

Antagonistic Behavior, Dominance, Hostility, and Coronary Heart Disease

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Purpose: This study investigated the relationship between antagonistic behavior, dominance, attitudinal hostility, and coronary heart disease (CHD). **Methods:** One hundred one men and 95 women referred for thallium stress testing were administered the Structured Interview and the Cook-Medley Hostility Scale. The Hostile Behavior Index, derived from the Structured Interview and developed by Haney et al., served as an index of antagonism, and the frequency with which interviewees interrupted their interviewer served as a measure of dominance. On the basis of their medical history and thallium stress test results, patients were classified as having ($N = 44$) or not having ($N = 99$) CHD. **Results and Conclusions:** Multivariate logistic regressions (with age, gender, disease, and lifestyle risk factors in the model) revealed that both the Hostile Behavior Index and dominance were significant independent risk factors for CHD (relative risk [RR] = 1.22 and 1.47, $p < .03$). Of the two Hostile Behavior Index component scores, indirect challenge and irritability, only the latter correlated significantly with CHD (RR = 1.27, $p < .03$). Separate logistic regressions for men and women suggest that subtle, indirect manifestations of antagonism confer CHD risk in women and that more overt expressions of anger confer risk in men. A significant univariate correlation between hostility scale scores and CHD became not significant when we adjusted for socioeconomic status. **Key words:** antagonism, irritability, dominance, hostility, socioeconomic status, coronary heart disease.

CHD = coronary heart disease; CVR = cardiovascular reactivity; HBI = hostile behavior index; Ho = Cook-Medley Hostility Scale; MI = myocardial infarction; RR = relative risk; SES = socioeconomic status; SI = structured interview; SPECT = single-photon emission computed tomography; STAXI = Spielberger State-Trait Anger Expression Inventory.

INTRODUCTION

This study has three foci: 1) the relationship between antagonistic behavior and CHD in men and women; 2) the relationship between dominance and CHD in men and women; and 3) the relationship between attitudinal hostility, as measured by the Ho scale (1), and CHD. These relationships were studied in a group of men and women referred for thallium stress testing.

Reviewers of the literature (2, 3) agree that of the two most popular methods for the assessment of hostility,¹ that is, the paper-and-pencil Ho scale (1) and SI-based (4) hostility ratings (5), the latter shows a more consistent pattern of significant positive relationships with CHD. A reanalysis of the Multiple Risk Factor Intervention Trials by Dembroski et al. (5) dem-

onstrates that the interview-based clinical ratings of hostility predict incidence of CHD and that they do so prospectively. In their study, Dembroski et al. (5) used a matched case-control design for comparing the incidence of coronary death and MIs in participants as a function of clinical hostility ratings. Case subjects consisted of 192 patients with coronary death and/or documented nonfatal MI. Angina only was not counted as a CHD event but served as an exclusion criterion for the 384 matched control subjects.

Participants were assigned a hostile content score, an intensity of hostility score (which takes into account the use of emotion-laden words, profanity, and emphatic expressions), and a hostile style score (displays of antagonistic behavior toward the interviewer, characterized by argumentativeness, rudeness, boredom, uncooperativeness, condescension, and the like). Of the three hostility scores, only style (antagonistic behavior) was a significant risk factor for CHD. To explain these findings, Dembroski et al. (5) refer to a study by Siegman et al. (6), who suggest that it is primarily the outward expression of anger and hostility that constitutes a risk factor for CHD, in contrast to the mere experience of anger, or neurotic hostility, which is not a significant risk factor for CHD. This explains why the hostile style scores, which load on a factor that measures the outward expression of anger but not on an anger-in factor (7), were significant predictors of CHD. Dembroski et al. (5) point out that of the three SI-derived hostility scores, that is, content, intensity, and style, only the latter does not also reflect neurotic hostility.

A recent study by Haney et al. (8), using patients referred for coronary angiography, confirmed the hypothesized positive relationship between antagonistic behavior during the SI and CHD. Patients' responses to the SI were scored by means of the interpersonal hostility assessment technique, which yields an HBI

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Received for publication June 2, 1998; revision received July 23, 1999.

¹ Hostility, as measured by the Ho scale (1) and SI-based hostility ratings (5), refers not only to hostile attitudes but also contains affective (anger) and behavioral (antagonistic behavior and aggression) components.

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score. The HBI is essentially an elaboration of the hostile style score developed by Dembroski et al. (5) with an emphasis on subtle manifestations of antagonistic behavior toward the interviewer. In the Haney et al. (8) study, the correlation (r) between participants' HBI scores and the severity of coronary occlusion was an impressive 0.58.

All participants in the Dembroski et al. (5) and Haney et al. (8) studies were men, so we know very little about the relationship between antagonistic behavior and CHD in women. There has been some speculation that the lower incidence of CHD in women, at least in premenopausal women, than in men might be related to women's relatively lower levels of aggression. However, even if women are less prone to engage in physical aggression than are men, they are not necessarily also less prone than men to engage in the more subtle forms of antagonistic behavior. This latter category and its role in CHD was the focus of this study, in which we ascertained the relationship between antagonistic behavior, as assessed by the HBI, and CHD, in both male and female patients referred for thallium stress testing.

Dominance and CHD

Recent research has focused primarily on the role of anger and hostility in CHD, but other affective states and personality traits, such as dominance, may also be significant risk factors for CHD. One of the first studies to provide evidence in support of the dominance-CHD relationship involved a group of patients referred for coronary angiography (9). All patients were administered Rosenman's (4) SI. The frequency with which patients attempted to "take the floor" from their interviewer during the SI correlated positively and significantly with patients' angiographically determined severity of coronary artery occlusion scores. The relevance of this finding is that attempts to take the floor by interrupting one's interviewer or speaking partner is characteristic of dominant and competitive individuals (10). However, the meaning of this finding is by no means unambiguous, because anger, too, is associated with frequent interruptions of one's partner and with simultaneous speech (11, 12).

Using a cluster analytic procedure, Houston et al. (13, 14) identified six speech patterns, including dominating-competitive speech (characterized by short response latencies, rapid speech, frequent interruptions, and simultaneous speech) and angry-hostile speech (characterized by loud, explosive speech, a quickening pace, muscular tension, and marked hostility). Both types of speech were independent predictors of CHD in 8.5-year and 22-year follow-up examinations of the

Western Collaborative Group Study. In the 22-year follow-up, both the dominating-competitive and angry-hostile speech patterns also correlated positively with all-cause mortality. Finally, in a recent study (15), the authors found that both anger-out, as measured by Spielberger's (16) STAXI scale, and scores on a dominance questionnaire of an aggression inventory were independent predictors of CVR (blood pressure) during a math task in which male participants were provoked and harassed. The relevance of this finding is that heightened CVR seems to be a significant risk factor for CHD (17–19).

In the present study, we tried to cross-validate the finding of Houston et al. (13, 14) that dominance is a risk factor for CHD independent of antagonistic behavior and hostility in a group of patients made up about equally of men and women.

Ho and CHD

Because the Ho scale (1) was included in this study, albeit primarily to ascertain the relationship between the HBI (8) and attitudinal hostility, we also determined the relationship between participants' Ho scores and their CHD status. Many studies, both prospective and cross-sectional, have obtained significant relationships between Ho scores and CHD, although null findings have also been reported (2, 3). The evidence (20) suggests that the Ho scale measures several relatively independent dimensions. Barefoot et al. (21), who conducted a rational analysis of the Ho scale items, identified the following four components: cynicism-mistrust, hostile attributions, hostile affect, and aggressive responding. In a recent large-scale prospective study, Barefoot et al. (22) reported that two of four Ho component scores (hostile attribution² and hostile affect) were each significantly associated with incidence of MI (at the p .03 level or better) but that the other two (cynicism and aggressive responding) failed to reach the $p < .05$ significance level. In another recent large-scale prospective study, Everson et al. (23) found that a Ho scale-derived measure of cynical mistrust was associated with an increased risk of MI but that this relationship was mediated through other risk factors. Yet another large-scale prospective study (24) also failed to show a significant relationship between cynicism, as measured by the Ho scale, and CHD. It would seem, then, that cynical mistrust, which has been identified as the core construct of the Ho scale (20), may not be an *independent* risk factor for CHD.

² It should be noted that the hostile attribution items have a distinct paranoid flavor.

There are, then, two issues with regard to the Ho-CHD relationship that need further clarification: 1) Precisely which components of the Ho scale confer risk for CHD? 2) Are these components independent risk factors for CHD, or are they mediated by other disease and lifestyle risk factors? These two questions were addressed in this study.

METHODS

Subjects

One hundred ninety-six patients (101 men and 95 women) were recruited among patients referred for thallium stress testing at the University of Maryland Medical Center and the Johns Hopkins Medical Institutions. Their mean age was 55.2 years (SD = 12.9 years), with no significant difference between the mean age of men and women patients. According to Hollingshead's Index for Social Position, 27.6% of the patients were upper class; 34.7%, middle class; and 37.8%, lower class. Mean years of schooling was 12.6 (SD = 4.03), with males attending school longer than females (13.3 vs. 11.8 years; $t = 2.51, p < .05$).³

Patients reported to their respective nuclear medicine departments for thallium scanning. Patients were recruited for this study after completing the first series of scans and while waiting for the second series. Only four patients refused to participate. While waiting for their second scan, participants were administered Rosenman's (4) SI. Interviewees' SI responses were scored for antagonistic hostility (HBI) according to the criteria developed by Haney et al. (8). Participants were also administered a background information questionnaire, the Ho scale (1), Spielberger's (16) STAXI, and Bendig's (25) Manifest Anxiety Scale. A subset of 97 participants were rated by their spouses for anger level by means of Spielberger's (16) STAXI.⁴

Thallium-201 Imaging Protocol

All patients underwent a symptom-limited regular or modified Bruce protocol treadmill exercise test. Patients fasted (NPO) for at least 4 hours before the study (with the exception of taking medication when indicated) to reduce splanchnic uptake of thallium. Patients were continuously monitored by 12-lead electrocardiography during and 5 minutes after the stress test. Blood pressure measurements were made at each stage of exercise. At peak exercise, 3.0 mCi (111.0 MBq) of thallium-201 chloride was administered intravenously, and exercise was continued for 40 to 60 seconds after injection.

Stress SPECT imaging was started within 10 minutes after thallium injection. Images were acquired with a triple-head gamma camera, in noncircular orbit, equipped with low-energy, ultrahigh-

³ Thirty-three patients were excluded from the statistical analyses reported in Results because of their uncertain CHD status. The mean age and years of schooling of the remaining 133 patients were very close to those of the original 196 recruits (56.2 and 12.7 years, respectively), as was their SES distribution (26% upper class, 36% middle class, and 37% lower class).

⁴ The correlations between patients' STAXI self-ratings, spouse anger ratings, Bendig's Manifest Anxiety Scale ratings, and CHD status have been reported elsewhere (26). (The STAXI items were rephrased to make them appropriate for the spouse anger ratings.)

resolution, parallel-hole collimators. Acquisition parameters were 30 seconds per step (frame) and a 3° step-and-shoot mode in a 64 × 64 image matrix. Three-hour delayed SPECT reinjection studies were acquired in a similar manner 10 minutes after reinjection of 1.0 mCi of thallium-201.

SPECT images were then reconstructed following a standard protocol, which includes uniformity correction with a 150 million count flood, center of rotation correction and low-pass filtering, no attenuation correction, and reconstruction into 1-pixel-thick (5.3 mm) transaxial sections. Oblique angle reorientation and summation produced 1-pixel-thick horizontal and vertical long-axis and short-axis sections of the left ventricle.

For each study, consecutive horizontal and vertical long-axis and short-axis slices of the left ventricle were displayed and reviewed concurrently by two nuclear medicine physicians without previous knowledge of the patient's clinical history, physical findings, laboratory data, wall motion studies, or cardiac catheterization results. Anterior, lateral, inferior, and septal walls on short-axis slices and the apical region on long-axis slices were evaluated for the distribution of activity using the following scoring scale: 0, normal; 1, mild; 2, moderate; and 3, severe reduction of thallium activity. For the purposes of the present study, categories 1, 2, and 3 were collapsed into a single impaired hypoperfusion category.

Patients were placed in one of three categories: 1) normal (ie, no previous CHD history, no ischemic electrocardiographic responses to exercise, and normal thallium scans), 2) documented CHD (ie, positive thallium scans or previous MI), or 3) equivocal (ie, no previous CHD history, normal scans, but failed to reach 85% of age-predicted maximum heart rate and/or showed ischemic electrocardiographic responses to exercise). Altogether, 44 patients were classified as normal; 119, as having documented CHD; and 33, as equivocal. The corresponding figures broken down by gender were 23, 55, and 17 for females and 21, 64, and 16 for males, respectively.

Randomly selected thallium scans of 40 patients were rated and categorized by a second experienced cardiologist. Interjudge reliability, as calculated by the κ statistic, was 0.89.

Measuring Antagonistic Behavior and Dominance From the SI

All participants were administered Rosenman's (4) SI, which lasted about 15 minutes. The interviewer (S.T.T.) adapted a matter-of-fact professional demeanor that was neither overly warm nor excessively challenging. Only some of the SI questions focused on antagonistic or aggressive behavior, but in this scoring system, the emphasis is on subtle manifestations of interpersonal antagonism, not on content. Furthermore, previous research (8) indicates that HBI scores derived from questions focusing on anger-antagonism are not more strongly related to CHD than scores based on the other SI questions. HBI scores are the sum of the occurrences of four categories of antagonistic behavior: hostile withhold or evasion, direct challenge, indirect challenge, and irritability. Hostile withhold or evasion is scored if the interviewee's response is uncooperative or evasive. Both content and vocal stylistics must be considered in scoring hostile withhold/evasion. Direct challenges involve an open confrontation with the interviewer (eg, "That's a stupid question."). Indirect challenge is scored if the respondent challenges the interviewer or interviewer by implication. Vocal stylistics is critical in this decision. Irritability is scored when a respondent's voice stylistics reflect negative arousal indicative of anger or antagonism. Of the four HBI component scores, the direct challenge component represents the most overt form of antagonistic behavior, and the indirect challenge represents the least overt form of antagonistic behavior.

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The irritability component is considered to be a form of anger expression.

The dominance score is the summed total of respondent's interruptions of the interviewer during the SI plus the incidence of simultaneous speech (overtalk). Interscorer reliability for this category was 0.93. The SI scorer was, of course, blind to patients' CHD status.

All participants were also administered the 50-item Ho scale (1). This scale was scored twice, once using all 50 items and again using only the items comprising the four subscales identified by Barefoot et al. (21) as predicting survival: cynical mistrust, hostile attributions, hostile affect, and aggressive responding. Results of prior studies suggest (2) that this abbreviated Ho scale is a better predictor of CHD outcome than the total Ho scale. Because Barefoot's (21) abbreviated Ho scale was also consistently better in predicting CHD outcome than the original 50-item Ho scale in this study, the findings to be presented for the Ho-CHD relationship are all based on Barefoot's (21) abbreviated scoring procedure.

Data Analyses

Logistic regression analyses were performed to determine 1) the relationship between participants' SI-derived HBI scores and their CHD status, 2) the relationship between participants' HBI component scores (indirect challenge and irritability)⁵ and CHD status, 3) the relationship between participants' SI-derived dominance scores and CHD status, and 4) the relationship between patients' Ho scores (and Ho component scores) and CHD status. CHD status was always a dichotomous variable (patients with documented CHD vs. patients without CHD) with equivocal excluded from the analyses.⁶

The data were submitted to multivariate logistic regressions in which the following traditional risk factors were entered into the model in the first step of the analysis: age, cholesterol, diabetes mellitus, hypertension, and SES.⁷ Gender was entered in the second step. HBI, dominance, indirect challenge, irritability, or Ho scores were entered in the third step, followed by gender by HBI, gender by dominance, gender by indirect challenge, gender by irritability, or gender by Ho score in the next step. Separate regressions were performed for each of the psychological variables. The above regressions were also performed separately for males and females (of course, without gender in the analyses).

RESULTS

Traditional Risk Factors and CHD

Relationships between traditional risk factors and disease outcome were assessed by means of logistic

⁵ There were insufficient scorable direct challenge and withhold/evasion responses to permit separate regression analyses of these two categories.

⁶ We also analyzed our data with the equivocal combined with the CHD group. In general, the results were very much like those obtained when equivocal were excluded from the analyses, except they were consistently somewhat less significant. When we analyzed the data with the equivocal combined with the normals, only HBI remained a significant risk factor. These findings support our assumption that the equivocal are a mixed group and contain at least some CHD cases, which is why they were excluded from our analyses.

⁷ All these risk factors correlated significantly with CHD in this study.

TABLE 1. Summary of Logistic Regression Analyses for Risk Factors Predicting CHD Status^a

Risk Factor	β	SE	RR
Age (y) ^b	0.037	0.014	1.04 ^c
Gender (males = 0; females = 1)	-0.242	0.353	0.78
SES level (low/middle/high)	-0.873	0.240	0.42 ^d
Hypercholesterolemia (no/yes)	0.865	0.360	2.37 ^e
Smoking (no/yes)	-0.502	0.412	0.60
Diabetes mellitus (no/yes)	1.136	0.51	3.11 ^e
Hypertension (no/yes)	0.937	0.361	2.55 ^c
Body mass index	0.025	0.027	1.02

^a $N = 163$.

^b Entered as continuous variable.

^c $p < .02$.

^d $p < .003$.

^e $p < .05$.

regression analyses. Significant relationships were obtained in relation to diabetes mellitus, hypertension, and cholesterol level. Age and SES were also significant risk factors. All these relationships were in the expected direction, so that patients with CHD tended to be older, of a lower SES level, and had a history of diabetes mellitus, hypertension, and hyperlipidemia (Table 1).

Gender Effects in Patients' HBI and Dominance Scores

There were no significant gender differences in relation to the patients' HBI, indirect challenge, irritability, dominance, and Ho scores (Table 2).

HBI and CHD

In the multivariate logistic regression analysis (ie, with the traditional risk factors in the model),⁸ HBI correlated positively and significantly with CHD status (RR = 1.22, $p < .01$) (Table 3). For the group as a whole, the odds of having CHD increased by 22% for each unit increase in HBI scores. The relationship between HBI and CHD remained significant even after controlling for dominance (RR = 1.22, $p < .02$).

Of the two HBI component scores, irritability and indirect challenge, only irritability correlated significantly with CHD outcome (RR = 1.22, $p < .02$) (Table

⁸ Covarying traditional risk factors consistently strengthened the relationships slightly as compared with the univariate analyses. Given the similarity of the two sets of findings, we present only the multivariate results, except for the Ho-CHD relationship, in which there was a clear difference between the univariate and the multivariate analyses.

TABLE 2. Means and SDs of Men and Women Participants' HBI, Irritability, Indirect Challenge, Dominance, and Ho Scores^a

Measure	Men		Women	
	Mean	SD	Mean	SD
HBI	4.68	3.29	4.32	2.95
Irritability	2.53	2.38	2.24	1.89
Indirect challenge	2.11	1.88	2.02	1.77
Dominance	1.83	1.64	1.10	1.59
Ho	19.87	7.86	20.88	8.72
Cynicism	6.26	3.63	6.59	3.05
Hostile attributions	3.78	1.72	3.97	2.01
Hostile affect	2.39	1.49	2.48	1.35
Aggressive responding	3.92	1.74	3.72	1.72

^a *N* = 196 (100 men and 96 women).

TABLE 3. Multivariate Logistic Regression Results for Relationships Between HBI, Irritability, Indirect Challenge, Dominance, and CHD (All Subjects)^a

Variable	β	SE	<i>p</i>	RR
HBI	0.203	0.081	.012 ^b	1.22
Irritability	0.268	0.135	.012 ^b	1.22
Indirect challenge	0.200	0.119	.092 ^c	1.22
Dominance	0.382	0.169	.023 ^b	1.47

^a Separate multivariate logistic regressions were conducted for HBI, irritability, indirect challenge, and dominance. *N* = 163.

^b *p* < .05.

^c *p* < .10.

3). The odds of having CHD increased by 22% for each unit increase in irritability scores.

Separate logistic regressions were conducted for men and women as planned (Tables 4 and 5). HBI and indirect challenge correlated significantly with CHD outcome in women (RR = 1.29 and 1.56, respectively; *p* < .05), but the relationship between irritability and CHD was clearly not significant (Table 4). For men, there was a positive relationship between HBI and CHD and between irritability and CHD, but both relationships fell short of clearcut significance (RR = 1.22

TABLE 4. Multivariate Logistic Regression Results for Relationships Between HBI, Irritability, Indirect Challenge, Dominance, and CHD (Women Only)^a

Variable	β	SE	<i>p</i>	RR
HBI	0.255	0.121	.035 ^b	1.29
Irritability	0.198	0.180	.270	1.21
Indirect challenge	0.448	0.217	.040 ^b	1.56
Dominance	0.336	0.237	.156	1.40

^a Separate multivariate regressions were conducted for HBI, irritability, indirect challenge, and dominance. *N* = 78.

^b *p* < .05.

TABLE 5. Multivariate Logistic Regression Results for Relationships Between HBI, Irritability, Indirect Challenge, Dominance, and CHD (Men Only)^a

Variable	β	SE	<i>p</i>	RR
HBI	0.189	0.112	.09 ^b	1.22
Irritability	0.268	0.131	.06 ^b	1.48
Indirect challenge	0.111	0.136	.41	1.11
Dominance	0.445	0.245	.06 ^b	1.56

^a Separate multivariate regressions were conducted for HBI, irritability, indirect challenge, and dominance. *N* = 85.

^b *p* < .10.

and 1.48, respectively; *p* < .10 and .06, respectively) (Table 5).

Dominance and CHD

Patients' dominance scores correlated positively and significantly with CHD status (RR = 1.47, *p* < .03) (Table 3). The odds of having CHD increased by 47% for each unit increase in dominance scores. This relationship was significant even after controlling for HBI (RR = 1.45, *p* < .03).

There was no significant interaction with gender. Separate regressions for men and women yielded a nearly significant relationship for men (RR = 1.56, *p* = .06) and a nonsignificant relationship for women (RR = 1.40, *p* > .15).

Hostility and CHD

In relation to the Ho score, unlike the other psychological variables, there was a clearcut difference between the results of the univariate analysis and the results of the multivariate analysis. In the univariate analysis, the relationship between patients' Ho scores and CHD status was clearly significant (*p* = .034) and remained so even after adjusting for age and gender (β = 0.081, RR = 1.08). However, this relationship was no longer significant after adjusting for the remaining traditional risk factors (RR = 1.03, *p* > .4). In fact, merely adjusting for SES or other disease risk factors (eg, hypertension or diabetes mellitus) was sufficient to eliminate the significant Ho-CHD relationship (RR = 1.05 and 1.06, respectively; *p* > .15).

Similar findings were obtained when we analyzed the relationships between participants' Ho component scores and CHD status. The relationships between aggressive responding and CHD and between hostile affect and CHD were marginally significant (β = 2.61 and 0.224, respectively; RR = 1.29 and 1.25, respectively; *p* < .10), but they, too, were wiped out when we adjusted for traditional risk factors (RR = 0.89 and 0.93, respectively; *p* > .4 and .5, respectively).

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Correlations (*r* Values) Between HBI, Dominance, and Ho Scores

Neither patients' HBI scores nor their HBI component scores correlated significantly with their dominance scores (Table 6). There were no significant correlations between patients' HBI, irritability, indirect challenge, dominance, and Ho scores (Table 6).

DISCUSSION

HBI and CHD

For the group as a whole, the odds of having documented CHD increased by 22% with each unit increase in HBI scores. Furthermore, this HBI-CHD relationship was independent of patients' dominance scores.

Although there was no significant interaction between gender by HBI on CHD, separate analyses revealed that the HBI-CHD relationship was significant for women (RR = 1.29, $p < .05$) and only marginally significant for men (RR = 1.22, $p < .10$). To the best of our knowledge, this is the first published study to report a significant positive relationship between HBI and CHD in women.

In this study, patients' HBI scores essentially consisted of two components: irritability and indirect challenge. These two components shared very modest common variance ($r(195) = 0.22$, $p < .002$) (Table 6). After controlling for traditional risk factors, only irritability remained a significant risk factor (RR = 1.22, $p < .02$). It should be noted that irritability loads significantly on an anger-out factor (27).

Although there were no significant interactions between gender and the two component scores, there is some indication that indirect challenge and irritability may relate differently to CHD in men than in women. In women, the indirect challenge scores correlated significantly with CHD (RR = 1.56, $p < .05$), but the correlation between irritability and CHD was clearly not significant ($p > .2$). In men, the relationship between irritability and CHD was marginally significant (RR = 1.48, $p = .06$), but the relationship between

indirect challenge and CHD was not significant ($p > .40$).

According to Haney et al. (8), of the original four HBI component scores, indirect challenge is the most subtle and indirect expression of antagonistic behavior. This suggests that only subtle expressions of antagonism are a significant risk factor for CHD in women. The reverse seems to be the case with men. For them, irritability, that is, the outward expression of anger, was a marginally significant risk factor for CHD, but indirect challenge, a subtle manifestation of interpersonal antagonism, was clearly not a significant risk factor.

There is one obvious discrepancy between the results of this study and those obtained by Haney et al. (8). In the Haney et al. study, the relationship between the men's HBI scores and CHD was clearly significant, whereas in this study it was not ($.05 > p < .10$). Perhaps the discrepancy is a consequence of the fact that there were many more incidents of direct challenges and withhold/evade responses (ie, direct expressions of antagonistic behavior) in the Haney et al. study (8) than in ours, in which there were almost none.

Dominance and CHD

The hypothesized positive relationship between dominance, as indexed by the interruption measure, and CHD was confirmed. For a one-unit increase in dominance scores, the odds of having CHD increased by 47%. Moreover, the effect of dominance was independent of HBI. This study, then, is the third study to suggest that dominance is a risk factor for CHD. The first study (9) had angiographically documented coronary occlusion as an end point. The second study (13, 14), a large-scale prospective study, had documented MI and sudden death as end points. Finally, this case-control study had documented CHD as an end point. The above studies also differ in terms of how dominance was assessed. Dominance was assessed behaviorally (number of interruptions) in the first and present studies and by interviewer ratings in the second study. Until recently, most research on the role of psychosocial factors in CHD has focused on hostility and anger. The above studies suggest that dominance, too, may be a risk factor for CHD. It is interesting to note that competitiveness or dominance is a major constituent of the Type A construct (4).

Although there was no significant interaction of gender by interviewee interruptions, separate analyses conducted for females and males revealed a marginally significant relationship between dominance and CHD in males but not in females.

TABLE 6. Intercorrelations Between HBI, Indirect Challenge, Irritability, Dominance, and Ho Scores^a

	Irritability	Indirect Challenge	Dominance	Ho
HBI	0.79 ^b	0.74 ^b	0.09	0.11
Irritability		0.22 ^c	0.14	0.03
Indirect challenge			0.01	0.08
Dominance				0.05

^a $N = 196$.

^b $p < .001$.

^c $p < .01$.

What Is Measured by the HBI and Dominance Indices?

Psychologists distinguish between anger, hostility, and aggression, with anger referring to an emotional state, hostility to attitudes, and aggression to behavior (28, 29). Furthermore, factor analytic studies of anger questionnaires have identified two factorially orthogonal modes of anger expression: anger-out and anger-in (26, 28, 30). Anger-out is defined as the tendency to express anger outwardly, either physically or verbally (ie, aggressive behavior). Anger-in refers to the inward experience of anger and/or the tendency to withhold or inhibit the outward expression of anger (ie, anger suppression rather than repression in the psychoanalytic sense). The evidence suggests that it is primarily the full-blown outward expression of anger, in all of its paraverbal intensity (eg, angry facial expression, loud voice, and clenched fists), that is associated with exceedingly high levels of CVR (31, 32) and that puts one at risk for CHD (6, 26, 31, 33). Finally, social psychologists distinguish between impulsive, anger-driven aggression and deliberate, instrumental aggression (29). Other terms occasionally used to denote these two types of aggressive behavior are "hot" and "cold" aggression.

As pointed out above, the spouses of 97 participants in the present study rated their wives or husbands on various anger dimensions using Spielberger's (16) STAXI.⁴ Participants' HBI scores correlated positively and significantly with their STAXI anger-out, angry temperament, and angry expression scores that were assigned to them by their spouses ($r(96) = 0.251, 0.202, \text{ and } 0.196$, respectively; $p < .05$). All these STAXI subscales load on an anger-out factor (26). In contrast, there was no significant correlation between participants' HBI scores and the STAXI spouse-assigned anger-in scores. These findings suggest that the HBI scores are related to anger-out rather than to anger-in. Furthermore, because there was no significant relationship between antagonistic hostility, as measured by HBI, and hostility (as measured by the Ho scale), the reference to HBI scores as an index of hostility is probably a misnomer and can be a potential source of confusion.

The pattern of correlations between participants' dominance scores and the STAXI scores assigned to them by their spouses differed from the pattern of correlations between participants' HBI and spouse-assigned STAXI scores. For the group as a whole, there were no significant correlations between participants' dominance scores and any of the STAXI scores, although separate correlations for males and females revealed a *negative* correlation between dominance

and anger-out scores in males ($r = -0.25, p < .10$) and a significant *positive* correlation between these two indices in females ($r = 0.30, p < .05$).

At least for males, then, dominance is not anger driven, nor does it correlate significantly with hostility, as measured by the Ho scale. Perhaps it is more an expression of cold, instrumental aggression than of anger-driven aggression. Although by some definitions, dominance may not qualify as a manifestation of aggression because it may lack intent to hurt, it should qualify as a manifestation of aggressiveness. (For a discussion of the distinction between these two terms, see Ref. 34). In fact, in a recent factor analytic study, a dominance questionnaire loaded significantly on an instrumental aggression factor (27).

Pathophysiology of the Dominance-CHD Relationship

Given the evidence that dominance may be a significant risk factor for CHD, at least in males, we need to know more about the mechanism and the pathophysiology that may be involved in this relationship. A study recently completed in our laboratory found that both anger-out and dominance-driven aggression were independently associated with heightened levels of CVR during a serial subtraction task (15). These findings suggest that heightened levels of CVR may mediate the dominance-CHD relationship as they apparently do the anger-CHD relationship (18–19, 31, 32). Similarly, Smith et al. (35, 36) report that effortful attempts to exert dominance are associated with heightened CVR. Additionally, hyperlipidemia may be involved in the dominance-CHD relationship: One study (37) found a significant positive relationship between questionnaire-assessed dominance and serum triglyceride concentration but not with serum cholesterol concentration. Another study (38), however, found that questionnaire-assessed dominance did correlate positively and significantly with total serum cholesterol levels in individuals low in physical fitness. Research on the CVR and neuroendocrine correlates of hostility and anger in provoked and angered individuals has contributed to our understanding of the mechanisms that are involved in the anger/hostility-CHD relationship (39). We now need to proceed with a similar research program on the CVR and neuroendocrine correlates of dominance behaviors.

Role of Gender

Of the two risk factors examined in this study, antagonistic behavior and dominance, the former seems to have been the strongest risk factor in our female

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population, and the latter seems to have been the strongest in our male population. This should not be interpreted to mean that *only* dominance is a risk factor for CHD in men. There is strong evidence, some based on prospective data, of a significant positive relationship between the outward expression of anger in men and CHD (6, 9, 24, 26, 31, 33). In the present study, too, there was a nearly significant relationship between the male participants' irritability scores and documented CHD. The relevance of this finding is that irritability items have been found to load on an anger-out factor (27). More significantly, in this study, as reported elsewhere (26), spouse ratings of their *husbands'* anger-out levels (anger-out factor scores) correlated significantly with their husband's CHD status. On the other hand, spouse ratings of their *wives'* anger-out levels (anger-out factor scores) did not correlate significantly with their wives' CHD status. Taken together, these findings suggest that different dimensions of the anger-antagonistic behavior domain may be CHD risk factors for men than for women. Taken together, the findings of this study suggest that the full-blown outward expression of anger and dominance are risk factors for CHD in men and that the more subtle expressions of antagonism (indirect challenge) are risk factors for CHD in women. However, this conclusion must be tempered by the fact that notwithstanding these indications of gender differences, these differences were not strong enough to yield significant gender by HBI, gender by indirect challenge, or gender by irritability interactions. Clearly, the role of gender as a mediator of the anger/antagonism-CHD relationship, which has been reviewed by Stoney and Engebretson (40), needs further systematic study.

Worthy of note is the finding that gender was not a significant source of variance in any of our anger/antagonism measures. The widely shared belief that men express anger primarily outwardly and women primarily inwardly is not supported by our data. What may have been true in the past may not reflect current reality.

Attitudinal Hostility and CHD

Age- and gender-adjusted Ho scores were associated with a significant increased risk for CHD. However, this relationship was no longer significant after making further adjustments for SES or disease risk factors (hypertension and diabetes mellitus), suggesting that the hostility-CHD relationship was primarily mediated through these other risk factors. Furthermore, in this study, there was a marginally significant relationship between two Ho component scores (hostile affect and

aggressive responding) and CHD ($p < .10$), but these relationships, too, were completely wiped out when we adjusted for SES or hypertension and diabetes mellitus. The finding that adjusting only for SES attenuates the Ho-CHD relationship so that it is no longer significant casts a cloud on the Ho-CHD studies that have failed to make such an adjustment. In this study, there was an inverse relationship between SES and Ho scores ($r = -0.29$, $p < .001$), which accounts for the finding that once we adjusted for SES, the Ho-CHD relationship was no longer significant. (For a more complete discussion of the role of SES in hostility, see Ref. 41.)

Even if attitudinal hostility turns out not to be an *independent* risk factor for CHD, it does not follow that attitudinal hostility is a benign factor as far as health is concerned. Attitudinal hostility may be a significant risk factor for diseases other than CHD. Thus, Everson et al. (23) found that hostility was an independent risk factor for carotid artery atherosclerosis, and in this study, the abbreviated Ho scores were associated with an increased risk of essential hypertension, even after adjusting for SES and the other traditional risk factors ($\beta = 0.102$, $SE = 0.040$, $p = .01$, $RR = 1.11$). Furthermore, recent evidence (42) suggests that even when it is not an independent risk factor, hostility can interact with other risk factors to produce heightened risk of CHD.

SES and CHD

Of the various CHD risk factors examined in this study (including the traditional risk factors), SES was, from a statistical perspective, one of the most significant. That low SES is a significant risk factor for CHD, as it is for morbidity and mortality in general, has been known for some time, but precisely what mediates this relationship is a matter of debate (43, 44). One major contender, as far as the SES-CHD relationship is concerned, is poor health. For example, in this study, SES correlated inversely and significantly with both hypertension ($r = -0.25$, $p < .001$) and diabetes mellitus ($r = -0.16$, $p < .03$). However, when we covaried these two risk factors (ie, hypertension and diabetes mellitus) from the SES-CHD correlation, the relationship remained significant ($RR = 0.542$, $p < .02$). Nor did covarying the other traditional risk factors from the SES-CHD relationship diminish its significance ($RR = 0.479$, $p = .02$). Perhaps the stress that is associated with a low SES lifestyle is what puts one at risk for CHD (45). This is a hypothesis that needs to be carefully tested.

Partialling out the effect of SES from the HBI-CHD relationship, or from the irritability-CHD, indirect

challenge-CHD, or dominance-CHD relationship, did not alter their significance, but doing the same for the Ho-CHD relationship reduced it from $p < .03$ to $p = .40$. It would seem, then, that in this study, SES accounted for the significant positive univariate Ho-CHD relationship. (The correlation between SES and Ho was -0.29 , $p < .001$). This finding implies that in studying the effects of hostility on CHD, or other diseases, it is important to control for SES.

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