (32)	12 (26)	4 (24)
Advanced degree	54 (29)	14 (27)	14 (17)	9 (32)	11 (23)	1 (6)
Income, $/y§‖						
<30 000	13 (9)	4 (10)	16 (24)	12 (57)	31 (70)	9 (69)
30 000-49 999	42 (29)	12 (30)	24 (35)	9 (43)	11 (25)	3 (23)
50 000-69 999	32 (22)	6 (15)	13 (19)	0 (0)	2 (5)	1 (8)
>70 000	60 (41)	18 (45)	15 (22)	0 (0)	0 (0)	0 (0)
Metabolic syndrome¶	6 (3)	2 (4)	7 (8)	1 (4)	3 (6)	0 (0)

*Values are given as number (percentage).
†$\chi^2_{15} = 35.64$, $P = .002$.
‡$\chi^2_{15} = 19.91$, $P = .18$.
§$\chi^2_{15} = 121.50$, $P < .001$.
‖In each group some subjects did not indicate their income (333 of the 413 subjects responded to this question).
¶$\chi^2_5 = 4.75$, $P = .45$.

of 150 mg/dL or greater (≥1.70 mmol/L), high-density lipoprotein cholesterol level lower than 50 mg/dL (<1.30 mmol/L), waist circumference greater than 88 cm, systolic blood pressure of 135 mm Hg or greater, and/or diastolic blood pressure of 85 mm Hg or greater. Use of antihypertensive or glucose-lowering medications was a proxy for elevated blood pressure values or glucose abnormalities. Waist circumference was not measured until the first follow-up examination of the Pittsburgh Healthy Women Study but was available at all subsequent visits. Therefore, we included body mass index greater than 30 as a surrogate measure of central adiposity for the baseline assessment of the metabolic syndrome. Body mass index and waist circumference were highly correlated across assessments ($r > 0.80$). For the follow-up metabolic syndrome evaluation we used data from the latest clinic visit available, which occurred on average 11.5 years following the baseline clinic visit (SD, 2.6 years; range, 2.6-15.9 years). The groups did not differ in length of follow-up ($P = .64$).

BEHAVIORAL AND PSYCHOSOCIAL COVARIATES

History of ever smoking (yes/no) and alcohol intake (amount of alcohol per day converted into grams of absolute alcohol) were assessed via self-report at the baseline examination. The Paffenbarger activity questionnaire,[25] administered at baseline, was used to measure energy expended per week in leisure-time activities. Information on the use of hormone replacement therapy was collected via self-report at the latest follow-up examination.

Baseline levels of depression, anxiety, and perceived social support were used as covariates. The Beck Depression Inventory[26] was used to evaluate depressive symptoms. Anxiety was measured with a 10-item version of the Spielberger State-Trait Anxiety Inventory.[27] Perceived social support was measured with the 10-item appraisal (ie, emotional) support subscale of the Interpersonal Support Evaluation List.[28]

STATISTICAL ANALYSIS

Pearson χ^2 analyses and *t* tests were used to test differences in sociodemographic characteristics and metabolic status at baseline. Hierarchical logistic regression analyses were used to examine the association between marital status/quality and the risk of having the metabolic syndrome at the latest visit. Age, length of follow-up, and baseline metabolic syndrome status (ie, present or absent) were covariates in all models. To test our hypotheses concerning the relative health advantage of maritally satisfied women, 4 dummy codes were entered into the equation comparing maritally satisfied women with women reporting low satisfaction at both time points (ie, dissatisfied), women reporting low satisfaction at only one assessment (ie, moderately satisfied), single women, divorced or separated women, and widowed women.

To test whether these effects were explained by sociodemographic, behavioral, or psychosocial characteristics of the participants, the following blocks of variables were entered prior to the marital codes in separate models: (1) ethnicity and education (used in place of income due to missing data); (2) history of smoking, use of hormone replacement therapy, energy expended per week in leisure-time activity, and alcohol consumption; and (3) depression, anxiety, and social support. The final full model adjusted for age, duration of follow-up, baseline metabolic syndrome status, sociodemographic characteristics, and behavioral and psychosocial risk factors. $P < .05$ was considered statistically significant.

RESULTS

The average age of the sample at baseline was 47.1 years (SD, 1.6 years) and was similar among groups. The sample was predominantly non-Hispanic white (91%), with a larger proportion of divorced women being black (**Table 1**). There were no group differences in educational attainment. A larger proportion of those in the unpartnered groups were in the lower income categories ($P < .001$), but bivariate tests showed no differences in income among the unpartnered groups (analyses not shown). Among the married women, a larger proportion of those in the dissatisfied group was in the lower income categories ($P = .03$; analyses not shown). Nine-

teen women (4.6%) had the metabolic syndrome at baseline, but there were no group differences in the likelihood of having the syndrome at study entry. At follow-up (**Figure**), dissatisfied women (odds ratio, 3.02; 95% confidence interval, 1.46-6.24), divorced women (odds ratio, 2.47; 95% confidence interval, 1.02-5.97), and widowed women (odds ratio, 5.82; 95% confidence interval, 1.88-18.03) were more likely than maritally satisfied women to have the metabolic syndrome.

The effects comparing maritally satisfied women with maritally dissatisfied women and with widowed women remained significant after adjusting for sociodemographic characteristics, although the maritally satisfied vs divorced contrast was only marginally significant ($P=.06$, model 1; **Table 2**). In the analysis controlling for behavioral risk factors, metabolic syndrome at baseline, smoking status, and differences between the maritally satisfied group and the dissatisfied, divorced, and widowed groups were all statistically significant ($P<.05$, model 2; Table 2).

None of the psychosocial risk factors was associated with the metabolic syndrome (model 3; Table 2), and the differences between the maritally satisfied group and the dissatisfied and widowed groups remained significant ($P<.05$). In addition, the differences between the maritally satisfied group and the single and divorced groups approached significance in this model ($P=.09$ and $P=.07$, respectively).

The differences between the maritally satisfied women and the dissatisfied and widowed women remained significant in the fully adjusted model ($P=.005$ for both; **Table 3**). The differences between the maritally satisfied and the single ($P=.09$) and divorced ($P=.08$) women approached significance.

To explore the possibility that marital quality affects risk of metabolic syndrome through initial weight and weight gain over time, baseline weight and change in weight from baseline to the last follow-up were adjusted statistically. The differences between maritally satisfied women and maritally dissatisfied and widowed women remained significant ($P=.01$ for both; data not shown); however, the difference between maritally satisfied and divorced women was no longer significant ($P=.10$).

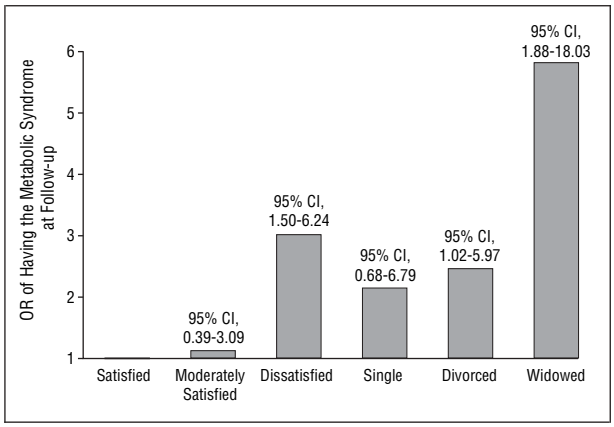

Figure. Odds ratio (OR) of having the metabolic syndrome at follow-up according to marital status and quality, adjusting for age, duration of follow-up, and metabolic syndrome at baseline. CI indicates confidence interval.

COMMENT

In the present study we tested whether women reporting satisfaction in their marriage were at lower risk of developing the metabolic syndrome than maritally dissatisfied women or unpartnered women (ie, single, widowed, or divorced). Our predictions were based on the notion that positive marital relationships buffer stressful events by providing both material and support benefits, whereas negative relationships or lack of a relationship may exacerbate and even cause stress. In the full multivariate model, married women who reported consistent marital dissatisfaction were at higher risk of developing the metabolic syndrome than those who reported consistent marital satisfaction. Divorced women tended to be at elevated risk compared with maritally satisfied women, presumably because of enduring exposure to marital discord and the concomitant stress of divorce, including socioeconomic decline. Widowed women were also at higher risk of developing the metabolic syndrome than maritally satisfied women, perhaps because of the cumulative effects of bereavement and the stressors associated with losing a spouse,[29,30] but these results must be considered in the context of the small sample size. Moreover, evidence suggests that the adverse effects of widowhood are most evident in the first 2 years following bereavement[31,32]; however, the power of this study was insufficient to analyze this possibility. Interestingly, the comparisons between maritally satisfied women and single women were not statistically significant, perhaps because of the diversity of experiences of single women, especially in a cohort with relatively high socioeconomic status. Finally, women who reported marital dissatisfaction at one but not both assessments (ie, moderately satisfied) were not at greater risk, suggesting that the chronicity of relationship distress may be the key factor contributing to metabolic risk.

Previous research suggests that marital distress is associated with behavioral and psychosocial risk factors for CVD[5,33] as well as immune-inflammatory and hemodynamic responses that may affect metabolic regulation.[34,35] The present results remained significant after controlling for age, demographic characteristics, and psychosocial and behavioral risk factors, suggesting that marital quality has unique effects on cardiovascular health. Notably, the marital variables accounted for approximately 5% of the variance in the metabolic syndrome, whereas known behavioral risk factors, including smoking history and physical activity, accounted for only 2% of the variance.

Limitations of the study include the use of a study-specific relationship measure, the use of body mass index as a surrogate for central adiposity at baseline, and the fact that our findings can only be generalized to relatively healthy white women.

Metabolic syndrome is a prevalent condition in middle-aged women, with an estimated rate of roughly 32% for women aged 50 through 59 years.[36] This rate is likely to increase in the future, given the epidemic of obesity occurring in the United States today.[37] Given that the metabolic syndrome is at least as important a risk factor for cardiovascular mortality in women as it is in men,[36,38] our

Table 2. Adjusted Logistic Regression Model Predicting Presence of the Metabolic Syndrome According to Relationship Group*

Covariate	β	ΔR^2	*P* (for ΔR^2)	Odds Ratio (95% Confidence Interval)	*P* (for Odds Ratio)
		Model 1			
Step 1 (sociodemographic characteristics)†		.21	<.001		
Step 2 (relationship group): satisfied vs		.05	.03		
Dissatisfied	0.95			2.57 (1.23-5.40)	.01
Moderately satisfied	–0.06			0.94 (0.32-2.78)	.91
Single	0.91			2.49 (0.77-8.05)	.13
Divorced	0.86			2.37 (0.95-5.90)	.07
Widowed	1.54			4.65 (1.45-14.95)	.01
		Model 2			
Step 1 (behavioral risk factors)‡		.18	<.001		
Step 2 (relationship group): satisfied vs		.05	.008		
Dissatisfied	1.09			2.96 (1.41-6.22)	.004
Moderately satisfied	0.11			1.11 (0.39-3.18)	.84
Single	0.77			2.15 (0.66-6.97)	.20
Divorced	0.92			2.51 (1.02-6.21)	.046
Widowed	1.85			6.37 (1.99-20.34)	.002
		Model 3			
Step 1 (psychosocial risk factors)§		.16	<.001		
Step 2 (relationship group): satisfied vs		.06	.007		
Dissatisfied	1.24			3.44 (1.56-7.56)	.002
Moderately satisfied	0.14			1.15 (0.41-3.28)	.79
Single	0.84			2.32 (0.72-7.50)	.16
Divorced	0.86			2.36 (0.95-5.85)	.07
Widowed	1.82			6.17 (1.96-19.42)	.002

*Adjusted for age, baseline metabolic syndrome, length of follow-up, sociodemographic characteristics (race and education; n = 413), behavioral risk factors (smoking history, hormone use, physical activity [energy expended], and alcohol consumption; n = 408), and psychosocial risk factors (depression, anxiety, and social support; n = 412).
†Baseline metabolic syndrome ($P<.001$) and education ($P = .001$) were significant predictors at step 1.
‡Baseline metabolic syndrome ($P<.001$) and smoking history ($P = .03$) were significant predictors at step 1.
§Baseline metabolic syndrome ($P<.001$) was the only significant predictor at step 1.

Table 3. Fully Adjusted Logistic Regression Model Predicting Presence of the Metabolic Syndrome According to Relationship Group

Covariate	β	ΔR^2	*P* (for ΔR^2)	Odds Ratio (95% Confidence Interval)	*P* (for Odds Ratio)
Step 1		.22	<.001		
Age	0.13			1.14 (0.94-1.39)	.19
Length of follow-up (years)	0.07			1.07 (0.94-1.22)	.30
Baseline metabolic syndrome status	2.96			19.25 (5.66-65.44)	<.001
Race (nonwhite/white)	–0.13			0.88 (0.34-2.28)	.79
Education (years)	–0.42			0.66 (0.50-0.86)	.003
Hormone use	–0.11			0.90 (0.49-1.65)	.73
Smoking (no/yes)	0.53			1.71 (0.91-3.21)	.10
Physical activity (energy expended)	0.00			1.00	.54
Alcohol consumption	–0.01			0.99 (0.96-1.02)	.48
Depression	0.03			1.03 (0.96-1.11)	.43
Anxiety	–0.05			0.95 (0.88-1.02)	.17
Social support	0.05			1.05 (0.92-1.21)	.47
Step 2 (relationship group): satisfied vs		.05	.02		
Dissatisfied	1.16			3.18 (1.42-7.15)	.005
Moderately satisfied	0.06			1.06 (0.35-3.21)	.92
Single	1.05			2.84 (0.84-9.64)	.09
Divorced	0.85			2.35 (0.89-6.18)	.08
Widowed	1.74			5.69 (1.70-19.04)	.005

data showing that marital quality predicts subsequent metabolic syndrome suggest the clinical utility of assessing marital quality as an integral part of the patient's social history. The current findings were based on a brief 7-item measure of marital quality; a similar assessment could easily be administered in the primary care setting via questionnaire or interview, perhaps in conjunction with a domestic abuse screening.[39] Understanding the

links between marital quality and metabolic risk factors may facilitate coordinated care at an early stage of cardiovascular risk and may ultimately inform primary prevention efforts.

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