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EMOTIONAL AND FAMILIAL DETERMINANTS OF ELEVATED BLOOD PRESSURE IN BLACK AND WHITE ADOLESCENT MALES

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Abstract—The relationships between blood pressure and several personality and traditional risk factors were examined in a sample of black and white adolescent males who were enrolled in a health science course in Tampa, Florida. Although a number of personality and traditional risk factors significantly predicted elevated blood pressure for both groups of adolescent males, suppressed anger and weight were the major independent predictors. Among black and white males, those who generally harbored grudges and suppressed their anger had higher systolic blood pressure; diastolic blood pressure was higher only for the white males who frequently held in their angry feelings. Weight and excessive salt usage significantly predicted both elevated systolic and diastolic pressures for white males, while these variables significantly predicted systolic pressures for black males. Familial factors were found to be independent predictors of systolic and diastolic blood pressure only for the white adolescent males. A further examination of the relationship between the frequency that anger is suppressed shows that the shape of the curves relating anger-in scores to blood pressure appears to have a 'threshold'. These findings indicate that adolescent males who are at increased risk for elevated systolic and diastolic blood pressure can be identified by how often angry feelings are held-in and suppressed.

INTRODUCTION

RESEARCH relating essential hypertension to anger is an outgrowth of interest in the empirical evaluation of Alexander's 'Specificity Hypothesis' regarding the etiology of hypertension. Alexander (1939) proposed that the frequent experience of anger and the intense prolonged blood pressure elevations associated with the chronic inhibition of anger and hostility were major determinants of hypertension. Early investigations using case study and interview methodology have consistently described hypertensives as being characterized by high levels of anger (most often unexpressed) and anxiety [2–4]. Anger has also been identified as an important variable in predicting cardiovascular reactivity to laboratory-induced stress [5–8].

In tests of Alexander's specificity hypothesis, using objective psychometric procedures, anger and anxiety have been identified as important factors in some studies [9–19], while the results have been inconsistent and equivocal, in other studies [20–22]. It has been suggested that these contradictory results may stem from the use of a wide variety of poorly validated measures of anger [21–25]. In addition, few studies have included measures of both the experience and expression of anger or used measures that distinguish between the intensity of anger as an emotional state from individual differences in anger proneness as an enduring personality

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trait. Another reason for the contradictory findings is that the data for some studies were ascertained from subjects with established hypertension. The major problem here is that the findings are subject to questions as to whether they relate to the mechanism of the elevated blood pressure or whether they are a secondary consequence of the longstanding elevation of blood pressure [20, 23]. Because of the issues presented above it has been difficult to evaluate the relative importance of the various dimensions of anger in the etiology of elevated blood pressure.

In the hypertension research literature, few studies have examined the relationship between anger and elevated blood pressure in blacks. This observation is intriguing given data which indicates that the prevalence of hypertension is greater for blacks than whites at every age [26, 27]. Moreover, the mortality rates related to this disorder are also substantially higher for blacks [27]. Since the cause of most cases of hypertension in adolescents and adults are unknown [27–31], there is a need to conduct systematic research to clarify the basis of greater prevalence and mortality in blacks than whites. Although there are few investigations of the association between suppressed anger and essential hypertension in blacks [13–15, 32–34], the results from the existing studies have provided strong support for Alexander's hypothesis. Moreover, the overall pattern of the findings are consistent with historical and social analyses which assert that black Americans encounter a great number of social and psychological situations where they experience high levels of anger, and anxiety, yet they suppress the expression of these emotions [35, 36]. It is possible that anger and anxiety resulting from racial prejudices, injustices, and low social status experienced by blacks may be causally related to excessive sympathetic nervous system activity which in turn causes the rise in blood pressure.

The major objectives of the present inquiry are to: (1) clarify the relationship between blood pressure and several personality and traditional risk factors for black and white adolescent males who have never been diagnosed as having hypertension, (2) determine the relative independent contribution of both the personality and traditional risk factors to the prediction of systolic and diastolic blood pressure, and (3) determine which dimensions of the experience (trait anger; intensity of anger) and expression (anger-in; anger-out) of anger are the most important predictors of elevated bloods pressure for adolescent males.

METHODS

Subjects

The data for this report are based on information obtained from 219 black and 270 white male high school sophomores ranging between 15 and 17 yr of age who had no previous history of a 'diagnosis' of hypertension. All subjects were enrolled in health science courses at seven of the nine high schools in and around Tampa (Hillsborough County), Florida, during the 1981–1982 school year. Although approximately 173 black and 286 white female adolescents participated in the investigation, the findings of the present inquiry will be restricted to the males. The results for females will be presented in another paper. Blood pressure and personality data was obtained from approximately 95% of the students who were present in the classrooms during the days of the study. The non-participants consisted primarily of those students who 'forgot' to obtain their parents' permission to participate in this phase of the investigation.

Measurement instruments

The following self-report instruments were employed in the study, and the individual items and response formats comprising each scale can be obtained from the authors.

State-trait personality inventory (STPI). The STPI was developed by Spielberger *et al.* [37] to measure state and trait anger, anxiety and curiosity. The STPI state scale consists of three ten-item subscales for measuring the intensity of anger (state anger), anxiety (state anxiety) and curiosity (state curiosity), while the trait scale measures the general disposition to experience frequent feelings of anger (trait anger), anxiety (trait anxiety) and curiosity (trait curiosity). The trait anger scale also has two subscales. The first is referred to as the trait anger temprement scale and it assesses the general disposition to experience anger while the trait anger reaction scale measures the disposition to experience intense anger when provoked. The directions for the state scales were altered so that it was possible to determine the intensity of emotions at the time the subjects' blood pressures were measured. The high internal consistency reliability of the STPI T-anger scales was reflected in the relatively high alpha coefficients (r = 0.82–0.85) and large item remainder correlations (0.42–0.73) that were found for college students and Navy recruits [37].

Anger expression scale (AX). The AX was developed by Spielberger *et al.* [38] to measure the frequency that anger is expressed. The AX yields a total scale score, AX/anger-in (suppressed anger) and AX/anger-out subscale scores. The internal consistency of the AX total scale and the anger-in and anger-out subscales as measured by Cronbach's alpha coefficients ranged from 0.70 to 0.84 for the subjects in the present investigation. Similar findings were reported for 911 undergraduate students (335 males, 576 females) by Pollans [39]. Item remainder correlations for the anger-in and anger-out subscales ranged from 0.30 to 0.63 and the test–retest correlations for the AX and its subscales, computed for 107 subjects (32 males, 75 females) over an 8–10 week time interval, ranged from 0.58 to 0.75. A more thorough description of psychometric properties of the AX has been described elsewhere [22, 25, 39].

Smoking behavior questionnaire (SBQ). The SBQ is a 50-item self-report questionnaire developed to elicit specific information about the cigarette smoking habits of students and their family members. In the present study, only 17 of the items were administered and data analysis will be presented only for the percentage of cigarette smokers and nonsmokers. The psychometric properties of the SBQ have been described elsewhere by Spielberger *et al.* [40].

Harburg anger-in/anger-out scale (HAX). Modeled after a scale developed by Harburg *et al.* [13], the HAX was used in the present study to assess the degree that anger is expressed outwardly. In order to measure anger expression, hypothetical situations that required subjects to report how they would express their feelings (anger-in or anger-out) if they were treated unjustly by a teacher, a movie patron and a club president. The subjects also rate themselves on a four-point scale according to how much guilt they would experience if they became angry at the person responsible for the injustice in the vignette. The HAX items are scored to create an anger expression (anger-out) index using the procedures reported by Gentry *et al.* [15].

State anger reaction scale (S-anger/RX). The S-anger/RX was developed to measure the intensity of anger experienced in stressful and frustrating social situations. The S-anger/RX yields a total scale score, and two subscales for angry responses to time-pressure (TP) and evaluative-threatening (ET) situations. The internal consistency of the S-anger/RX total scale and its time pressure (TP) and evaluative-threatening (ET) subscales as measured by alpha coefficients ranged from 0.81 to 0.87 for the subjects in the present study. Item remainder correlations for the TP and ET subscales ranged from 0.42 to 0.67. A more thorough description of psychometric properties of the S-anger/RX scale has been described elsewhere [22, 39].

Dietary checklist. This instrument measures the frequency that foods rich in sodium, sugar and cholesterol are eaten. It consists of 52 food items and requires the subjects to rate how often they use these foods on a four-point scale. Some of the items in the checklist were taken from a Kitchen Inventory of Salty Junk Foods developed by Karp *et al.* [41]. Additional items were added based on a nurse's evaluation of the contents of vending machines located on or near the high school campuses.

Family history of heart disease questionnaire. This is a 20-item questionnaire to determine the history of hypertension and heart disease among the natural parents and grandparents of the subjects for the present study. The responses to this questionnaire were obtained from the parents at the same time that they completed the consent statement for their child to participate in the investigation.

PROCEDURE

The complete details of the sample selection and data acquisition are provided elsewhere [22, 25]. In brief, the data was obtained from students enrolled in Health Sciences courses during regular class periods. All students were given a test booklet containing the instructions and questionnaires. The students were informed that

their blood pressure measurements would be recorded on a card which they would receive at the end of the class period. They were also informed that the meaning of their measurements would be explained during the 'Hypertension Study Unit' that would be presented by members of the research team at the next meeting of their class. Shortly after the students began work on the questionnaires, the first students were escorted to the back of the classroom where research assistants obtained the following measurements: (1) height and weight; (2) blood pressure; and (3) self-reports of the feelings experienced while blood pressure was being taken (STPI state scale). Height and weight were recorded by the first research assistant with the standard instruments used by school personnel, while blood pressure was measured by the second assistant using an automatic blood pressure monitor that is manufactured by the Sears Company (Model No. 8-2153), which has a microphone located within the cuff to pick up Korotkoff sounds. The cuff was attached to the right forearm, above the elbow and just under the bicep muscle, with the microphone positioned over the brachial artery. The blood pressure monitor was programmed such that Korotkoff sounds first appeared at systolic blood pressure and then diminished sharply in amplitude before disappearing. The point of the disappearance of sound rather than the point of 'muffling' was used as an estimate of the diastolic blood pressure. Immediately after the cuff was deflated systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse rate were displayed on a digital readout and recorded by the research assistant. The students were kept unaware of their blood pressure levels until they completed the study and departed from the classroom. Each student was provided with a record of their blood pressure and the principal investigator (EHJ) met individually with each student who had elevated blood pressure (SBP $\geq$ 135/or DPB $\geq$ 85mm Hg) to inform him or her that their blood pressure was mildly elevated and to schedule them for a follow-up examination. With the exception of the principal investigator, who was a black male, all research assistants were white college students (two males and four females). No attempt was made to match the race or sex of the subject and the research assistant measuring blood pressure. After height and weight were measured, the first blood pressure measurement was obtained after each student was seated in an unpadded chair for approximately 2–5 min. A second blood pressure was taken about 30 sec after the first measurement. Immediately following the blood pressure measures, the students were administered the STPI State Scales by the third research assistant, with instructions to report how they felt at the time the blood pressure was being taken. After completing the STPI state scale, the student was escorted back to his seat, and instructed to continue working on the questionnaires in the test booklet. At the end of the class period the students were provided with information on hypertension to read for the 'Hypertension Study Unit' that was scheduled for the following day.

ANALYSES

The average of the two systolic and diastolic blood pressure measures were used in all analyses because of the high Pearson product–moment correlations between the first, second, and average blood pressures for the black and white males. The

correlation between the systolic blood pressure measures ranged from 0.68 to 0.98, while the correlations between diastolic blood pressure measures ranged from 0.86 to 0.98.

Black and white males were treated separately in all analyses because the results of previous analyses [22, 25], showed that the average blood pressure and distribution of blood pressure (systolic and diastolic) was significantly different for the two groups. The data for this report were analyzed using Pearson product–moment correlations and least-squares regression. For these analyses, correlations matrices were computed using pair-wise deletion of missing data. Two-tailed tests of significance were used in all analyses. Correlations were used to determine the linear associations between blood pressure and both the personality and traditional risk factors. Multiple regression assessed the strength of the associations and a forward stepwise regression approach was employed to determine which significant personality and traditional risk factor measures explained unique proportions of the variance in systolic and diastolic blood pressure.

RESULTS

Table I presents the correlations between the personality measures, traditional risk factors and both systolic and diastolic blood pressure stratified by race. For black and white males, those who frequently suppress their anger — as measured by the AX-total, AX/anger-in, or Harburg in/out — have higher systolic and diastolic blood pressures. Among black and white males, the intensity of anger (S-anger/RX) in time-pressure (TP) and evaluative-threatening (ET) situations shows a significant positive association with SBP; these associations were also significant for DBP among the white males. For black males, those who reported experiencing higher anxiety (state anxiety) and anger (state anger) reactions while their blood pressures were being measured have higher systolic and diastolic blood pressures. White males who reported higher state anxiety also had higher systolic blood pressure. Black males who reported more generalized anxiety (trait anxiety) also had higher DBP, while those who reported more generalized anger (trait anger) and lower guilt about expressing anger when provoked, had higher SBP.

Although many of the traditional risk factors were significantly correlated with blood pressure, the magnitude of the correlations were smaller for black males. For black and white males, those who had a parental history of hypertension (mother or father) had higher systolic and diastolic blood pressure. Among white males, those who had a parental history of heart disease (mother or father) had higher systolic and diastolic blood pressure. Black males who had a parental history of heart disease (father only) had higher diastolic blood pressure. Both systolic and diasatolic blood pressure showed a significant positive association with weight, height, and salt intake for the white males. Among black males, weight and salt showed a significant positive association only with systolic blood pressure.

Multiple regression was used to examine the associations between blood pressure and various personality and traditional risk factors, while controlling for the potential confounding influence of all other variables. Table II presents the partial correlations between blood pressure and the personality and traditional risk factor measures. Among black and white males, suppressed anger — as measured by

TABLE I.—CORRELATIONS BETWEEN PERSONALITY, TRADITIONAL RISK FACTORS, AND BLOOD PRESSURE BY RACE FOR ADOLESCENT MALES

	Black (n = 219)		White (n = 270)	
	Systolic	Diastolic	Systolic	Diastolic
Personality measures				
Trait anxiety	0.02	0.15*	−0.07	0.04
State anxiety	0.20‡	0.18†	0.12*	0.03
Trait anger	0.13*	0.07	0.07	0.08
T-anger/T	0.01	0.02	0.02	0.03
T-anger/R	0.04	0.03	0.02	−0.04
State anger	0.15†	0.16*	0.01	0.02
S anger/RX	0.27‡	0.08	0.30‡	0.22‡
TP-anger	0.24‡	0.10	0.37‡	0.26‡
ET-anger	0.27‡	0.06	0.16‡	0.13*
AX-total	−0.40‡	−0.25‡	−0.48‡	−0.31‡
Anger-in	0.47‡	0.22‡	0.50‡	0.35‡
Anger-out	−0.05	−0.13*	−0.14†	0.08
Harburg anger in/out	−0.32‡	−0.26‡	−0.40‡	−0.24‡
Guilt	−0.12*	0.04	0.09	0.06
Traditional risk factors				
MFHBB§	0.16†	0.13*	0.17†	0.12
FFHBP‖	0.14*	0.13†	0.31‡	0.19‡
MFHD¶	0.06	0.08	0.20‡	0.21‡
FFHD**	0.08	0.15†	0.25‡	0.22‡
Weight	0.25‡	0.07	0.48‡	0.37‡
Height	0.08	0.05	0.27‡	0.22‡
Salt	0.26‡	0.08	0.38‡	0.30‡
Smoking	0.00	0.00	0.06	0.02

*$p<0.05$; †$p<0.01$; ‡$p<0.001$.

§Mother's family history of hypertension; ‖ father's family history of hypertension; ¶ mother's family history of heart disease; ** father's family history of heart disease.

AX/anger-in and Harburg in/out — remained significantly associated with both systolic and diastolic blood pressure. For the black males, state anger and the anger expression (AX) total scale remained significantly associated with DBP while the intensity of angry reactions related to evaluative-threatening (ET) situations remained significantly associated with SBP. Although weight, height, and the frequency that salty junk foods are consumed remained significantly associated with SBP, neither of the family history measures remained significantly related to SBP or DBP after controlling for other risk factors and personality measures.

Among the white males, state anxiety remained significantly associated with SBP and the intensity of angry reactions to time pressured (TP) and evaluative-threatening (ET) situations remained significantly associated with both systolic and diastolic blood pressure. Trait anxiety became a significant predictor of SBP after adjusting for the other variables. Finally, each of the traditional risk factors (family history of hypertension, family history of heart disease, weight, salt) remained significantly associated with blood pressure; although the associations were marginal for measures of the family history of hypertension.

The extent to which the personality and traditional risk factor measures contributed to the prediction of blood pressure was examined using (forward) stepwise multiple regression analyses. The minimum F of variables to be entered into the

TABLE II.—PARTIAL CORRELATIONS BETWEEN PERSONALITY, TRADITIONAL RISK FACTORS, AND BLOOD PRESSURE BY RACE FOR ADOLESCENT MALES

	Black (n = 219)		White (n = 270)	
	Systolic	Diastolic	Systolic	Diastolic
Personality measures				
Trait anxiety	−0.13*	0.12*	−0.15‡	0.02
State anxiety	0.10	0.09	0.18‡	0.04
Trait anger	0.01	0.13*	0.01	0.05
T-anger/T	0.02	0.01	−0.05	−0.04
T-anger/R	0.01	0.01	0.01	0.01
State anger	0.04	0.24§	0.04	0.09
S-anger/RX	0.14*	0.01	0.25§	0.22§
TP-anger	0.11	0.02	0.28§	0.22§
ET-anger	0.14†	−0.01	0.16‡	0.17‡
AX-total	0.04	−0.16†	−0.38§	−0.24§
Anger-in	0.48§	0.12*	0.39§	0.26§
Anger-out	0.07	−0.09	−0.12*	−0.08
Harburg in/out	−0.13*	−0.18‡	−0.32§	−0.14†
Guilt	0.04	0.01	−0.02	−0.02
Traditional risk factors				
MFHBP	0.08	0.02	0.14‡	0.09
FFHBP	0.04	0.01	0.17‡	0.12*
MFHD	0.02	0.02	0.20§	0.21§
FFHD	0.01	0.06	0.16‡	0.16‡
Weight	0.25§	0.11	0.49§	0.36§
Height	0.13†	0.05	0.01	0.01
Salt	0.23§	0.10	0.32§	0.23§
Smoking	0.03	0.03	0.03	0.06

*$p < 0.10$; †$p < 0.05$; ‡$p < 0.01$; §$p < 0.001$
Note: correlations in each column have been adjusted for each variable in the column.

linear equation was specified at $p < 0.01$. Among the black males, the results of this analysis indicated that four variables (anger-in, weight, salt, ET-anger) accounted for 34% of the total SBP variance. The anger-in variable, which entered first into the equation, correlated 0.48 with SBP. Thus, anger-in alone accounted for approximately 68% of the variance explained by the four variables in the regression model. The results of the stepwise regression analysis for DBP indicated that two variables (state anger, Harburg in/out) accounted for 9% of the total DBP variance for black males.

Among the white males, the results of the regression analysis predicting SBP indicated that six variables (anger-in, weight, salt, trait anxiety, Harburg in/out, MFHD) accounted for 48% of the total variance. The first variable to enter the equation was weight which correlated 0.49 with SBP. Thus, weight alone accounted for approximately 50% of the variance explained by the six variables in the regression equation. The regression findings for DBP indicated that four variables (anger-in, weight, salt, MFHD) accounted for 24% of the total DBP variance. As with SBP, weight was the first variable to enter the regression equation for the white males. The correlation of 0.36 between weight and DBP indicated that weight alone accounted for approximately 54% of the variance explained by the four variables in the regression model.

While the magnitude of the linear relationship between AX/anger-in and blood pressure is reflected in the partial correlation coefficients reported in Table II and the findings of the regression analyses presented above, it is possible that these relationships may actually be curvilinear, i.e. moderate levels of anger-in (suppressed anger) may have no more influence on blood pressure than low levels, whereas high levels of AX/anger-in may have a strong impact on blood pressure. Therefore, in an effort to clarify the nature of the relationship between the frequency that angry feelings are held in (AX/anger-in) and blood pressure, the students were divided into five subgroups on the basis of their AX/anger-in scores.

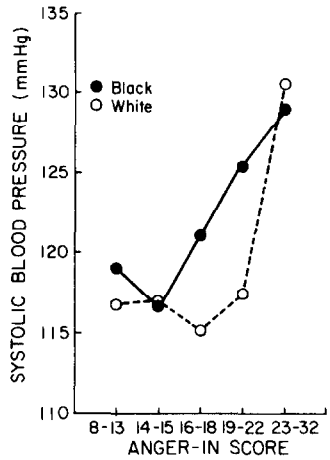

FIG 1.—Mean systolic blood pressure for five groups of black and white male adolescents defined on the basis of increasing scores on the anger-in subscale.

Since the number of white males exceeded the number of black males, and it was considered desirable to use the same cut-off scores for both ethnic groups, the white males were divided into five subgroups using an unbiased 'counting off' procedure, in which the extreme groups were as nearly equal in size as possible. The same cut-off scores were then used in defining comparable anger-in subgroups for the black males. The anger-in cut-off scores for the five subgroups of white males, and the number of students in each of these groups were : 8–13 (n = 53), 14–15 (n = 51), 16–18 (n = 59), 19–22 (n = 50), 23–32 (n = 57). Using the same cut-off scores for the black males, the number of students in the five anger-in subgroups were 29, 24, 46, 36 and 84, respectively. Fig.1 reports mean SBP in millimeters of mercury (mm Hg) for five subgroups of white and black male students defined as a function of increasing AX/anger-in scores.

Differences in SBP for white and black males in the five anger-in groups were evaluated by a 5 × 2 factorial ANOVA in which anger-in and race were the independent variables and all of the remaining personality and traditional risk factor measures were controlled. In this analysis, the main effects of anger-in (F [4,475] = 23.82, $p < 0.001$) and race (F [1,475] = 7.23, $p < 0.001$), and the anger-in by race interaction (F [4,475] = 3.29, $p = 0.001$) were statistically significant. The large anger-in effect reflected the finding that SBP was substantially higher for both groups of males who had the highest anger-in scores than for males who were

low on anger-in, as can be seen in Fig. 1. The race main effect indicated that the SBP for black males was consistently higher than for the white males at the first four levels of the anger-in variable. The anger-in by race interaction resulted from the finding that the SBP for the black males began to increase at a lower level of anger-in than for the white males, and was approximately 2 to 7 mm Hg higher for the first four anger-in groups, whereas the SBP of the white males in the highest anger-in group was approximately 2 mm Hg higher than the black males. A similar procedure was also used to evaluate differences in DBP as a function of anger-in and race. The results of this analyses shows that the main effects of anger-in (F [4,475] = 6.69, $p < 0.001$) and race (F [1,475] = 9.52, $p < 0.001$) were highly significant. However, the anger-in by race interaction (F [4,475] = 1.48) was not significant in this analysis. These results indicated that the DBP for the black and white males who had the highest anger-in scores was substantially higher than for both groups of males who had low anger-in scores, as can be seen in Fig. 2. The race main effect reflected the finding that DBP for black males was consistently higher than for the white males at the levels of the anger-in variable. The absence of an anger-in by race interaction seems to indicate that the DBP for the black males was uniformly higher than for the white males at every level of the anger-in variable.

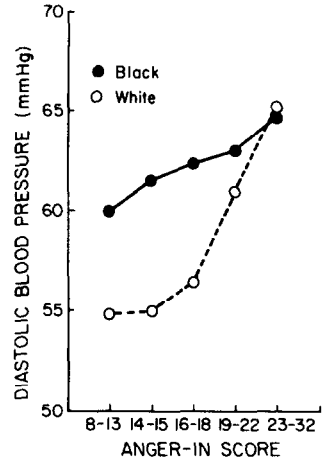

FIG. 2.—Mean diastolic blood pressure for five groups of black and white male adolescents defined on the basis of increasing scores on the anger-in subscale.

DISCUSSION

The most important contribution of the present inquiry is that the overall pattern of the findings strongly supports the hypothesis that suppressed anger is an etiological component to elevated blood pressure in adolescent males. Anger is thought to elevate blood pressure through the activation of the sympathetic nervous system [12, 2–45] and the elevations are believed to be highest when anger is experienced but cannot be openly expressed [43, 44]. Elevation in plasma and urine norepinephrine, a hallmark of the degree of sympathetic activation, have been related to

the experience of anger [46, 47] and plasma norepinephrine was found to be higher for borderline hypertensives who had high levels of plasma renin and suppressed hostility [12].

Although the findings of the present inquiry clearly indicate that suppressed anger is an independent predictor of elevated blood pressure among adolescent males, the strength of this association was somewhat different for blacks and whites. In fact, the findings indicate that emotional factors are more strongly related to elevated blood pressure among black males than traditional risk factors. In contrast, the findings for white males clearly indicate that suppressed anger and other dimensions of anger significantly predict systolic and distolic blood pressure, but weight is the strongest predictor of both elevated systolic and diastolic blood pressure. It is not immediately obvious why the emotional factors are better predictors of blood pressure for black males than for white males. Perhaps black males experience a greater degree of irritation and annoyance, as well as heightened sympathetic nervous system activity and subsequent elevations in blood pressure, when their health status (blood pressure) is measured and evaluated, but suppress the expression of their emotional reactions. Black males may also be more likely, than their white counterparts, to deny the importance of their blood pressure evaluation and feel embarrassed or more emotionally aroused when blood pressure is measured as part of a group or mass screening project as was carried out in the present study. Although it may be important to recognize that the setting in which blood pressure was measured, within a busy classroom while other students completed personality questionnaires, may have contributed to the findings of the present inquiry, it is our belief that elevated blood pressure is a reaction to the chronic (trait) and habitual suppression of anger rather than the transient (state) emotional reactions of subjects during the screening procedures. To some extent, this hypothesis is supported by the findings of the present inquiry. For example, the correlations and partial correlations between blood pressure and state-anxiety and state-anger, which reflects the intensity of anxiety and anger at the time pressure was measured, are smaller in magnitude than the correlations between blood pressure and the anger expression measures. However, the findings of the present inquiry do not address the issue of whether suppressed anger is predictive of elevated blood pressure sustained across time or outside of the 'classroom screening' situation. In a recent study [19], using the same measures of the experience and expression of anger/anxiety as used in the present inquiry, the hypothesis that suppressed anger predicts elevated pressures outside of the clinic was supported. In that study, subjects who had elevated pressures (SBP $\geq$ 140/DBP $\geq$ 90) at screening, at a visit to the Hypertension Clinic, and at home (subjects were taught to measure their own blood pressure and recorded readings for 7 days/nights) had significantly higher scores on the anger-in scale than subjects whose pressures were elevated (SBP $\geq$ 140/DBP $\geq$ 90) only at screening.

The present investigation extends and strengthens earlier findings [13,15,16] because elevated blood pressure was found to be significantly related to a 'trait' measure of suppressed anger rather than to a hypothetical or situation-specific assessment [13] of anger expression. This difference may explain the difficulty of some prior studies in detecting significant associations between certain measures of anger and elevated blood pressure. Moreover, the findings of the present inves-

tigation emphasize the importance of utilizing measures of anger and anxiety where the dimensions of these emotions are clearly conceptualized. Without such clarity it will be difficult, if not impossible, to determine the dimensions of anger and anxiety that reliably identify individuals who are at risk for hypertension and other cardiovascular disorders.

To our knowledge, this is the first study to report significant relationships between suppressed anger and blood pressure for black and white male adolescents. By using empirically derived measures of anger and anxiety which provide conceptually clearer assessments of the various dimensions of these emotions, some of the limitations of previous studies were addressed. Moreover, the significant relationships observed between suppressed anger and blood pressure cannot be explained by the effects of other dimensions of anger (frequency, intensity, chronicity) or traditional risk factors such as weight, family history of hypertension, smoking and salt usage. However, certain methodological limitations of this study indicate specific directions for future investigations. For example, the issue of causality is difficult to determine in cross-sectional studies and prospective investigations are needed to show how well suppressed anger predicts future hypertension in prehypertensive black and white adolescents. It should be noted that a particular strength of the present investigation is that the data were obtained from adolescents who had no prior history of a 'diagnosis' of hypertension. Therefore, these data are not biased by the possibility that suppressing anger as a persistent ('trait') response style may be a reaction to a diagnosis of hypertension, as has been a major problem in determining whether anger precedes or is a consequence of hypertension. There is, however, the possibility that controlling for certain pathophysiological (e.g. plasma catecholamines and renin), indicators of stress (e.g. parental income/education levels, life events), and behavioral factor (e.g. Type A status, exercise habits) that were not available for study could modify the association between blood pressure and suppressed anger. For example, plasma renin activity and heart rates are reported to be lower, indicating a lesser amount of sympathetic tone, in black children and adults than in whites [48–51]. In contrast, previous investigators have reported that white borderline and mild hypertensives with high levels of suppressed anger are physiologically characterized by high plasma renin activity, plasma norepinephrine, sympathetic tone and decreased parasympathetic drive to the heart [12, 52, 53].

There is a great need for future research aimed at the identification of the linkage between pathophysiological and personality factors among blacks with borderline and established hypertension. It would be of great interest to conduct controlled laboratory investigations of the physiological and biochemical (e.g. catecholamines, cortisol and plasma renin) responses to behavioral stress and emotional states such as anger in blacks and whites with borderline and established hypertension. As pointed out above, it is conceivable that the pattern of sympathetic activity is different for black and white borderline hypertensives who have high levels of suppressed anger. Future research is also needed to determine how well self-report measures of anger predict cardiovascular and emotional reactivity (e.g. blood pressure levels and variability of blood pressure) in natural (day-to-day situations) and laboratory conditions. It would be interesting to see if the results of such an investigation show that suppressed anger is a significant predictor of sustained hyperten-

sion across settings while other dimensions of anger significantly predict blood pressure variability.

At the present time, a number of behavior therapy interventions including biofeedback [54, 55] and training in progressive muscle relaxation or meditation [56–61] have been utilized to treat hypertension. However, the long-term benefits of such treatment procedures are questionable [62]. It may very well be that the efficacy of these procedures would be greatly enhanced by incorporating behavior therapy procedures aimed at the management of anger/hostility [63] and exaggerated emotional reactions to stress as was demonstrated by Friedman *et al.* [64, 65] to reduce the myocardial infarction rate among men receiving therapy to manage Type A behavior.

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