Psychological Variables in Hypertension: Relationship to Casual or Ambulatory Blood Pressure in Men

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Objective: The evidence linking hypertension with personality or psychological characteristics, such as anger, anxiety, or depression, remains equivocal. This may be due in part to limitations of personality theory, confounding by awareness of hypertension, and/or inherent difficulties in measuring blood pressure. This study was designed to investigate the association between mild hypertension as defined by both ambulatory and casual (clinic) blood pressure measurements and various measures of personality and psychological characteristics. **Methods:** We examined this association in a population-based sample of 283 men between the ages of 30 and 60 years from eight work sites in New York City, using an ambulatory blood pressure monitor and controlling for age, race/ethnicity, and body mass index. **Results:** We found no consistent difference between participants with mild hypertension and those with normal blood pressure on any of the psychological variables assessed, including Type A behavior pattern, state and trait anger, anger expression, anxiety, symptoms of psychological distress, locus of control, or attributional style. Results were not due to the use of antihypertensive medication by some of the participants with hypertension nor to the dichotomization of blood pressure into those with and without mild hypertension. This contrasts with previous findings from this study showing a sizable association of ambulatory blood pressure and hypertension with job strain (a situational measure), age, and body mass index. **Conclusions:** These null results suggest that situational, biological, and perhaps behavioral factors are the primary determinants of mild hypertension and that the predictive significance of psychological or dispositional factors is low or negligible in those without overt cardiovascular disease. **Key words:** hypertension, blood pressure, personality, psychological factors.

ASQ = Attributional Style Questionnaire; BMI = body mass index; JAS = Jenkins Activity Survey; SCL-90-R = Symptom Checklist 90-Revised; STAI = State-Trait Anger Inventory.

INTRODUCTION

The "hypertensive personality" is among the most enduring constructs in psychosomatic medicine. The construct implies that there is an important relationship between psychological variables and the likelihood of developing high blood pressure. Despite the persistence of the hypertensive personality construct, evidence substantiating its existence remains equivocal (1).

Anger and anxiety are the psychological factors most often implicated as being associated with hypertension. Alexander (2) was the first to suggest that autonomic activation and elevated blood pressure in individuals with hypertension resulted from repressed hostility or "anger-in." One early study supporting this notion showed that individuals with hypertension reported more restrained aggression and more inner tension than individuals with allergies but without hypertension and hospitalized patients without hypertension (3). A more recent study comparing participants with borderline hypertension and those with normal blood pressure found that the group with hypertension exhibited less externalized aggression, more internalized aggression, and more submissiveness (4). However, other studies have failed to detect a relationship between anger or aggression and high blood pressure (5–7).

The data linking anxiety to high blood pressure also remain ambiguous (7–10). Although four prospective studies have failed to show an association (reviewed in Ref. 8), three recent prospective studies (7–9) tend to support the etiological significance of anxiety in hypertension. In the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study, blacks aged 25 to 64 years and whites aged 45 to 64 years who had high levels of anxiety symptoms were more likely to have hypertension than groups with intermediate or low levels of anxiety symptoms (8). In a subgroup of 330 men initially aged 45 to 59 years from the Framingham study who were followed for 18 to 20 years, a high level of tension or anxiety at baseline predicted future hypertension (7). However, tension was not a predictor of hypertension in older men or in women. In a prospective study using a shorter

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We dedicate this article to Richard Friedman, our good friend and respected colleague, who died in August 1997.

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follow-up period of 3 years, however, the same authors found that tension did predict the development of hypertension in women (9). The instrument used to assess tension in these studies was the Framingham Tension Scale. Many of the symptoms evaluated by the scale, such as nervousness, shaking, and tenseness, are experienced during arousal of the sympathetic nervous system or during the infusion of epinephrine (11). Hence, these results do not resolve the basic question of whether sympathetic arousal manifests itself symptomatically as tension and anxiety or, alternatively, whether anxiety induces sympathetic arousal. Despite its longevity, the debate over whether a relationship exists between psychological variables and hypertension remains unsettled.

A more precise understanding of the relationship between personality and elevated blood pressure has been impeded by a number of factors. One concerns psychological theory. No theory about the hypertensive personality is generally accepted, and there is a lack of consensus on which personality or psychological traits are related to blood pressure. Nonetheless, as noted above, most interest has focused on anger, anxiety, and, more recently, depression. A related aspect of this same problem is the lack of a model specifying interactions or other causal relationships (eg, mediation) between environmental stressors and personality characteristics in the development of hypertension (12). One possible model is suggested by the observation that suppressed anger is associated with the prevalence of hypertension in male hourly workers only among those reporting job stress (eg, ambiguity about the future and dissatisfaction with coworkers and promotions) (13). Other studies have shown that asymptomatic participants with hypertension (14), as well as those with normal blood pressure who have a family history of hypertension (15), seem to express fewer emotions, have a noncomplaining attitude, and lack the ability to differentiate feelings, similar to those with a personality characterized by denial (16). Theorell (15) hypothesized that such personality characteristics may result in part from a stressful psychosocial work environment that "enforces a noncomplaining attitude and prevents development of active emotional coping."

A second factor impeding progress toward resolving the hypertensive personality debate is that there is no generally accepted assessment strategy. Hence, several of the studies in the literature did not use standardized psychological tests (6, 17, 18). Some studies measured only anger and anxiety, whereas others measured these variables as well as their expression or suppression. The variability in assessment strategies makes cross-study comparisons problematic.

Third, most studies have not investigated whether the obtained differences are specific to the normotension vs. hypertension dichotomy or more generically related to the well vs. sick dichotomy (19). Many studies examining the potential relationship between psychological characteristics and hypertension have not carefully excluded participants with other cardiovascular disorders.

A fourth issue concerns a potential confound, the "labeling" phenomenon, in some of the studies reporting an association between psychological characteristics and hypertension. The relatively high levels of anxiety and anger occasionally observed in individuals with hypertension may not be an etiological association but rather a consequence of the diagnosis (20, 21). For example, one important study found that participants aware of their hypertension scored significantly higher on neuroticism, trait and state anxiety, and self-reported Type A behavior than both participants with normal blood pressure and unaware participants with hypertension (21).

A fifth problem is the inherent difficulty in measuring blood pressure, which results in substantial unreliability. The classification of participants into hypertensive and normotensive groups is a crucial aspect of many studies examining the relationship of psychological variables and blood pressure, yet few studies have systematically related personality/psychological measures to a variety of blood pressures assessed in different settings or using different measurement strategies. It is widely believed that situational and psychological factors are importantly involved in the determination of blood pressure in the clinic. Individuals categorized as having hypertension on the basis of casual clinic measurements might not be so classified if blood pressure readings were obtained with a greater degree of concern for spurious elevations. It has been estimated that as many as 20% of all diagnosed patients with hypertension may have "white coat" hypertension (22). Furthermore, even blood pressure measurements obtained under carefully controlled clinical situations may be different from blood pressures obtained using an ambulatory monitor in a person's natural environment (23). One might predict that clinic blood pressures would be more strongly related to trait anxiety than pressures obtained at a work site or ambulatory pressures.

Situational variables were extremely important to the definition of hypertension in one study that examined anger intensity and its suppression in two groups of participants with borderline hypertension (24). Both groups of participants with hypertension had elevated blood pressure in the clinic, but only one group had elevated pressures when participants measured their

own pressures at home. The group with elevated blood pressure in both settings had higher anger scores than the group that had home pressures in the normal range. If the definition of hypertension was based on clinical values, then both the relatively high and relatively low anger patients would be combined before comparisons with the normal blood pressure group. If, on the other hand, home blood pressure levels defined hypertension, then only the relatively high anger patients would be compared with the normal blood pressure control group. In the first case, support for the hypertensive personality would be weaker than in the second case. This study, as well as several others, demonstrates the need to examine the relationship between blood pressure and psychological factors with sensitivity toward measurement issues.

A particularly pertinent study examined the relationship between anxiety and blood pressure as a function of repeated measurements (25). The results indicated that patients with hypertension whose blood pressure decreased with repeated measurement had higher anxiety scores at the beginning of the study than patients with hypertension whose blood pressure did not decrease with repeated measurements. Stated another way, this study found that anxiety scores discriminated between those with reactive hypertension and those with sustained hypertension.

The Work Site Blood Pressure Study is a prospective study examining psychosocial variables, especially job strain, as potential risk factors for hypertension and for increased left ventricular mass. The psychological data obtained in the first wave of this ongoing study are used here to examine the cross-sectional relationship between psychological characteristics and hypertension in a manner that addresses several of the concerns described above. First, an extensive psychological assessment battery was completed by all study participants. Only frequently used, psychometrically validated, standardized instruments were administered. This battery is representative of factors evaluated in several studies examining the relationship between psychological factors and blood pressure, not just anxiety and anger. Second, participants with other cardiovascular disorders were excluded. Third, at the time of their participation, the vast majority of participants (89%) had never been prescribed antihypertensive medication and hence were unlikely to have ever been labeled as hypertensive. We were particularly interested in the potential relationship of psychological variables to both casual and ambulatory blood pressure measurements. Based on data from the literature, we hypothesized that participants who were more angry, more anxious, more depressed, and more Type A would be more likely to be hypertensive and, relatedly, would tend to have higher casual and ambulatory blood pressures.

METHODS

The overall recruitment strategy for this study was reported in detail elsewhere (26, 27). Briefly, all participants ($N = 283$) in the study were employed men between the ages of 30 and 60 years recruited at eight work sites in New York City. All were free of major cardiovascular illness according to self-report, a 12-lead electrocardiogram, and an echocardiogram.

Psychological Assessment

Jenkins Activity Survey. The JAS consists of 52 items measuring time urgency, impatience, irritability, competitiveness, striving for achievement, conscientiousness, and commitment to and involvement in a career that involves heavy responsibility, deadlines, and a sense of job overload (28, 29). Hostility is not measured on the JAS. The four scales of the JAS are Type A Behavior, Factor J (job involvement), Factor S (speed and impatience), and Factor H (hard driving and competitive). Internal consistency (Cronbach's α) in this data set ranges from 0.55 to 0.63. Response options are scored on three-, four-, and five-point Likert scales.

Spielberger State-Trait Anger Inventory and Trait Anxiety. The STAI consists of two sets of 15 items that measure general (trait) and present (state) anger. Response options are scored on a four-point scale ranging from "almost never" to "almost always" (30). Cronbach's α values are 0.86 and 0.95, respectively. The Trait Anxiety scale consists of 20 similarly scaled items and has an α value of 0.89.

Spielberger Anger Expression scale. The Anger Expression scale measures whether anger is frequently expressed or held in (31). The scale measures anger-in (8 items), anger-out (8 items), and anger-total (previous 16 items plus 4 more). Cronbach's α values range from 0.67 to 0.76.

Symptom Checklist 90-Revised. The 90 items of the SCL-90-R measure symptoms of psychological distress that form nine scales: Somatization, Interpersonal Sensitivity, Obsessive-Compulsiveness, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism (32). In addition, the Global Severity Index is the most sensitive single measure of respondents' psychological distress, combining information on the number of symptoms and intensity of distress. A five-point Likert scale, ranging from "not at all" to "extremely," was used in the current study. All scale scores are converted, based on normative data, to T scores (with a mean of 50 and standard deviation of 10). Cronbach's α values are between 0.77 and 0.88 for the nine scales and 0.97 for the Global Severity Index.

Rotter Internal-External Locus of Control. The Locus of Control scale is designed to measure both personal experience (reality) and one's subjective interpretation of wants and needs (ideals). Each of the scale's 29 questions involves a forced choice between two statements, one reflecting an internal orientation and one reflecting an external orientation. On one extreme, someone with an "internal" orientation tends to believe that the world is easy, just, politically responsive, and subject to his influence. Those giving "external" responses believe themselves to be helpless pawns, even in situations where they may have control, and tend to be more passive, unmotivated, and depressed (33). High scores on this scale indicate an external orientation ($\alpha = 0.72$).

Attributional Style Questionnaire. The ASQ asks participants about the causes of events that have occurred to them and whether the events are 1) due mainly to themselves (internal) or due to other people or circumstances, 2) whether the cause will always (stable) or never again be present, and 3) whether the cause affects their whole

life (global) or just this situation (34). Response options to the 36 questions concerning 12 situations are scored on a seven-point scale. The ASQ is based on the reformulated learned helplessness model (35), which posits that control perceptions about negative situations that are internal, stable, and global will have the most profound effects on depression, passivity, and lowered self-esteem. Scales constructed from the six negative situations presented are Internal Negative, Stable Negative, Global Negative, Hopelessness (the average of Global Negative and Stable Negative), and Composite Negative (the sum of the first three scales). Scales constructed from the six positive situations presented are Internal Positive, Stable Positive, Global Positive, Hopefulness (the average of Global Positive and Stable Positive), and Composite Positive (the sum of the first three scales). Cronbach's α values of the six basic scales range from 0.51 to 0.70, except for the Internal Negative scale, which has an α value of 0.40. α values for Hopelessness, Hopefulness, and the two composite scales range from 0.70 to 0.79.

Blood Pressure Measurement

Three casual sitting blood pressure measurements were taken at a work-site screening by specially trained staff using the American Heart Association protocol (36). Systolic and diastolic blood pressures were defined by the first and fifth Korotkoff phases, respectively. The casual systolic (and diastolic) blood pressure value for each potential participant was defined as the average of the last two measurements; the first was ignored. After the screening session, a subset of potential participants were invited to a recruitment session, at which time a second set of casual blood pressures were obtained. Those with screening diastolic blood pressures >85 mm Hg were oversampled to increase the statistical power to detect differences between individuals with normal blood pressure and those with mild hypertension. If both the screening and recruitment casual diastolic blood pressures were ≤85 mm Hg, an individual was classified as normotensive (control, $N = 186$). If both casual diastolic blood pressures were >85 mm Hg or the individual was taking antihypertensive medication, he was classified as a "case," someone having mild hypertension ($N = 84$). Individuals not taking medication who crossed over categories from screening to recruitment ($N = 13$) were not assigned a hypertensive status based on casual blood pressures. Individuals with severe hypertension (ie, those with a systolic/diastolic blood pressure >160/105 mm Hg) were not recruited for the study because we considered it medically imprudent to withdraw antihypertensive medication from such individuals for the 3 weeks required for the ambulatory blood pressure monitoring protocol.

Participants wore a SpaceLabs monitor (model 5200 for participants at the first seven sites and model 90202 at the eighth, and largest, site) for 24 hours during a normal workday using procedures described previously (37). The monitor was attached at the participant's work site and calibrated by comparing five successive systolic and diastolic readings against simultaneously determined casual readings measured with a mercury column; the technician's and monitor's averages had to agree to within 5 mm Hg for monitoring to proceed. The monitor was programmed to record blood pressure at 15-minute intervals during the day and 30-minute intervals during the participant's normal hours of sleep. Participants were instructed to remain as motionless as possible when the monitor took a reading during waking hours but otherwise to proceed through a normal workday. Each participant's mean ambulatory diastolic and systolic blood pressures were calculated for all readings taken while the participant was awake (average, 55; range, 9–79). The 27 participants taking antihypertensive medication discontinued their medication under supervision for a period of 3 weeks before wearing the monitor.

Individuals were classified into an "ambulatory normotension" group if their mean waking ambulatory diastolic blood pressure was ≤85 mm Hg ($N = 203$) or "ambulatory hypertension" group if their mean ambulatory diastolic blood pressure was >85 mm Hg ($N = 80$). Of the 270 participants whose hypertensive status was classified by both criteria, 167 (62%) had both normal casual and ambulatory diastolic blood pressures, 58 (21%) had both elevated casual and ambulatory blood pressures, 26 (10%) had elevated casual blood pressure but normal ambulatory blood pressure, and 19 (7%) had normal casual blood pressure but elevated ambulatory blood pressure. The resulting κ statistic of 0.60 reflects a moderately high level of agreement between these two methods of defining hypertension status.

We based our definitions of casual and ambulatory hypertensive status on only diastolic blood pressures for methodological reasons. The case definition for (mild) hypertension status, and hence the recruitment strategy for the study, dichotomized participants into case and control subjects on the basis of only diastolic screening and recruitment pressures; participants at six of the eight work sites were recruited only if the casual diastolic blood pressure was consistently >85 mm Hg or ≤85 mm Hg on two occasions. Because systolic blood pressure was not part of the case definition, we also used only diastolic blood pressure to define ambulatory hypertensive status.

Two additional blood pressure measurements were analyzed (see below): a seated casual blood pressure taken according to the American Heart Association protocol during a physical examination conducted by one of our staff at the work site and a supine clinic blood pressure taken by a trained echocardiography technician after the participant had been supine for approximately 30 minutes in a dimly lit room.

Statistical Analysis

Logistic regression analysis was used to estimate the association of hypertension with each personality/psychological characteristic. For both casual and ambulatory diastolic hypertension, two equations were estimated for each predictor. The first estimated the simple bivariate association, and the second controlled for three major risk factors: age; race/ethnicity, using two "dummy" or "indicator" variables to differentiate blacks (9%), Hispanics (5%), and others (almost all whites); and BMI (weight ÷ height^2). To provide a consistent set of "standardized" estimates of the strength of association of the various personality/psychological scales with hypertension, we report the estimated odds ratio for hypertension of those at the 75th percentile relative to those at the 25th percentile of the predictor.

Because of concerns that 1) the dichotomization of continuous measures usually reduces the statistical power to detect associations with other variables (38) and 2) the analysis of diastolic hypertension could miss an association between systolic blood pressure and some personality/psychological measures, we also used linear regression analysis to estimate the association of seated casual, supine clinic, and ambulatory awake diastolic and systolic blood pressures with each personality/psychological measure. Again, two equations were estimated for each pair of outcome and predictor: one estimating the simple bivariate relationship and one that controlled for age, race/ethnicity, and BMI. Here, the standardized effect size that we report is the estimated blood pressure difference (in mm Hg) between those at the 75th and 25th percentiles of the predictor.

For both the logistic and linear regression analyses, diagnostic statistics (39, 40) were used to identify potential outliers and excessively influential observations. Sidak's inequality (41) was then

used to exclude those observations that had a <10% probability of occurring by chance, assuming the studentized residuals (the observed residual ÷ its standard error) and the DFFITS (a standardized measure of how much the predicted score of an observation is influenced by that observation's data) diagnostic statistics were normally distributed. Across the 264 analyses, zero to five outliers were detected. Except as noted below, when analyses were replicated after outliers were deleted, the results were essentially unchanged.

To address the concern about a possible effect of labeling, both the logistic and linear regression analyses were repeated after excluding the 30 participants who had ever taken antihypertensive medication (27 withdrawn from medication and 3 past users) and therefore knew that they had elevated blood pressures.

RESULTS

The mean, standard deviation, interquartile range (used to calculate the standardized effects contrasting those at the 25th and 75th percentiles), and range of each psychological measure and blood pressure measure are shown in Table 1.

The ratio of the estimated odds of being hypertensive for someone at the 75th percentile relative to someone at the 25th percentile of each psychological measure is shown in Table 2. Two estimates, obtained before and after controlling for race/ethnicity, age, and BMI, are reported. Even without making an adjustment to the significance level to account for the large number (66 bivariate and 66 multivariate) of analyses, the results were essentially completely null. Without the control variables (bivariate analyses), the SCL-90-R Somatization scale was associated with an increased risk of ambulatory hypertension (estimated odds ratio for 75th vs. 25th percentiles = 1.38, unadjusted $p < .05$), and the Factor J (job involvement) scale of the JAS was associated with a decreased risk of casual hypertension (estimated odds ratio = 0.59, unadjusted $p < .01$). The latter association is in the opposite direction from what some might hypothesize. The Global Positive scale of the ASQ had an estimated odds ratio of about 1.5 predicting both casual and ambulatory hypertension, again in the opposite direction of what we believe most researchers would hypothesize. Participants at the first work site did not complete this instrument, and the reduced number of observations meant that this association was only marginally significant (unadjusted $p = .051$ and .08, respectively). After controlling for race/ethnicity, age, and BMI (multivariate analyses), none of the personality/psychological measures was associated with an increased risk of either casual or ambulatory hypertension at an unadjusted significance level of $p < .05$. Except as noted above, all estimated odds ratios comparing the 75th with the 25th percentiles were between 0.70 and 1.37. If there were no associations in the population between any of the personality/psychological measures and hypertension status, one would expect three or more of the estimated odds ratios from both the bivariate and multivariate analyses to be "significant" at the unadjusted $p < .05$ level. Clearly the observed findings failed to exceed chance expectation.

The linear regression analyses predicting the six continuous blood pressure measures (ie, seated casual, supine clinic, and mean awake ambulatory systolic and diastolic pressures) are summarized in Table 3. Of the 396 analyses, the only two that yielded significant results at an unadjusted $p < .01$ level are the bivariate analyses predicting supine systolic and diastolic blood pressure from the job involvement scale of the JAS. Men at the 75th percentile are estimated to have 4.1/2.4 mm Hg lower systolic/diastolic blood pressures than those at the 25th percentile. The corresponding Pearson correlation coefficients are −0.20 and −0.17. Job involvement is also associated with lower seated casual diastolic blood pressure (effect size of −2.1 mm Hg, $r = -0.15$, unadjusted $p < .05$). Although the parallel multivariate analyses that control for race/ethnicity, age, and BMI were initially not significant, exclusion of five outliers from the analysis of supine systolic blood pressure and two outliers from the analysis of supine diastolic blood pressure resulted in estimates for the effect of job involvement that were just significant at the unadjusted $p < .05$ level.

None of the six Spielberger anger and anxiety scales, locus of control, the submissiveness scale of Cattell's 16-PF personality inventory (52), nor any of the 10 SCL-90-R scales was significantly related to any of the six blood pressure measures in either bivariate or multivariate analyses. The largest Pearson correlation was −0.12, between Spielberger's anger-out scale and mean awake ambulatory diastolic blood pressure; all other correlations were <0.10 in magnitude.

Several of the associations between scales of the ASQ and various blood pressure measures were significant at the unadjusted $p < .05$ level. The Global Positive scale was positively associated with all blood pressures except the seated casual diastolic pressure. These associations were strongest for the supine clinic systolic and diastolic blood pressures, which then carried over to the Hopefulness and Composite Positive scales, which both include the Global Positive scale. None of these associations remained significant in the multivariate analyses that control for race/ethnicity, age, and BMI. The Global Negative scale was also positively associated with mean awake ambulatory systolic and diastolic blood pressures. This association carried over to the Hopelessness and Composite Negative scales, which both include the Global Negative scale. Several of these associations remained significant at an unadjusted $p < .05$ level in the multivariate

TABLE 1. Mean, Standard Deviation, Interquartile Range (IQR), and Range of Personality/Psychological and Blood Pressure Measures

	N	Mean	SD	IQR	Range
Jenkins Activity Survey					
Type A (global)	280	−2.16	9.83	15.3	41.5
Factor S (speed and impatience)	281	−0.62	9.44	15.0	46.2
Factor J (job involvement)	280	−2.48	9.96	14.5	49.2
Factor H (hard driving and competitive)	281	−1.50	10.35	15.4	49.6
State-Trait Inventory					
State Anger	280	18.9	6.8	5.0	45.0
Trait Anger	280	27.5	6.4	8.0	31.0
Trait Anxiety	279	25.0	3.8	5.0	20.0
Anger Expression Scale					
Anger-in	279	14.3	3.4	12.0	44.0
Anger-out	279	47.1	5.7	4.0	23.0
Anger total	280	36.5	8.4	6.0	38.0
Locus of Control	278	8.7	3.8	6.7	16.0
Submissiveness (*N* = 173)	173	13.3	4.5	6.0	25.0
SCL-90-R					
Somatization	281	52.5	11.2	13.0	51.0
Obsessive-Compulsive	281	55.9	11.8	14.0	51.0
Interpersonal Sensitivity	281	55.7	11.8	13.0	46.0
Depression	281	55.2	12.9	14.0	51.0
Anxiety	280	53.1	12.2	15.0	46.0
Hostility	280	51.9	10.8	9.0	46.0
Phobic Anxiety	280	47.2	11.0	19.0	41.0
Paranoid Ideation	280	52.1	12.3	24.0	44.0
Global Severity Index	280	55.7	11.0	15.0	51.0
Global Grand Total	280	37.4	32.5	37.5	171.0
Attributional Style Questionnaire (*N* = 227)					
Internal Positive	227	5.30	0.83	1.2	4.3
Stable Positive	227	5.29	0.77	1.0	4.0
Global Positive	227	4.91	0.97	1.3	6.0
Hopefulness	227	5.10	0.77	1.0	4.2
Composite Positive	225	15.5	2.17	2.8	12.3
Internal Negative	226	3.99	1.05	1.5	5.7
Stable Negative	225	4.18	0.86	1.2	5.8
Global Negative	225	3.82	1.16	1.7	6.0
Hopelessness	225	4.00	0.88	1.1	5.9
Composite Negative	225	12.0	2.45	2.8	16.7
Composite Difference	225	3.48	3.06	4.0	21.0
Blood pressure (mm Hg)					
Seated casual (AHA)[a]					
Diastolic	267	81.1	9.8	15.0	50.0
Systolic	267	121.8	14.5	19.0	86.0
Supine clinic					
Diastolic	265	79.9	10.0	12.0	54.0
Systolic	265	127.6	14.0	16.0	96.0
Mean awake ambulatory					
Diastolic	283	81.8	7.9	10.7	42.8
Systolic	279	130.1	12.5	14.0	77.1

[a] AHA = American Heart Association–recommended position.

analyses. However, when we deleted three outliers from the analysis of ambulatory systolic blood pressure, none of its associations with the ASQ scales remained significant in either the bivariate or multivariate analyses. When we similarly deleted one outlier from the analysis of seated casual systolic blood pressure, its bivariate association with the Internal Negative scale became just statistically significant (unadjusted $p = .048$), helping also to explain the borderline association between the Composite Negative scale and casual systolic blood pressure. All of the effects described here correspond to a <3-mm Hg estimated difference in systolic blood pressure or 2.5-mm Hg difference in diastolic blood pressure between those at the 75th and 25th percentiles of the ASQ subscales, with correlations ranging between 0.13 and 0.16.

TABLE 2. Relationship of Hypertension Status to Personality/Psychological Measures: Estimated Odds Ratio of Those at the 75th and 25th Percentiles of the Predictor

	Hypertension Status Defined By[a]			
	Casual DBP		Ambulatory DBP	
	Bivariate	Multivariate[b]	Bivariate	Multivariate
Jenkins Activity Survey				
Type A (global)	0.88	1.09	1.01	1.16
Factor S (speed and impatience)	0.99	1.18	0.98	1.09
Factor J (job involvement)	0.59**	0.71	0.70	0.82
Factor H (hard driving and competitive)	1.17	1.26	1.30	1.38
State-Trait Inventory				
State Anger	1.09	1.08	1.06	1.05
Trait Anger	1.11	1.34	1.00	1.10
Trait Anxiety	1.07	1.34	0.87	0.99
Anger Expression Scale				
Anger-In	1.05	0.87	1.02	0.93
Anger-Out	0.90	0.94	0.83	0.86
Anger Total	0.93	0.85	0.89	0.85
Locus of Control	0.83	0.93	1.00	1.12
Submissiveness (N = 173)	0.82	0.83	0.99	0.99
SCL-90-R				
Somatization	1.32	1.32	1.38*	1.37
Obsessive-Compulsive	0.99	1.04	1.06	1.09
Interpersonal Sensitivity	1.00	1.20	1.02	1.14
Depression	1.09	1.22	1.04	1.10
Anxiety	1.06	1.28	1.07	1.19
Hostility	1.04	1.19	1.03	1.11
Phobic Anxiety	1.16	1.30	1.07	1.11
Paranoid Ideation	0.88	0.92	0.86	0.89
Global Severity Index	1.03	1.16	1.11	1.20
Global Grand Total	1.02	1.08	1.15	1.21
Attributional Style Questionnaire (N = 227)				
Internal Positive	1.27	1.17	0.99	0.90
Stable Positive	1.07	0.94	1.10	1.03
Global Positive	1.56	1.27	1.45	1.25
Hopefulness	1.34	1.11	1.31	1.16
Composite Positive	1.35	1.15	1.18	1.03
Internal Negative	1.19	1.01	1.49	1.34
Stable Negative	1.24	1.32	1.08	1.05
Global Negative	1.19	1.16	1.34	1.29
Hopelessness	1.22	1.23	1.22	1.18
Composite Negative	1.21	1.14	1.31	1.23
Composite Difference	1.03	0.97	0.88	0.84

[a] DBP = diastolic blood pressure.
[b] Controlling for race/ethnicity, age, and body mass index.
* $p \leq .05$; ** $p \leq .01$.

We were concerned that the use of linear regression might underestimate the strength of association between the psychological and blood pressure measures. Therefore, we also computed Spearman rank order correlation coefficients and compared them with the Pearson (linear) correlations. Although the differences were generally small, not favoring one type of correlation over the other, the Spearman correlations of Factor J (job involvement) and Global Positive attributional style with supine clinic systolic and diastolic blood pressures were 0.02 to 0.04 larger than the Pearson correlations.

To test whether a relationship between the personality/psychological measures and either hypertensive status or the continuous blood pressure measures might be present only in younger (<45 years old) or older (≥45 years old) participants, and hence obscured in the above analyses, we reran each multivariate logistic and linear regression analysis to include the corresponding two-category age measure and its inter-

TABLE 3. Relationship of Blood Pressure to Personality/Psychological Measures: Estimated Difference in Blood Pressures (mm Hg) Between Those at the 75th and 25th Percentiles of the Predictor

	Analysis[a]	Blood Pressure					
		Seated Casual		Supine Clinic		Ambulatory	
		Diastolic	Systolic	Diastolic	Systolic	Diastolic	Systolic
Jenkins Activity Survey							
Type A (global)	B	−0.1	−1.1	0.2	−1.3	−0.0	−0.5
	M	0.3	−0.1	1.1	0.4	0.6	0.2
Factor S (speed and impatience)	B	0.1	−1.2	−0.1	−1.9	−0.1	0.0
	M	0.1	−0.2	0.6	−0.1	0.3	0.7
Factor J (job involvement)	B	−2.1*	−1.9	−2.4**	−4.1**	−0.8	−1.6
	M	−1.4	−0.3	−1.3	−1.8	0.0	−0.5
Factor H (hard driving/competitive)	B	0.7	0.7	0.6	−0.2	0.7	0.6
	M	0.5	0.6	0.4	−0.1	0.7	0.7
State-Trait Inventory							
State Anger	B	0.2	−0.1	0.4	0.0	0.2	−0.2
	M	0.2	0.1	0.3	0.0	0.1	−0.2
Trait Anger	B	−0.0	−0.4	0.3	−0.4	−0.5	−0.7
	M	0.2	0.7	0.9	1.2	−0.1	0.1
Trait Anxiety	B	0.4	−0.5	−0.0	−0.9	−0.3	−0.5
	M	0.7	0.6	0.5	0.7	0.2	0.4
Anger Expression Scale							
Anger-In	B	−0.4	0.6	0.5	1.5	0.4	0.5
	M	−0.7	−0.3	−0.1	0.2	−0.0	−0.1
Anger-Out	B	−0.8	−1.4	−1.1	−1.5	−1.1	−0.8
	M	−0.8	−0.9	−0.7	−0.6	−0.8	−0.6
Anger Total	B	−0.6	−0.8	−0.2	0.2	−0.4	0.0
	M	−0.8	−1.0	−0.3	0.1	−0.4	−0.2
Locus of Control	B	0.1	−0.5	−1.2	−2.2	0.1	−0.0
	M	0.3	−0.2	−0.7	−1.1	0.5	0.2
Submissiveness	B	−1.2	−1.0	−0.3	−1.2	0.6	0.4
	M	−1.2	−0.9	−0.0	−0.8	0.8	0.4
SCL-90-R							
Somatization	B	1.0	0.1	0.8	−0.0	1.0	0.8
	M	0.7	−0.2	0.6	−0.2	0.8	0.5
Obsessive-Compulsive	B	−0.1	−0.8	−0.2	−0.9	−0.3	−0.7
	M	−0.1	−0.5	−0.1	−0.3	−0.2	−0.4
Interpersonal Sensitivity	B	−0.2	−0.9	0.1	−0.7	−0.6	−0.6
	M	0.2	0.1	0.6	0.5	−0.2	0.0
Depression	B	−0.0	−0.4	0.1	−1.2	−0.4	−1.0
	M	0.2	0.3	0.3	−0.3	−0.3	−0.5
Anxiety	B	0.5	−0.7	0.8	−0.3	0.1	0.0
	M	0.8	0.3	1.3	1.1	0.4	0.7
Hostility	B	0.0	0.1	0.3	−0.3	−0.2	0.0
	M	0.3	0.9	0.6	0.5	0.0	0.4
Phobic Anxiety	B	−0.1	−1.2	1.5	0.6	0.1	−1.4
	M	0.1	−0.7	1.5	0.7	0.2	−1.2
Paranoid Ideation	B	−1.2	−1.2	−0.6	−1.0	−1.1	−1.1
	M	−1.1	−0.5	−0.6	−0.3	−1.0	−0.8
Global Severity Index	B	−0.1	−0.9	0.6	−0.8	−0.2	−0.6
	M	0.1	−0.2	0.9	0.1	−0.0	−0.2
Global Grand Total	B	0.1	−0.5	0.9	0.0	0.2	−0.1
	M	0.2	−0.0	1.0	0.8	0.2	0.1
Attributional Style Questionnaire							
Internal Positive	B	0.5	0.1	1.3	1.4	0.4	0.7
	M	0.4	−0.5	0.7	0.1	−0.0	0.2
Stable Positive	B	−0.2	0.6	1.7	2.2	0.4	1.0
	M	−0.5	0.0	1.1	1.2	0.1	0.7
Global Positive	B	1.1	2.6*	2.2*	2.9*	1.8*	2.3*
	M	0.2	1.2	1.2	1.5	1.0	1.4
Hopefulness	B	0.5	1.8	2.1*	2.8*	1.3	1.9
	M	−0.1	0.7	1.3	1.5	0.6	1.2
Composite Positive	B	0.7	1.5	2.0*	2.6*	1.0	1.7
	M	0.1	0.5	1.1	1.1	0.4	0.9
Internal Negative	B	1.8	2.5	0.8	2.1	1.5	2.3*
	M	1.1	1.3	0.3	1.1	1.0	1.4
Stable Negative	B	0.7	1.6	0.5	1.9	0.7	1.5
	M	0.5	1.3	0.7	2.0	0.7	1.2
Global Negative	B	1.7	2.6	1.1	1.1	1.9*	2.5*
	M	1.2	2.1	1.1	1.2	1.8*	2.3*
Hopelessness	B	1.2	2.2	0.9	1.5	1.4*	2.1*
	M	0.9	1.7	0.9	1.6	1.3*	1.9
Composite Negative	B	1.4	2.3*	0.8	1.7	1.5*	2.2*
	M	0.9	1.6	0.7	1.4	1.2*	1.8*
Composite Difference	B	−0.8	−1.1	0.6	0.3	−0.6	−0.8
	M	−0.8	−1.1	0.1	−0.6	−0.9	−1.0

[a] B = bivariate analysis (no control variables); M = multivariate analysis (controls for race/ethnicity, age, and body mass index.
* $p \leq .05$; ** $p \leq .01$, *** $p \leq .001$.

action with the psychological predictor. In none of the 64 logistic regression analyses and only 2 of the 198 linear regressions was the interaction term significant at the unadjusted $p < .05$ level (both p values = .04, and one of these became nonsignificant after deleting outliers). Given the large number of tests, we concluded that there was no evidence in this study that the relationship between the psychological measures and blood pressure differs by age group.

To determine whether inclusion of participants taking antihypertensive medication obscured some relationships, all analyses were repeated after eliminating data from the 27 currently medicated participants and 3 participants with a history of prior medication use. The results were essentially unchanged. In the logistic regressions, only the association between the SCL-90-R Depression scale and ambulatory diastolic hypertension reached statistical significance, and only in the multivariate analysis (unadjusted $p = .049$, controlling for race/ethnicity, age, and BMI). In the regression analyses predicting the six continuous blood pressure measures, the JAS job involvement scale was again negatively associated with some of the nonambulatory blood pressures, whereas the ASQ Global Negative and Global Positive scales were positively associated with awake diastolic ambulatory blood pressure. In summary, one of the 132 logistic regression coefficients was significant at $p < .05$. Of the 392 linear regression analyses, one coefficient was significant at $p < .01$, and six more were significant at $p < .05$. As before, fewer of these test results are statistically significant than one would expect by chance.

DISCUSSION

The results of this study were negative in that once we controlled for three standard risk factors, no psychological variable distinguished between normotensive and mildly hypertensive participants, defined according to either casual or ambulatory diastolic blood pressure. In contrast, using the same measure of casual hypertension status, we previously found that the proportion of men with hypertension was significantly higher (odds ratio = 2.7) in men experiencing job strain (26), defined as the combination of high psychological job demands and low decision latitude. Mean awake ambulatory blood pressure was also substantially higher (6.0/2.5 mm Hg) in men with job strain (26, 27). This suggested that certain *situational* psychosocial variables are associated with hypertension. Using the same analytic strategy, the current study failed to find *dispositional* psychological variables that are associated with hypertension. The hypertensive personality hypothesis would predict that some psychological characteristic, or constellation of characteristics, should distinguish those participants whose blood pressures were relatively low from those whose blood pressures were relatively high. On the basis of prior studies reported by others (eg, Ref. 4), some aspect of anxiety or anger was predicted to be most likely to discriminate between these two groups. This was not the case in the present study. Neither casual nor ambulatory diastolic hypertension was associated with a pattern of psychological variables different from that of men with normal pressures.

Because of the reduction in statistical power that usually results from analyzing a dichotomized version of a continuous measure like blood pressure, we also investigated the relationship of continuous casual, supine, and ambulatory blood pressure measures to the psychological measures. This enabled us to analyze systolic as well as diastolic pressures. In this working sample, job involvement was associated with somewhat lower casual and supine blood pressures, whereas both Global Positive and Global Negative attributional styles were associated with slightly higher blood pressures. Given the items that are most strongly related to the job involvement scale of the JAS (bring work home at night, educational attainment, recent increase in annual income, number of job titles held in past 10 years, spend time at work when not expected to be there, and everyday life filled with problems/challenges), we suspect that those scoring high tend to work in higher status jobs having heavy psychological demands and providing high decision latitude. Although we suspect that some would have hypothesized that persons in such jobs would have higher blood pressures, this finding is more consistent with studies showing the protective effects of job control and socioeconomic status (42). However, it is unclear why this measure is more closely related to clinic supine blood pressure than mean awake ambulatory blood pressure. The Global Positive and Global Negative scales of the ASQ measure the extent to which participants believe that the primary cause of specific events/situations also contribute to other situations. The positive association between Global Negative attributional style and ambulatory blood pressure is the only finding consistent with the hypertensive personality hypothesis. The same association between Global Positive attributional style and several of the blood pressure measures, which becomes insignificant when race/ethnicity, age, and BMI are controlled, seems counterintuitive.

When planning the analysis, we were concerned about the increased risk of Type I errors that arises when the statistical significance of a large number of relationships is examined. However, the pattern of

results was so consistently negative, across two measures of hypertension status and six continuous blood pressure measures (especially when controlling for a small number of standard risk factors), that we concluded that no evidence from this study supports the hypertensive personality hypothesis.

There are several potential explanations for these negative results. Some might question the statistical power of our study design. In fact, averaged across the many bivariate logistic analyses reported in Table 2, this study had 80% power (using a .05 level of significance, two-tailed test) to detect an odds ratio for hypertension, contrasting the 75th vs. 25th percentiles of the psychological measures, of 1.7 or larger and 90% power to detect an odds ratio of 1.8 or larger. The corresponding odds ratios for the multivariate analyses that control for race/ethnicity, age, and BMI are 1.8 for 80% power and 2.0 for 90% power. Table 4 shows the differences in blood pressure between those at the 75th and the 25th percentiles of the psychological measures that were detectable with 80% or 90% power. This study was more than amply powered to detect effects of 3 mm Hg diastolic and 4 mm Hg systolic blood pressure. In more conventional terms, this study had 80% power to detect a correlation of 0.17 between a psychological measure and blood pressure and 90% power to detect a correlation of 0.19. According to Cohen (43), this study was adequately powered to detect moderately small effects, although it could have missed some small associations that might still be of public health significance.

It is also possible that we failed to detect an effect because we assessed the wrong psychological variables. Mitigating against this, we used many of the scales used in prior research to support the hypothesized relationship between personality and hypertension. In recent years the focus of personality and cardiovascular disease research has shifted to the constructs of hostility (44) and anxiety (7). Therefore, despite our negative findings using the Hostility scale of the SCL-90-R, we have been administering the Cook-Medley Hostility Scale and the Framingham Tension Scale as part of a follow-up evaluation.

Alternatively, perhaps 85 mm Hg diastolic blood pressure is not the optimal cutoff for classifying individuals as having hypertension. However, a diastolic blood pressure of >85 mm Hg has become a recommended clinical demarcation point for hypertension (45). It has also been frequently used in other studies reporting differences in psychological characteristics between participants with normal blood pressure and those with hypertension (see Refs. 1 and 46 for reviews). Finally, we would suggest that if differences in personality and/or psychological characteristics are observed only in individuals with severe hypertension, then perhaps these differences are a consequence of hypertension and/or the associated labeling of individuals as hypertensive rather than the cause of hypertension. Only long-term longitudinal studies can clarify the direction of the causal relationship if one exists.

Our classification of individuals as having hypertension or normal blood pressure was based only on diastolic blood pressure. Could this explain the variance between the results of our study and other studies reporting psychological differences between participants with normal blood pressure and participants with hypertension? Although several studies relied on systolic blood pressure, there are also several reports of positive results based on diastolic pressure (see Refs. 1, 5, and 46 for reviews). Additionally, our analyses of continuous blood pressure measures showed no evidence that systolic blood pressure was more

TABLE 4. Difference in Blood Pressure (mm Hg) Between the 75th and 25th Percentiles That Was Detectable With Indicated Power in This Study (Effect Size Averaged Across 33 Psychological Measures)

	Blood Pressure					
	Seated Casual		Supine Clinic		Ambulatory	
	Diastolic	Systolic	Diastolic	Systolic	Diastolic	Systolic
Bivariate analyses[a]						
80% power	2.3	3.4	2.4	3.4	1.8	2.9
90% power	2.7	3.9	2.8	3.9	2.1	3.3
Multivariate analyses[b]						
80% power	2.1	3.1	2.2	3.0	1.7	2.8
90% power	2.5	3.6	2.6	3.4	2.0	3.2

[a] Linear regression of blood pressure on individual psychological measure (no control variables).
[b] Multiple linear regression of blood pressure on individual psychological measure, controlling for race/ethnicity, age, and body mass index.

strongly associated with the psychological measures than diastolic blood pressure.

The use of medication by some participants with hypertension might have obscured differences in psychological profile between the hypertension group and the group with normal blood pressure. However, this seems unlikely because the exclusion of all currently and formerly medicated participants weakened, rather than strengthened, the results.

Our overall null results may also be attributed to the use of a model that was too simplistic. Trying to psychologically distinguish participants with normal blood pressure from participants with hypertension, defined on the basis of either casual or ambulatory pressures, without considering other potentially relevant variables may be inappropriate. Although we controlled for race/ethnicity, age, and BMI, other factors, such as underlying pathophysiology or current levels of environmental stress, may be relevant. Although our failure to examine such factors may be a limitation of this study, most studies reporting positive associations between personality and blood pressure have also not controlled for such variables.

It is possible that the study design contributed to our failure to obtain positive results. Several of the studies that obtained results supporting the hypertensive personality hypothesis were conducted on clinical samples, which may include a large number of participants with hypertension and/or other cardiovascular disorders. Because we explicitly excluded participants with cardiovascular disorders, some of the distinctions between participants with normal blood pressure and participants with hypertension reported by others may be due to psychological characteristics associated with cardiovascular diseases other than hypertension (19). Also, many earlier studies were confounded by comparison of patients aware of their hypertension status with healthy control subjects.

In addition, our sample of participants with hypertension included only healthy, working, mostly white men, who may not be psychologically similar to other individuals with hypertension. One experimental study highlights the complexity of this issue (47). It reported that black and white women and black men exhibited positive correlations between anger and blood pressure, whereas in white men there was a negative correlation between hostility and blood pressure. Another possible interaction is between job stressors and psychological characteristics such as suppressed anger (13), which we will assess in future analyses. Such potential interactions, coupled with our negative results, led us to conclude that the relationship between psychological variables and hypertension, if one exists at all, is probably quite complex.

Reconciling our negative results with those in the literature is difficult. A thoughtful review of the literature (46) concluded that although interpretive caution is required, "a character portrait of the 'hypertensive personality' clearly emerges. This portrait bears a striking resemblance to the descriptions produced by early analytic thinkers (2) and later observers of the personality functioning of hypertensive individuals (3, 48). That is, hypertensive patients are likely to be characterized by three major factors: a) their tendency to have conflicts and problems regarding the identification and expression of aggressive feelings; b) their tendency toward interpersonal isolation, and relative anxiety and strong physiological reactions to interpersonal situations (particularly those that require communication); and c) their general use of denial, repression, and other inhibiting or distancing defenses to cope with underlying conflicts." The present findings provide no support for this formulation.

In future analyses we will explore the possibility that job stressors in general or job strain in particular might increase the risk of hypertension, in part, by influencing such psychological characteristics (12) as denial (16), hostility (5, 19), or negative affectivity (42, 49, 50). Some evidence exists for associations of job stress with coping (15, 42), hostility (42), and negative affectivity (42, 49). In our sample, although trait anxiety (a widely used measure of negative affectivity) is associated with lower job decision latitude (lower job control), it is not associated with job demands or job strain (50) or with hypertension status. Job control and complexity have also been associated prospectively with changes in personality measures, such as increased intellectual flexibility and nonauthoritarianism (51) and greater participation in political and leisure activities (16), but the link between these changes and blood pressure has not been investigated.

In summary, our conceptualization of the relationship between personality variables or psychological characteristics in particular and dispositional variables in general is that they may play a permissive role in the development of hypertension. Biological, situational, and perhaps behavioral factors are probably the primary determinants of hypertension, whereas personality characteristics, psychological characteristics, or coping style probably do not "result" in hypertension. It remains to be investigated whether a particular set of environmental demands is more likely to result in hypertension in some personality types than in others, but the predictive significance of psychological variables in this regard seems to be quite low.

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