

Associations Between Psychological Traits and Endothelial Function in Postmenopausal Women

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Objective: The objective of this study was to determine whether psychosocial risk factors for cardiovascular disease (CVD) are associated with impairments in endothelial function and to determine whether use of hormone replacement therapy (HRT) can moderate observed associations among women without prior CVD. **Methods:** Flow-mediated dilation was assessed by brachial ultrasound after reactive hyperemia in 193 postmenopausal women enrolled in the prospective Healthy Women Study. Measures of psychosocial characteristics had been completed at study entry, when the women were premenopausal (mean = 13.6 years earlier), and at a separate postmenopausal follow-up exam near the time of the ultrasound (mean = 1.5 years earlier). **Results:** Factor analyses of the psychosocial characteristics yielded two factors: Type A/anger and anxiety/depression. Anxiety/depression scores at the study entry and follow-up exams and Type A/anger scores at the study entry exam were associated with less vasodilation (p values < 0.05). Type A/anger scores at the follow-up exam were associated with less vasodilation among women not using HRT (p < .05). **Conclusions:** Psychosocial risk factors for CVD are associated with impaired brachial artery dilation among postmenopausal women. HRT use may mask some associations between psychosocial risk factors and endothelial dysfunction among postmenopausal women. **Key words:** endothelial function, psychosocial characteristics, hormone replacement therapy, menopause, atherosclerosis.

BMI = body mass index; CVD = cardiovascular disease; HRT = hormone replacement therapy; ISEL = Interpersonal Support Evaluation List.

INTRODUCTION

Negative psychosocial characteristics may be risk factors for cardiovascular disease (CVD). Type A behavior (1), hostility (2), trait anger (2), anger suppression (1, 2), anxiety (1), and depression (3) have all been prospectively linked to CVD in women. In contrast, other factors, such as social support, might protect women against the development of disease (4). A recent review of prospective population-based studies indicated that although psychosocial characteristics may increase risk for clinical CVD outcomes, more studies are needed to examine associations between psychosocial characteristics and subclinical measures of disease among healthy individuals (5). Importantly, only 15 of the 43 prospective etiological studies that were reviewed included women.

Women may be protected against CVD until after menopause, probably because of the influence of

reproductive hormones. Circulating estrogens and hormone replacement therapy (HRT) may be protective in part by delaying declines in endothelial function (6). Endothelial function is determined by the ability of a blood vessel to dilate in response to appropriate stimuli, such as an increase in blood flow. Vessels with impaired endothelial function will fail to dilate, or possibly vasoconstrict, in response to an endothelium-dependent vasodilator. Impaired endothelial function is an early marker for atherosclerosis and is highly correlated with other measures of vascular disease, such as coronary artery stenosis and carotid artery intima-media thickness (7, 8). Additionally, among patients undergoing angiography, impaired endothelial function is predictive of subsequent clinical cardiovascular events (9).

It is unknown whether psychosocial traits are related to endothelial function. Recently, Ghiadoni et al. (10) reported that acute mental stress contributed to temporary declines in endothelial function among a sample of healthy middle-aged men. Brachial artery flow-mediated dilation was significantly lower when measured at 30 and 90 minutes after exposure to a 5-minute speech stressor relative to baseline assessments measured before the stress protocol (10). This suggests that psychological factors may influence endothelial function.

The primary purpose of this study was to examine potential relationships between endothelial function and psychosocial characteristics that have been related to clinical CVD in healthy postmenopausal women. The secondary purpose was to determine whether the use of HRT can moderate associations between psychosocial characteristics and endothelial function.

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METHODS

Participants

Endothelial function was evaluated in 193 women from the Healthy Women Study, which has been described previously (11). In 1983, 541 premenopausal women were recruited on the basis of the following inclusion criteria: age 42 to 50 years, most recent menstrual period occurred within the past 3 months, no previous surgical menopause, resting diastolic blood pressure less than 100 mm Hg, not using insulin or hormone supplements, and not taking any medication with cardiovascular or psychotropic effects. Physical and psychological CVD risk factors were assessed at study entry and at approximately 2, 5, 8, and 12 years after the menopause. In 1996, women who were at least 5 years postmenopause (range, 5–12 years; $N = 210$) were invited to participate in assessments of endothelial function. Eight women refused, and nine women were ineligible because of Raynaud's disease, a prior mastectomy, or an arteriovenous fistula, bypass graft, or significant stenosis in the right arm, resulting in a total sample of 193 women. The images from three women were of insufficient quality to evaluate. Of those included, 17 women had undergone a hysterectomy, and 96 reported current use of HRT. Written, informed consent was obtained, and the University of Pittsburgh Institutional Review Board approved all procedures.

Psychosocial Measures

Measures of psychosocial characteristics thought to be associated with alterations in risk for CVD were selected for analysis. Psychosocial characteristic scores from two different points in time were available and relevant to the present study. Psychosocial scores from questionnaires administered at study entry, while the women were premenopausal, included the following: Bortner Type A Rating Scale, emphasizing time urgent and competitive aspects of Type A behavior (12); Spielberger Trait Anger Scale, measuring the frequency of feelings of anger (13); Spielberger Anger Expression Scale, measuring the extent to which feelings of anger are suppressed (anger in) or expressed (anger out) (14); Spielberger Trait Anxiety Inventory, assessing the frequency of feelings of anxiety (13); Framingham Tension Scale, measuring the frequency of nervous symptoms (15); Beck Depression Inventory, assessing symptoms of depression over the previous 2 weeks (16); and Interpersonal Support Evaluation List–appraisal subscale (ISEL–appraisal), assessing the availability of others with whom problems can be discussed (17). Premenopausal psychosocial characteristics were measured on average 13.6 years ($SD = 0.72$) before assessment of endothelial function.

All questionnaires, with the exception of the Spielberger Anger Expression Scale, were readministered at a postmenopausal follow-up exam close in time to the assessment of endothelial function. In addition, the Cook-Medley Hostility Scale, reflecting a cynical attitude and mistrust of others (18), was completed at this postmenopausal clinic visit. Postmenopausal psychosocial characteristics were measured on average 1.5 years ($SD = 1.75$) before the assessment of endothelial function.

Endothelial Function

Endothelial function was determined at the postmenopausal follow-up exam using brachial ultrasound after reactive hyperemia, similar to methods described by Celermajer et al. (19). With the participant in a supine position, a pediatric blood pressure cuff was placed distal to the right elbow and electrocardiographic electrodes

were attached. The participant rested for 10 minutes before data collection. A Toshiba scanner (SSA-270) with a 7.5-MHz linear array transducer was used to image the artery 5 cm proximal to the elbow. After collection of baseline images, the blood pressure cuff was inflated 30 mm Hg above systolic pressure for 4.5 minutes. After release of the cuff, brachial artery images were obtained at 30-second intervals for a total of 3 minutes. The distances between the near and far wall intima-lumen interfaces were read by a single trained sonographer. At each time, end-diastolic images from three separate cardiac cycles were digitized and averaged. Reproducibility of the protocol was evaluated in 20 women who had a second scan an average of 7 months after the first (range, 2 weeks to 14 months). The intraclass correlation between the two measures was 0.72.

Data Reduction and Analysis

To try to simplify the associations between psychosocial characteristics and endothelial function and to provide a better understanding of possible relationships, a factor analysis of all the psychosocial scales was conducted. A principle-components factor analysis with orthogonal rotation was conducted on standardized pre- and postmenopausal psychosocial trait scores separately. Trait scores that clustered together were unit weighted and summed to calculate values for each factor score. If one score was missing from the factor, the factor score was based on the remaining scores.

A general linear model repeated-measures analysis (GLM, SPSS version 8.0) was conducted with HRT use (yes/no) and psychosocial factor scores as the independent variables. Time was the within-subject factor with six levels (30, 60, 90, 120, 150, and 180 seconds after reactive hyperemia). Psychosocial factor scores were included as continuous variables in all analyses; however, for illustrative purposes, tables and figures present dichotomized high and low trait scores based on averages of the upper and lower thirds of the distribution, respectively. Significant associations involving the psychosocial factor scores were followed by repeating the analysis for each individual psychosocial trait separately, and significant interactions involving HRT were followed by repeating the analyses for HRT users and nonusers separately. Univariate analyses were conducted to assess associations between endothelial function and cardiovascular risk factors (age, body mass index [BMI], and smoking status), baseline lumen diameter, and medication use. P values of .05 or less (two-tailed) were considered to be statistically significant.

RESULTS

Factor analysis of the psychosocial traits resulted in two factors with eigenvalues greater than 1.0 that were conceptually similar for both the study entry and follow-up analyses (Table 1). These two factors were labeled anxiety/depression and Type A/anger. Factor scores were available for analysis from all 190 women for the study entry scores, from 132 women for the follow-up Type A/anger scores, and from 154 women for the follow-up anxiety/depression scores. The factors were highly correlated across the two examinations.

Characteristics of the women who underwent brachial ultrasound assessments are presented in Table 2. Of the 190 participants, 50.5% were using HRT at the time of the ultrasound. Use of other medications was

TABLE 1. Factor Structure and Test-Retest Reliability of Psychosocial Traits at Study Entry and Follow-Up

Psychosocial Trait	Study Entry Loadings	Follow-Up Loadings	Reliability
Anxiety/depression factor			0.68
Spielberger trait anxiety	0.83	0.70	0.74
Beck depression	0.74	0.73	0.60
Spielberger anger in	0.69	NA	NA
Framingham tension	0.63	0.70	0.52
ISEL-appraisal social support	-0.68	-0.70	0.60
Eigenvalues	3.16	2.92	
Type A/anger factor			0.69
Bortner Type A	0.70	0.80	0.77
Spielberger trait anger	0.63	0.74	0.74
Spielberger anger out	0.84	NA	NA
Cook-Medley hostility	NA	0.53	NA
Eigenvalues	1.56	1.18	

TABLE 2. Sample Characteristics

Characteristics	Total (N = 190)	Used HRT at Ultrasound Exam	
		Yes (N = 96)	No (N = 94)
Age, y (mean)	61.4	61.5	61.3
Education > high school (%)	70.0	75.0	64.9
Current smoker (%)	14.3	8.3	20.4*
BMI, kg/m ² (mean)	27.1	26.7	27.6
Lipid-lowering medicine use (%)	6.3	7.3	5.3
Antihypertensive medicine use (%)	10.5	13.5	7.4
Diabetes medicine use (%)	1.1	1.0	1.1
Antiinflammatory use (%)	6.3	7.3	5.3
Aspirin use (%)	1.6	1.0	2.1

* $p < .05$ for HRT/no HRT group difference.

similar among HRT users and nonusers. There was no difference in age, BMI, or educational attainment of HRT users relative to nonusers. Nonusers were more likely to be smokers than HRT users. Psychosocial trait scores did not differ between HRT users and nonusers (Table 3; p values $> .10$).

Vessel diameter change demonstrated a curvilinear pattern in response to reactive hyperemia (Fig. 1). There was a large increase in diameter during the first minute that leveled off and gradually declined after 90 seconds. Vasodilation was still apparent 3 minutes after cuff release. Maximum vasomotor responses varied, ranging from 14.3% constriction to 27.6% dilation. Repeated-measures analysis showed no group differences in percentage of diameter change by HRT use ($F = 1.58$, $p = .21$), use of other medications ($F = 1.03$, $p = .31$), or smoking status ($F = 0.05$, $p = .83$). Age was not related to diameter change at any time point (r values < 0.09 , p values $> .23$). BMI correlated with percentage of diameter change at 90 and 120

TABLE 3. Mean Value of Psychosocial Trait Scores From Study Entry and Follow-Up by HRT Use

Psychosocial Trait	Used HRT at Ultrasound Exam			
	Study Entry		Follow-Up	
	Yes	No	Yes	No
Anxiety/depression factor				
Spielberger trait anxiety	17.78	17.24	17.19	15.90
Beck depression	4.49	4.01	4.87	5.52
Spielberger anger in	14.68	14.89	NA	NA
Framingham tension	0.28	0.25	0.21	0.21
ISEL-appraisal social support	7.81	7.48	8.13	7.74
Type A/anger factor				
Bortner Type A	194.21	191.73	189.46	185.63
Spielberger trait anger	17.78	17.81	15.94	15.70
Spielberger anger out	14.72	14.51	NA	NA
Cook-Medley hostility	NA	NA	9.02	10.16

seconds (r values ≥ 0.16 , p values = .02), and baseline lumen diameter correlated with percentage of diameter change at all time points after 30 seconds (r values ≥ -0.20 , p values $\leq .01$). Therefore, BMI and baseline diameter were included as covariates in all analyses.

Mean baseline diameter and percentage of diameter change at each time after reactive hyperemia are presented by the psychosocial factors in Table 4. Psychosocial factor scores were not significantly related to baseline lumen diameter (p values $> .05$).

Study Entry

Results of the analysis of the psychosocial factors and each trait subscale assessed at study entry are reported in Table 5. Higher scores on both the Type A/anger factor and the anxiety/depression factor were associated with less vasodilation among the total sample of postmenopausal women on average 13.6 years later (p values $\leq .04$). The factors did not interact with current HRT use at the time of the brachial ultrasound or time after reactive hyperemia to predict diameter change (p values $> .25$).

To determine which traits accounted for the associations between factor scores and diameter change, separate analyses were conducted for each psychosocial trait. Of the traits composing the Type A/anger factor, higher scores on Bortner Type A behavior were significantly associated with smaller diameter changes ($p = .04$). Scores on Spielberger anger out and Spielberger trait anger were not significantly related to diameter change when examined separately (p values $> .07$). Of the traits composing the anxiety/depression factor, higher scores on Spielberger trait anxiety and Spielberger anger in were related to less vasodilation (p values $\leq .03$). Scores on Beck depression, ISEL-ap-

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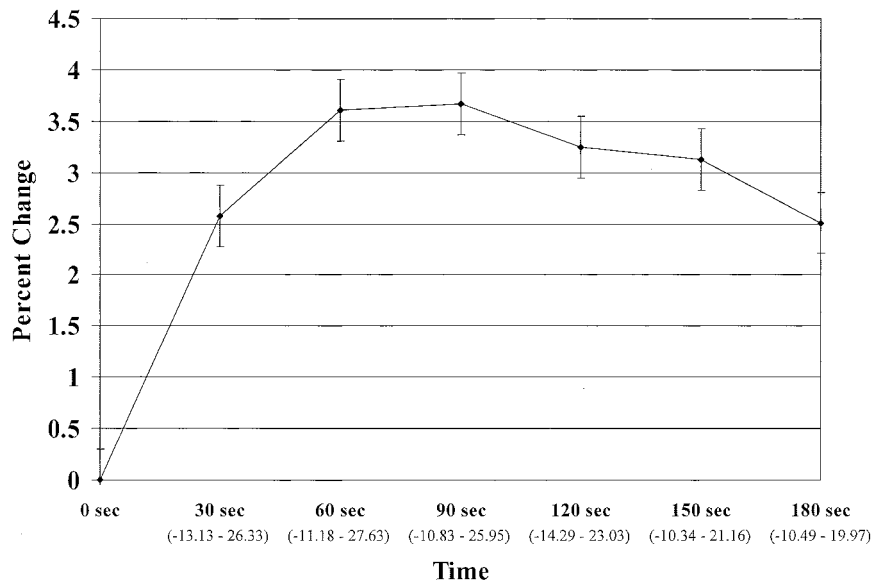


Fig. 1. Mean percentage change in brachial artery diameter by time after reactive hyperemia. Range of the percentage change scores are listed in parentheses below the time axis. Bars represent SEM.

TABLE 4. Mean Percentage Change in Vessel Diameter by Psychosocial Factor Scores at Each Time^a

Psychosocial Factors at	Baseline	30 s	60 s	90 s	120 s	150 s	180 s
Study entry							
Anxiety/depression							
High	3.02	1.48	2.68	2.66	2.50	2.28	1.15
Low	2.94	3.56	4.30	4.55	3.54	3.69	3.59
Type A/anger							
High	3.07	2.15	3.06	3.08	2.06	2.45	1.76
Low	2.92	3.74	4.70	4.67	4.43	3.78	3.70
Follow-up							
Anxiety/depression							
High	3.08	0.63	1.71	2.24	2.30	2.23	1.20
Low	3.05	2.76	4.00	3.94	3.32	3.40	3.40
Type A/anger							
High	3.10	2.13	3.07	3.06	2.28	2.31	1.75
Low	2.96	2.94	3.82	4.12	4.24	3.90	3.99

^a Means were calculated for high and low groups using the upper and lower third of the distribution, respectively, for each psychosocial factor. Higher factor scores were related to smaller percentage changes in vessel diameter, adjusted for baseline and BMI (*p* values < .05).

praisal social support, and Framingham tension were not significantly related to diameter change (*p* values > .12).

Follow-Up

Although fewer women were available, the analyses were repeated using psychosocial scores from the visit closest in time to the brachial ultrasound to further explore potential interactions between HRT use and psychosocial characteristics. Results of the analysis of the psychosocial factors and each trait subscale assessed at the follow-up visit are reported in Table 5. The Type A/anger factor was related to impaired va-

sodilation (*p* = .03), but this association was affected by HRT use (*p* = .02 for factor-by-HRT use interaction). Among HRT users, the Type A/anger factor was not related to diameter change (*p* = .87), whereas among HRT nonusers, higher scores on the Type A/anger factor were associated with less vasodilation (*p* < .01). Higher scores on the anxiety/depression factor were associated with less vasodilation (*p* = .03), but HRT use did not affect this association (*p* = .32 for factor-by-HRT use interaction). Factor score interactions with time were all nonsignificant (*p* values > .12).

All three traits composing the Type A/anger factor demonstrated significant interactions with HRT use in predicting vasodilation (*p* values ≤ .05). Higher scores

TABLE 5. *F* Values for Effects of Psychosocial Traits and HRT Use on Percentage of Change in Brachial Artery Diameter Controlling for Baseline Lumen Diameter and BMI

Psychosocial Trait	Study Entry		Follow-Up	
	Trait Main Effect	Trait by HRT Use	Trait Main Effect	Trait by HRT Use
Anxiety/depression factor	4.74*	0.27	4.57*	0.99
Spielberger trait anxiety	10.28**	1.28	11.50**	1.79
Beck depression	2.41	1.10	2.83	5.83*
Spielberger anger in	4.61*	0.04	NA	NA
Framingham tension	1.02	0.72	1.09	0.92
ISEL-appraisal social support	0.09	0.33	0.40	2.46
Type A/anger factor	4.26*	0.95	4.87*	6.04*
Bortner Type A	4.12*	1.08	3.60	5.00*
Spielberger anger out	0.82	0.40	NA	NA
Spielberger trait anger	3.25	0.56	5.77*	4.13*
Cook-Medley hostility	NA	NA	0.00	3.92*

* $p < .05$; ** $p < .01$.

on Bortner Type A behavior and Spielberger trait anger were related to less vasodilation among HRT nonusers (Fig. 2; p values $< .01$), but not among HRT users (p values $> .53$). Cook-Medley hostility was not significantly related to diameter change in either HRT users or nonusers taken separately (p values $> .10$). Of the traits composing the anxiety/depression factor, higher Spielberger trait anxiety scores were associated with less vasodilation regardless of HRT use ($p < .01$). The relationship between Beck depression scores and diameter change differed by HRT use ($p = .02$ for trait-

by-HRT use interaction). In HRT users, depression was not related to diameter change ($p = .72$), whereas in nonusers, higher scores on depression were associated with less vasodilation (Fig. 2; $p < .01$). ISEL-appraisal social support and Framingham tension were not related to diameter change (p values $> .11$).

Additional Analyses

The primary analysis was repeated several times to exclude the possibility that potential confounders may be influencing the results. First, the analysis was repeated controlling for smoking status since prior studies have reported impaired vasodilation among individuals who smoke (19). In the current study, controlling for smoking status did not alter the results. Additionally, among the women who smoked ($N = 27$), the number of cigarettes per day (range, 1–30) was not related to percentage of change in diameter ($F = 0.02$, $p = .88$). Second, to examine the influence of including women at high risk for CVD, an additional analysis was conducted excluding women who were taking medication for hypertension, hypercholesterolemia, or diabetes at the time of the ultrasound ($N = 31$); the results obtained were similar. Among the women not using HRT, three women were taking tamoxifen. Because tamoxifen has both estrogenic and antiestrogenic properties, the main analysis was repeated excluding women taking tamoxifen, and the results were the same. Results were also similar when repeated with absolute, instead of percentage, diameter change. Because the results were the same in all of

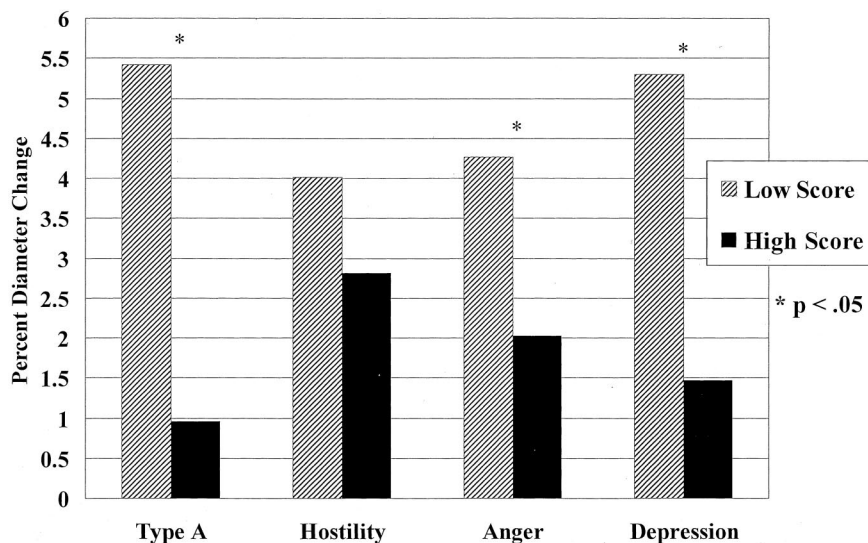


Fig. 2. Mean percentage change in brachial artery diameter by postmenopausal psychosocial trait scores among HRT nonusers. BMI and baseline lumen diameter were included as covariates in the analysis. Means were calculated for high and low groups using the upper and lower third of the distributions of psychosocial trait scores, respectively. Among HRT nonusers, higher Bortner Type A behavior, Spielberger trait anger, and Beck depression scores were associated with less brachial artery vasodilation.

the above analyses, only the results from the primary analysis are reported herein.

DISCUSSION

This study is the first to demonstrate that high scores on two psychosocial clusters, anxiety/depression and Type A/anger, are associated with impaired brachial artery vasodilation in healthy postmenopausal women. The association is apparent whether the anxiety/depression construct is measured on average 13.6 years earlier than the assessment of vascular function, when the women were premenopausal, or on average 1.5 years earlier than the measurement of vascular function, when the women were postmenopausal. The association between the Type A/anger construct and vasodilation is apparent among the full sample of women when the Type A/anger construct is measured before menopause. When measured after menopause, high scores on the Type A/anger construct are associated with impaired vasodilation among women not using HRT but not among women using HRT. Results are maintained after adjusting for BMI and baseline lumen diameter. These findings show that psychosocial factors are associated with CVD markers early in the natural history of atherosclerosis among women.

The predictive ability of the psychosocial traits assessed may result from the stability of these traits over time. Indeed, the psychosocial scales used in this study demonstrated moderate stability (ie, r values ranged from 0.52 to 0.77), even as the women made the transition from pre- to postmenopause. After menopause, approximately half of the women in this study chose to use HRT. The rate of HRT use among this sample of postmenopausal women is in agreement with other recent studies reporting higher rates of HRT use among white women and among women in higher socioeconomic status groups (20, 21). Additionally, the range of vasomotion observed among women in the current study (14.3% constriction to 27.6% dilation) is consistent with brachial artery flow-mediated dilation responses demonstrated previously in a similarly aged sample of postmenopausal women (6). Although our finding that HRT use was not associated with greater vasodilation was surprising, another prior study failed to demonstrate an association between long-term HRT use and endothelial function (22). Additionally, the women in this sample were taking a variety of different regimens of HRT with potentially variable influences on the endothelium. These variable influences may have reduced the ability to detect a significant association between HRT use and endothelial function.

In contrast to prior studies, smoking status and age

were not related to endothelial function in this study. The age range of the women included (58–65 years) may have been too narrow to detect any significant differences in vasodilation. Additionally, with relatively few smokers in the current sample (only 27 of the 193 women), the statistical power may have been too weak to detect a significant smoking effect.

For vasodilation to occur, the vasodilating capacity of both the endothelium as well as the vascular smooth muscle must be intact. Because there was no measure of endothelium-independent dilation administered in this study to test the ability of the smooth muscle to relax, it is possible that vasodilation was impaired in women high in anxiety/depression and Type A/anger because of impairment at the level of the smooth muscle. However, acute mental stress does not contribute to deficits in endothelium-independent dilation (10), and there is no evidence to support an association between psychosocial factors and impaired smooth muscle function. Furthermore, inability of the smooth muscle to relax is unusual in this age group (23) and is generally apparent only in patients with CVD (8). Eliminating women at the highest risk for CVD (ie, those undergoing treatment for hypertension, hyperlipidemia, or diabetes) did not affect the results of this study. Although in large samples a negative correlation between risk factors for CVD and endothelium-independent dilation may be observed, the primary determinant of endothelium-independent vasodilation is resting vessel diameter (24). Controlling for resting lumen diameter, as was done in the current study, can negate group differences in endothelium-independent dilation (6). For these reasons, impaired smooth muscle relaxation, as seen in CVD patients, is not likely to be responsible for the associations observed in this study. Therefore, the impaired vasodilation associated with psychosocial factors in this sample of healthy postmenopausal women is most likely due to impairments in endothelial function.

Psychosocial characteristics may influence endothelial function through several mechanisms. First, psychosocial traits that are associated with fewer healthy behaviors may put some individuals at a greater risk of disease. In women, hostility and anger are associated with elevated BMI (25, 26) as well as inactivity (26, 27). Type A behavior and hostility are associated with consumption of high-fat diets (27, 28). Type A behavior (27), hostility (2, 25, 29), anxiety (29), anger (2, 26, 30), anger suppression (2, 30), and depression (27) are associated with smoking and alcohol abuse. Unhealthy lifestyle habits, including a diet high in fat (31), lack of exercise (32), smoking (19), and alcohol abuse (33), may contribute to impairments in endothelial function.

Psychosocial traits may also be related to endothelial function through differences in regulatory patterns of the autonomic nervous system. Psychosocial stress contributes to alterations in heart rate variability, reflecting increases in sympathetic and decreases in parasympathetic activity (34, 35). Heightened sympathetic stimulation is associated with a variety of psychosocial characteristics in women, including Type A behavior (36), hostility (37), trait anger (37), anger suppression (36), anxiety (38), and depression (39). Heightened sympathetic stimulation may negatively influence endothelial function. Greater increases in systolic blood pressure during sympathetic stimulation are associated with impaired endothelium-dependent dilation among children (40). Individuals with brachial artery endothelial dysfunction have greater increases in peripheral resistance during mental stress (41). After brief exposure to mental stress, brachial artery flow-mediated dilation is temporarily suppressed (10). Heightened sympathetic activity could influence endothelial function through the direct impact of neural stimulation (42) or through alterations in blood flow hemodynamics (43).

Social support, defined as having others to talk to about difficulties, was unrelated to endothelial function in this study. Social support has been associated with healthy behaviors, such as exercise (44), and decreased sympathetic arousal in response to stress (45). For these reasons, social support was expected to be protective against endothelial dysfunction. However, prospective studies examining the relationship between a related concept, social integration (being involved in social networks), and mortality have reported mixed results in women, with some studies finding that social integration is protective (4) and some finding no effect (46). It is speculated that social integration and support may be less protective in women than men because of burdensome aspects related to women having a larger social network.

Among women using HRT, the lack of association between endothelial function and postmenopausal Type A behavior, trait anger, and depression may be due to the protective effects of estrogen. Estrogen administration has a positive influence on endothelial function (6). Estrogen may protect against endothelial damage in the presence of CVD risk factors, or it may merely mask deficits in endothelial function because of its vasodilatory properties.

HRT use did not eliminate deficits in endothelial function associated with trait anxiety. Trait anxiety may be a more "toxic" characteristic in relation to endothelial function than the other psychosocial traits and could therefore be more resistant to protective factors, such as HRT. Alternatively, women high in

anxiety may have experienced more stress during assessment of endothelial function. This stress may contribute to temporary deficits in endothelial function attributable to the testing procedure. Although estrogen administration may protect against chronic endothelial dysfunction, HRT use may not be protective against transient declines in endothelial function due to daily stress.

In conclusion, psychosocial characteristics, including Type A behavior, anger, anxiety, and depression, are related to impairments in endothelial function among healthy postmenopausal women. HRT use may protect women who are high in these traits against impaired vasodilatory responses.

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