

STRESS, STRESS REDUCTION, AND HYPERTENSION IN AFRICAN AMERICANS: AN UPDATED REVIEW

Vernon Barnes, PhD, Robert Schneider, MD, Charles Alexander, PhD, and Frank Stagers, MD
Fairfield, Iowa, and Oakland, California

This is a comprehensive and integrative review of multiple factors underlying the greater prevalence of hypertension in African Americans compared with whites. Evidence linking stress with hypertension and cardiovascular disease in African Americans is reviewed. A survey of mechanisms of hypertension in African Americans and existing behavioral strategies for the treatment of hypertension is presented. Given that the excess of hypertension may be mediated in part by behavioral factors operating through biological mechanisms, a case is presented for behavioral stress reduction measures.

This review of stress reduction techniques especially the Transcendental Meditation program for the treatment of hypertension in African Americans highlights current issues facing the field. New information is provided to help direct future nonpharmacological research and practice in hypertension to prevent morbidity and premature mortality in this underserved population. (*J Natl Med Assoc.* 1997;89:464-476.)

Key words: hypertension ♦ African Americans
♦ behavior ♦ stress reduction ♦ meditation

EPIDEMIOLOGY OF HYPERTENSION IN AFRICAN AMERICANS

Hypertension in African Americans compared with whites is more likely to develop at a younger age,^{1,2} to be more severe,³ to be under-controlled for longer periods, and to progress more rapidly with age.⁴ The overall age-adjusted prevalence of mild to

moderate hypertension is almost 40% higher in US blacks than in whites.^{5,6} Hypertension along with other risk factors is associated with elevated cardiovascular morbidity and mortality in African Americans.⁷ Target organ damage is more frequent and severe, and there is a higher incidence of congestive heart failure, hypertensive retinopathy, and left ventricular hypertrophy.⁸

Due to the greater prevalence and incidence of hypertension and its association with morbidity and mortality, hypertension is considered the number one health problem in African Americans today.⁹ The largest contributing factor to the mortality difference in blacks versus whites is cardiovascular disease, which accounts for 35% of total deaths in black men and 45% in black women.¹⁰ Forty percent to 60% of coronary heart disease mortality risk in blacks is attributable to excess prevalence and severity of hypertension alone.¹¹ Mortality rates for coronary heart disease are higher in African-American women and younger persons. Rates of cardiovascular diseases are 43% higher and cerebrovascular dis-

From the Center for Health and Aging Studies and the Department of Psychology, College of Maharishi Vedic Medicine, Maharishi University of Management, Fairfield, Iowa, and the Hypertension Research Clinic West Oakland Health Center, Oakland, California. Preparation of this manuscript was supported in part by grants #1 RO1 HL48107 and HC5159-04 from the National Heart, Lung, and Blood Institute. Requests for reprints should be addressed to Dr Robert H. Schneider, Ctr for Health and Aging Studies, College of Maharishi Vedic Medicine, Maharishi University of Management, Fairfield, IA 52557-1028.

eases are 89% higher than in whites.¹² In 1989, age-adjusted mortality rates for hypertensive and hypertensive heart diseases were 4.5 times higher in African-American men and 4.9 times higher in African-American women compared with white men and women, respectively.⁷ End-stage renal disease attributed to hypertension is significantly higher in blacks than whites.¹³

RELATIONSHIPS BETWEEN PSYCHOSOCIAL STRESS AND HYPERTENSION IN AFRICAN AMERICANS

Essential hypertension generally is considered to be multifactorial in its etiology.¹⁴ The etiology of higher prevalence and incidence of essential hypertension in blacks is unknown. It is thought that multiple pathophysiological mechanisms are involved in a complex interaction among factors that are both extrinsic and intrinsic to physiological functioning.¹⁵ Regarding differences between African Americans and whites in prevalence and severity of hypertension, four components have been examined as possible mechanisms underlying this disparity:

- biological and nutritional factors,
- social and environmental factors,
- psychological and behavioral factors, and
- psychophysiological reactivity.

Biological and Nutritional Factors

Several observed black-white biological differences contribute to the pathogenesis of hypertension and have been reviewed extensively in the recent literature.¹⁶⁻¹⁹ African Americans have a decreased ability to excrete excess sodium²⁰ and a greater rise in blood pressure with sodium loading than whites.²¹ This underlying disturbance in sodium handling is a key factor implicated in the mechanism responsible for vascular reactivity differences in blacks.²² Reactivity refers to changes in the autonomic response of the vasculature to challenging stimuli.²³ Heightened sympathetic nervous system activity in blacks induces sodium retention, which in turn augments cardiovascular reactivity.^{22,24}

Intracellular sodium and calcium overload and magnesium depletion are important in the pathophysiology of black hypertensives.²⁵⁻²⁷ Dietary surveys report no consistent racial differences in dietary sodium intake although African Americans may consume lower levels of potassium and calcium.²⁸ African Americans accumulate more sodium with increasing sodium intake than whites,²⁹ possi-

bly due to a salt-conserving genotype.¹⁹ A controversial hypothesis predicts that as a result of salt-depletive diseases, African-American descendants have undergone a natural selection, resulting in an enhanced genetic-based ability to conserve salt.³⁰

A commonly cited explanation for black-white differences in hypertension prevalence is differences in renal physiology—higher renal vascular resistance³¹ and lower plasma renin activity.³² Differences also are seen in the autoregulation of glomerular filtration rate in response to changes in dietary sodium.³³ Greater incidence of end-stage renal disease³⁴ and nephrosclerosis generally characterize the African-American hypertensive.³⁵ A more rapid decline in creatinine clearance with age also contributes to a higher prevalence of hypertension in blacks.¹⁹ These renal difficulties could be inherited or secondary to other factors such as lower levels of kallikrein-kinin and prostaglandins, increased insulin resistance,³⁶ hyperresponsiveness to growth factors,⁷ and suppression of plasma renin activity without suppression of aldosterone production.¹⁹ Altered plasma aldosterone responses are common in black hypertensives.³⁷

Further biological differences include increased target organ damage, which is associated with a blunting in the usual nocturnal blood pressure decrease in blacks versus whites.³⁸ African Americans display an increased nighttime blood pressure and left ventricular index than whites or South African blacks; these differences suggest an environmental origin.³⁹ Intra-racial differences in blood pressure levels further contribute to the non-genetic argument. Hypertension is relatively low in rural areas of African countries south of the Sahara,⁴⁰ with the exception of South Africa. The combined effect of exposure to risk factors may interact to induce hypertension through modulation of gene expression.¹⁵ Thereby, systems controlling arterial pressure induce dysregulation, resulting in hypertension in blacks.^{14,41}

Indirect evidence supporting the suggestion that blacks are genetically susceptible to hypertension has been presented in a study of renin and atrial natriuretic peptide gene fragments and elevated blood pressure in blacks.⁴² Quantitative family history studies indicate higher familial risk for hypertension.³ For example, there is a fourfold increased hypertension risk in young adult blacks with a family history of hypertension.⁴³ A similar familial risk among blacks and whites suggests that racial dispar-

ity in hypertension incidence may be influenced by socioenvironmental factors. Significant genetic and environmental influences on the population variation in blood pressure have been reported in African-American twins.^{44,45}

Numerous interacting biological, behavioral, and psychosocial factors may exacerbate an increased tendency toward obesity. Obesity is a strong predictive factor associated with blood pressure, contributing to 21% of hypertension in black men and 18% in black women.⁴⁶ This association between obesity and hypertension appears to be more prevalent among African-American than white hypertensives.⁴⁶⁻⁴⁹ The association of hypertension and body size between blacks and whites suggests differences in blood pressure regulation mechanisms.⁵⁰

Socioeconomic Status and Environmental Factors

Although biological black-white differences are considered important, emphasis also has been placed on socioeconomic status and environmental factors in hypertension etiology in African Americans. It has been proposed that Westernized and urbanized cultures expose African Americans to greater environmental and psychosocial stress.^{22,51} Potential components of psychosocial stress in blacks include socioecological stress, social disorganization, lack of resources and social support, rural-urban migration, and social-familial factors, as well as socioeconomic status.⁵² Other psychosocial stressors include higher rates of poverty, higher unemployment, lower occupational status,⁵³ exposure to racism, and crowded and substandard living environments.²² These stressors collectively are risk factors for self-defeating behaviors and ill health.⁵⁴

In the United States, lower socioeconomic status, whether defined by income, education, or occupation, has been associated with hypertension.⁵⁵ Higher arterial blood pressure in Southern US blacks relates to lifestyle inequality, especially among ages 40 to 55.⁵⁶ Evidence from the Charleston Heart Study shows that racial disparities in all-cause and coronary disease mortality become insignificant when socioeconomic status is controlled.⁵⁷ Lower levels of family income in blacks are associated with higher cardiovascular disease mortality rates.⁵⁸ Anderson et al^{51,52} have described the multiple dimensions of hypertension that give rise to the high rates in African Americans. In blacks of lower socioeconomic strata, an association has been

found between skin color and blood pressure.⁵⁹ In addition, incidence, prevalence, and severity of hypertension and its sequelae associate inversely with African-American educational achievement.⁶⁰

Incidence of high blood pressure associates with occupational class position. A higher relative risk of hypertension is found among blacks near the lower end of the occupational hierarchy.⁶¹ Occupational and environmental stressors are thought to be linked to chronically high levels of autonomic arousal.^{62,63} This stressor-induced increased autonomic activity is linked to negative health behaviors such as inactivity, smoking, drinking, and unhealthy eating habits. Together with psychological factors, such as suppressed anger and hostility, multiple interacting behavioral-socioenvironmental stressors result in unhealthy lifestyles involving cardiovascular disease risk factors and negative health behaviors. These stressors may induce the psychophysiological stress response, which is thought to lead to psychosocial stressor-induced hypertension and cardiovascular disease outcomes in blacks.^{46,48}

Psychological and Behavioral Factors

Creating a consistent and universally accepted designation of race is a controversial task, mainly because the consequences of differences in economic and social status are difficult to separate from biological processes.⁴³ The concept of ethnicity, which takes into account sociopolitical and psychosocial factors, is more useful. Specific psychological and behavioral factors in African Americans may interact with socioeconomic conditions to contribute to elevated blood pressure. For example, John Henryism—an active coping style of hard work and determination to succeed against all odds—is a psychosocial factor correlated with hypertension in low socioeconomic status in blacks.^{64,65} In an urban sample of blacks, higher psychological stress seems to be responsible for an interaction found between socioeconomic status and John Henryism regarding hypertension prevalence.⁵⁵

Expression of emotion and physiological reactivity to psychosocial stressors may be moderated socioculturally.⁶⁶ Frequent experience of anger relates to higher ambulatory blood pressures among working black women.⁶⁷ High blood pressure is found more frequently in black girls than in white girls attending public schools. This may reflect a family-environment effect on hypertension risk.⁶⁸ African Americans who frequently suppress their

anger when provoked or who express their anger without reflection have higher resting blood pressures than those who routinely express their anger or express it only after some reflection.²²

Harburg et al⁶⁹ observed a positive relationship between suppressed hostility and blood pressure for African-American males up to age 60. Anger suppression predicted high levels of blood pressure in African-American college students independent of traditional risk factors such as weight, family history, salt intake, and cigarette smoking.⁶⁸ Increased anger level correlates with increased blood pressures in other racial groups.⁴⁷ High anger intensity and anger suppression associate with elevated levels of blood pressure measured at home.⁷⁰ The suppressed hostility and anger hypothesis also was found to be relevant to black females.⁷¹ However, not all studies have confirmed these associations. In one study, there was no association between suppressed hostility and blood pressure found in middle-aged African-American men and women.⁴⁷

Psychophysiological Reactivity in African Americans: Integrated Mechanisms of Stress-Induced Hypertension

There may be interdependent mechanisms for chronic stress consequences in the development of African-American hypertension due to exposures to combinations of risk factors.⁴³ Multiple chronic psychological, physiological, social, and economic stressors may interact with various risk factors to increase sympathetic nervous system activity and acute autonomic reactivity.¹⁹ Racial differences are implicated in physiological reactivity to stress as a potential mechanism for the higher rates of hypertension in blacks.²² Predictors of reactivity in African Americans include factors such as blood pressure status and personality. Recent data are conflicting with regard to racial differences in blood pressure reactivity since family history of hypertension may account for these differences.⁷² A relationship between family history of hypertension and cardiovascular reactivity has not been found among black adults,²⁴ possibly due to the influence on psychosocial factors in hypertension development.²²

Greater cardiac involvement (β -adrenergic pattern) mediates blood pressure reactivity in whites whereas blacks respond with greater peripheral vasoconstriction (α -adrenergic pattern).²² Chronic stressors elicit greater increases in blood pressure in blacks compared with whites during laboratory

stress.⁷³ In black African normotensives, withdrawal of parasympathetic tone is implicated as a hemodynamic reactivity mechanism.⁷³

The combined interactive effect of stressors may lead to chronic autonomic arousal that over time contributes to elevated blood pressure. Reduced sodium excretion and increased sodium retention associate with acute and chronic stress.²² Increased sympathetic nervous system activity leads to release of neuroendocrine products and enhanced peripheral vasoconstriction. Over time, constant episodes of stressor-induced reactivity may lead to structural damage to the vasculature. Increasing peripheral vascular resistance directly or through increased vascular hypertrophy results in sustained hypertension²² and a higher prevalence and proportion of cardiovascular disease (Figure 1).^{9,74}

OVERVIEW OF PHARMACOLOGIC AND NONPHARMACOLOGIC ANTIHYPERTENSIVE TREATMENT TRIALS IN AFRICAN AMERICANS

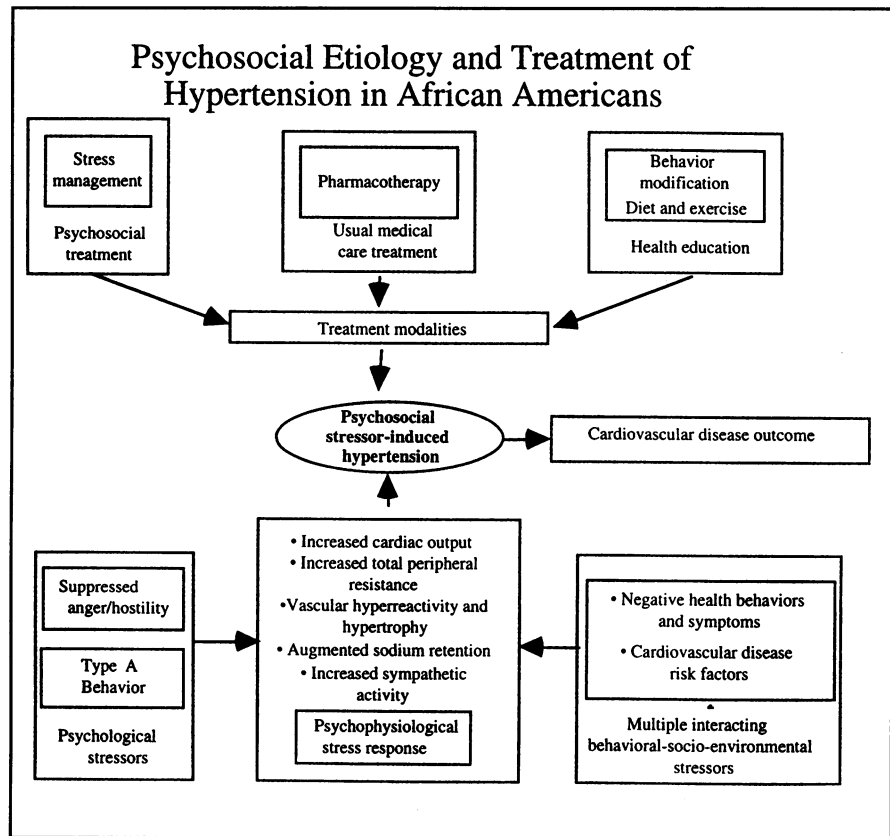
Pharmacologic Treatment

Antihypertensive drug therapy has been shown to be effective in reducing cardiovascular morbidity and mortality in African Americans.⁶ Nevertheless, insufficient physician-patient communication, high costs, impaired quality of life due to adverse side effects, poor quality health education and care, and the asymptomatic nature of hypertension have been cited as possible anti-hypertensive treatment limitations. Many patients refuse or cannot tolerate drugs and perceive harmful drug effects as outweighing the benefits of treatment.⁷⁵

Another problem is poor compliance ($\leq 30\%$ in the African-American community).^{76,77} Inner-city blacks, with higher levels of illiteracy, poverty, homelessness, and chemical dependency, have a compounded compliance problem.⁷⁸ Nevertheless, greater compliance in African Americans associates with increasing age.⁷⁹ Some have suggested that antihypertensive pharmacologic treatment is minimally cost effective in the mild hypertensive.⁸⁰ There are other disadvantages such as toxicity leading to deleterious metabolic effects, adverse interaction with smoking,^{81,82} and ischemic changes in the heart. Effective blood pressure control was not associated with improving renal function in blacks.⁸³ The disproportionately higher renal disease risk in the African-American hypertensive calls for therapy regimens that offer improved protection from vascular and renal complications.⁸⁴

Figure 1.

Psychosocial stressors include psychological as well as multiple interacting behavioral-socioenvironmental stressors. Psychological stressors in African Americans result in suppressed anger and hostility, giving rise to Type A behavior. Multiple interacting behavioral-socioenvironmental stressors include cardiovascular disease risk factors and negative health behaviors and symptoms. These stressors impact on the psychophysiological stress response that involves augmented sodium retention and increased sympathetic nervous system activity. This leads to psychosocial stressor-induced hypertension—a risk factor for cardiovascular disease. Treatment modalities may include psychosocial treatment such as stress management and usual medical-care treatment such as pharmacotherapy. Health education may include behavior modification, diet, and exercise regimens.



Nonpharmacologic Treatment of Hypertension in African Americans

To augment the curative procedures of pharmacologic medicine, behavioral interventions may have positive effects on long-term disturbances in adaptive mechanisms that have accumulated due to chronic stress. The most effective means of eradicating cardiovascular disease require primary prevention of hypertension.⁸⁵ The need for an effective approach to the prevention and treatment of mild hypertension that is cost effective, free of adverse side effects, and improves quality of life has been widely recognized. In response to this need, the Fifth Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure (JNC-V) has encouraged the use of behavioral therapies for the treatment of mild hypertension and as an adjunct to pharmacologic therapy for more severely hypertensive patients.⁸⁶ However, culturally determined lifestyle behaviors such as overeating, alcohol and tobacco consumption, use of illicit drugs, and sedentary behaviors are not overcome easily.⁷⁵

Nevertheless, some have proposed that lifestyle modifications may be even more effective in lower-

ing blood pressure in blacks than whites.⁸⁷ A 30% to 50% reduction in the incidence of hypertension may be expected with lifestyle modification.⁸⁸ Weight loss treatment in blacks is considered a cornerstone in the treatment of hypertension.⁸⁹ Nonpharmacologic treatment has demonstrated positive and sustained effects in clinical trials including blacks.⁹⁰ Education to improve diet, restrict sodium, reduce weight, and increase exercise are considered important, especially for African-American women.^{90,91}

Stress-Reduction Approaches

Modifying oppressive environmental stressors and adverse living conditions in African-American communities will take time and may be difficult.¹⁵ The need exists to explore interventions that are efficacious in reducing individual responses to stress across differing age, socioeconomic, and cultural subgroups.⁹² In those individuals well-habituated to measuring their own blood pressure at home, stress management based only on relaxation or nonaerobic stretching exercises for treating mild hypertension has been found to be relatively ineffective in lowering blood pressure.⁹³

Other reports have questioned the effectiveness of relaxation techniques in reducing risk factors for cardiovascular diseases.^{86,94} These reports have drawn conclusions based on statistically combining the treatment effect of various relaxation and meditation techniques,⁹⁵ and then generalizing that all stress management techniques are ineffective. Progressive muscle relaxation and generic meditation techniques have not been shown to be effective.⁹⁶

Other reviewers have concluded that the practice of relaxation techniques should be encouraged.⁹⁷ One theory is that although adaptation to socioeconomic stressors may be slow, the emotional and physiological response to these stressors may be modified more rapidly by a behavioral intervention. For example, vigorous risk factor modification, including diet, stress management, and exercise, has demonstrated significant regression of coronary artery disease.⁹⁸

Although stress management has been studied widely in the general population, there are few published clinical hypertension studies using this intervention in blacks. Haber⁹⁹ reported on a 10-week health promotion program that included yoga exercise and aerobics components. Eighty-eight low-income elderly African-American subjects showed no significant change in blood pressure. Harrison and Rao¹⁰⁰ published a report of their uncontrolled clinical experience with biofeedback-relaxation in the treatment of 22 African-American hypertensive patients with a mean age of 42. There were no significant long-term changes in blood pressure. In a more recent study, black and white hypertensives lowered diastolic blood pressure with biofeedback-assisted relaxation.¹⁰¹ Magnus⁷⁴ reviewed the literature on cardiovascular preventive and health promotion programs among African Americans and concluded that there is an embarrassing paucity of experience with these programs for blacks of all ages. The studies that do exist included evaluation components that were "either nonexistent, still in process, or crudely qualitative."⁷⁴

On the basis of this and other findings, the Fifth Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure reported insufficient support for the use of stress management in preventing hypertension.⁸⁶ The Committee's conclusions were based on narrative reviews of two prior randomized trials where muscle relaxation and other stress management approaches did not lower blood pressure significant-

ly as compared with controls.^{90,102} Even though it generally is presumed that all stress reduction techniques produce similar results, other evidence indicates that this is not the case. A recent meta-analysis of all stress management studies has found dissimilarities in their effectiveness.¹⁰³ This highlights the necessity of evaluating each stress management technique separately.

One stress-reduction approach, the Transcendental Meditation® program, which is described as the principal technology of consciousness of the Maharishi Vedic Approach to Health,¹⁰⁴ has been found to be clinically useful for the sole or adjunctive treatment of elevated blood pressure.^{105,106} This treatment reduces the chronic emotional, physiological, and sympathetic arousal that are considered important in the etiology of African-American hypertension.¹⁰³ Transcendental Meditation has been found in initial research to reduce blood pressure in hypertensives.¹⁰⁷⁻¹¹¹ Adults practicing Transcendental Meditation have markedly lower resting blood pressure than normal.¹¹⁰ Elderly practicing Transcendental Meditation have reduced blood pressure compared with controls.¹¹²

Transcendental Meditation is associated with multidimensional effects on risk factors for hypertension and cardiovascular diseases, reducing physiological arousal,¹¹³ anxiety,¹⁰³ reactivity to stress,¹¹⁴⁻¹¹⁶ smoking,¹¹⁷ alcohol consumption,¹¹⁸ cortisol,¹¹⁹ and improving overall psychological health.¹²⁰ The Transcendental Meditation technique is thought to provide an experience of deep rest that facilitates a reduction in chronic stress associated with enhanced neurophysiological homeostasis.¹²¹ Transcendental Meditation practice is associated with reduced myocardial ischemia in patients with coronary artery disease.¹²² Studies indicate the effectiveness of Transcendental Meditation in normalizing stress-related conditions as chronic anxiety, anger/hostility, and depression.^{103,123,124} Benefits of enhanced personal inner control, efficacy, and confidence that come from greater self-sufficiency in personal health promotion from Transcendental Meditation practice suggest that Transcendental Meditation may be an ideal stress reduction and self-development technique.

In view of the high levels of psychosocial stress and hypertension in African Americans, the Transcendental Meditation program recently was tested to determine its effectiveness in treating mild hypertension.¹²⁵ To evaluate the short-term efficacy and feasibility of two stress-reduction approaches for

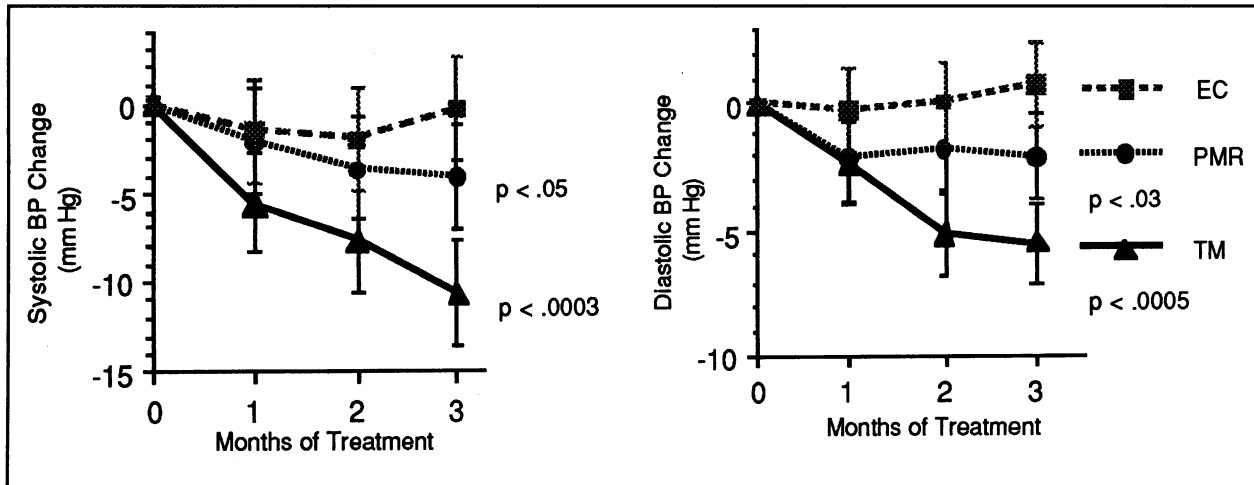


Figure 2.

Change in clinic blood pressure before and after 3 months of stress-reduction intervention. The graphs chart mean changes in clinic systolic (left) and diastolic (right) blood pressure (follow-up minus baseline), with standard errors of means. *P* values are for repeated measures ANCOVA comparing each experimental group (Transcendental Meditation [TM] or progressive muscle relaxation [PMR]) to control [EC]. (Transcendental Meditation, *n*=36; progressive muscle relaxation, *n*=37; and lifestyle modification education controls, *n*=36.)

the treatment of elderly African-American mild hypertensives, a randomized controlled, single-blind trial with a 3-month follow-up was held in a primary care, inner-city health center. Of 213 African American men and women screened, 127 individuals, aged 55 to 85 years were selected. Their initial diastolic blood pressure was 90 to 109 mm Hg, systolic blood pressure was ≤ 189 mm Hg, and final baseline blood pressure blood pressure was $\leq 179/104$ mm Hg. Sixteen patients did not complete follow-up blood pressure measurements. Mental and physical stress reduction approaches—the Transcendental Meditation program and progressive muscle relaxation—were compared with a lifestyle modification education control. Changes in clinical systolic and diastolic blood pressure from baseline to final follow-up were primary outcomes, measured by blinded observers. Secondary outcome measures included changes in home blood pressure and intervention compliance. Subjects in the control program were provided with usual care instructions and recommendations for nondrug management of hypertension along with specific diet and exercise guidelines.

Adjusted for significant baseline differences and compared with the control, Transcendental Meditation reduced systolic blood pressure by 10.7 mm Hg ($P < .0005$) (Figure 2) and diastolic blood pressure by 6.4 mm Hg ($P < .00005$). Progressive

muscle relaxation lowered systolic blood pressure by 4.7 mm Hg ($P < .054$) and diastolic blood pressure by 3.3 mm Hg ($P < .025$). Transcendental Meditation lowered systolic blood pressure ($P < .025$) and diastolic blood pressure ($P < .05$) more than progressive muscle relaxation. Compliance was 97% in the Transcendental Meditation group and 81% in the progressive muscle relaxation group.

In addition to these findings, the effects of stress reduction with the Transcendental Meditation in older African-American hypertensives appeared to generalize to both genders and to a range of high and low risk factor subgroups.¹²⁶ Transcendental Meditation was equally effective in reducing blood pressure in subjects with the highest risk profile for subsequent cardiovascular disease and mortality (including subjects with higher levels of smoking, drinking, obesity, sodium intake, and low physical activity).¹²⁶ There also was a significant reduction in alcohol use for the Transcendental Meditation group (6 drinks per week) compared with other groups.¹²⁶ The Transcendental Meditation group showed significant reductions in poor perceived health, social isolation, and anger compared with the other groups.

This study indicated that selected mental and physical stress reduction techniques are able to demonstrate efficacy in reducing mild hypertension in this sample of older African Americans. Of the

two techniques, Transcendental Meditation was approximately twice as effective as progressive muscle relaxation. Long-term effects of this study are presented in the next section.

Stress Reduction in Older African-American Hypertensives: Reduced All-Cause and Cardiovascular Mortality

Based on the blood pressure reductions at 3 months in older African Americans, it was hypothesized that Transcendental Meditation (n=36) would reduce incidence of all-cause and cardiovascular mortality compared with progressive muscle relaxation (n=37), education control (n=36) and a combined control (progressive muscle relaxation + education control) group over the long term. After 5 years, an all-cause and cardiovascular disease mortality follow-up study was conducted. Controlling for age and medication status, cardiovascular disease mortality was significantly lower for the Transcendental Meditation group than for the combined control group ($P=.045$). The relative risk for all-cause mortality was 68% lower for the Transcendental Meditation group compared with the combined control group based on the Cox proportional hazards model (relative risk [RR]=.32; 95% confidence interval [CI], 0-.89). Incidence of cardiovascular disease mortality was consistently lower for the Transcendental Meditation group compared with all other groups. Controlling for age and medication status, cardiovascular disease mortality was significantly lower for Transcendental Meditation than for the combined control group ($P=.018$). The relative risk for Transcendental Meditation patients compared with combined controls was 0.00 (95% CI 0-.51), ie, zero cardiovascular disease fatalities in the Transcendental Meditation group. These findings suggest that Transcendental Meditation practice reduces incidence of all-cause and cardiovascular disease mortality in older hypertensive African Americans.¹²⁷ This study was confirmed in a trial with a white study sample.¹²⁸

Quality of Life Issues

It is now widely recognized that the efficacy of hypertension treatments should be determined not only by assessing effects on blood pressure, but also on a wide range of other functions that may be adversely affected by conventional drug treatments.¹²⁹ Drug treatments for hypertension often cause adverse side effects that reduce quality of life—impairing phys-

ical and emotional functioning, as well as cognitive acuity. The African-American patient may be especially prone to many of these side effects.¹³⁰

Evaluation of well-being or quality of life is therefore directly relevant to the assessment of hypertension treatment. Whereas psychosocial distress (eg, anger) may contribute directly to hypertension incidence, other quality of life factors, such as social support and positive coping capacity have been shown to buffer effectively against stressors and consequent premature morbidity and mortality for blacks.¹³¹

Schneider et al have conducted the first studies on the quality of life effects of behavioral treatments with this population.¹³² In the randomized, controlled trial mentioned above, the efficacy of Transcendental Meditation and progressive muscle relaxation—compared with lifestyle education modification control was assessed in reducing blood pressure and enhancing quality of life in older mildly hypertensive African Americans. Fourteen quality of life measures were evaluated. Two statistical factors accounted for 50% of the variance among scales: psychological well-being and perceived general health. Among subjects with normal pretest stress levels, Transcendental Meditation subjects improved significantly compared with the educational control subjects on well-being ($P<.019$) and compared with progressive muscle relaxation subjects on perceived health ($P<.017$). Transcendental Meditation subjects also showed significantly increased scores on health internal locus of control than both progressive muscle relaxation ($P<.025$) and education control subjects ($P<.05$). High score on health locus of control has been shown to predict better health habits and lower morbidity and mortality. After a 6-month interval, a short-form survey was completed. Transcendental Meditation subjects reported larger improvements than progressive muscle relaxation on eight of 10 quality of life dimensions. Transcendental Meditation subjects also reported larger improvements than education control on enhanced locus of control, reduced trait anger, and improved sleep. A cost-effectiveness study reported that compared with five standard antihypertensive medications over a 20-year simulated treatment period, the Transcendental Meditation program was the most effective.¹³³

Trials in Progress

A long-term randomized, blinded, controlled trial investigating two different classes of stress reduction

therapies is currently under way with mildly hypertensive African Americans. Two hundred forty male and female volunteers ≥ 18 years are being recruited from a pool of known hypertensives at a large primary care community health center. A series of four blood pressure assessments will comprise the baseline testing period, after which subjects will be matched for antihypertensive medication usage, age, and gender. The subjects are then randomly assigned to three treatment conditions matched for attention and expectancy. These stress reduction interventions include Transcendental Meditation, progressive muscle relaxation, and preventive cardiology counseling. Subjects are tested for 12 months at regular intervals for clinical blood pressure, automated ambulatory blood pressure monitoring, cardiovascular reactivity, confounding variables, and quality of life. (Schneider, in review).

In another related study currently underway, a sample of urban African Americans are being recruited for a single-blind randomized controlled clinical trial. This study investigates the efficacy of Transcendental Meditation in preventing and treating hypertensive disease. Subjects are being matched on demographics and then randomized to Transcendental Meditation and a lifestyle modification education program. Pretesting will cover five baseline sessions followed by monthly posttests after 3 months and 9 months of follow-up. Outcomes include changes in clinic and ambulatory blood pressure, left ventricular mass measured by echocardiography, left ventricular diastolic dysfunction measured by Doppler, carotid atherosclerosis, or arterial stiffness measured by B-mode ultrasound, cholesterol levels, quality of life, and other cardiovascular risk factors.¹³⁴

Current Issues and Recommendations for Future Research

It has been suggested that holistic health behavior strategies for African Americans necessitate both personal responsibility and advocacy for social system change. Each individual must empower himself to take personal responsibility for his or her own health. The community-based self-help mechanism has important implications for African-American health promotion.⁵⁴ The most productive hypertension research involves randomized trials that focus on primary prevention.⁴³ Research might include locating high-risk African-American families and longitudinally monitoring the effect of risk factor reduction on hypertension and health outcomes.

Phenotypic and genetic data should be collected and correlated. Effective programs should be developed and evaluated for preventive health-care delivery that would include community health-care workers and health screening programs that would focus on improving risk factor control in African-American communities. Further research is needed to develop innovative primary prevention programs that involve risk factor identification and intervention at work sites, churches, and schools.⁴³

Factors that influence blacks in early seeking of health care and treatment need to be determined. Educational and behavioral programs should be developed to enhance prevention, evaluation, management, and treatment of hypertension in blacks. Hypertension treatment should include educational strategies that are population-specific and address ways to change disease-promoting behaviors.¹³⁵ Community-based programs are needed to increase acceptance for behavioral stress reduction methods among African Americans and other groups exposed to psychosocial stressors. In view of the limitations imposed by racial categories on studies of cardiovascular morbidity disparities, clarifying the distinctive roles of social class and biological race is considered a research priority. For example, research is needed to give us deeper understanding of the mechanisms involved in differences in humoral and hemodynamic responses in psychological stressors in hypertensive African Americans.

Community-based programs should give a wider scale dissemination of information to physicians, community health workers, and other medical professionals.^{136,137} Health education alone will not close the gap effectively on black-white differences in health. Finally, innovative treatment approaches for secondary prevention of hypertension need to be developed and evaluated with special attention to patient compliance and community acceptance of primary risk reduction information.⁴³

CONCLUSION

Reducing racial disparities in hypertension is a major national public health goal.¹³⁸ Hypertension and related morbidity and mortality in African Americans may be preventable through an effective behavioral stress reduction approach such as the Transcendental Meditation program.¹³⁹ The costs of practicing an effective stress reduction technique are modest compared with the cost of treating a stroke or myocardial infarction.^{133,134} Supportive evidence

is accumulating for taking responsive action to adopt stress-reduction strategies for hypertension in the African-American community.⁴⁶

Authors' Note: ®Transcendental Meditation and TM are service marks registered in the US Patent and Trademark Office, licensed to Maharishi Vedic Development Corp and used under sublicense.

Literature Cited

1. Falkner B. Characteristics of prehypertension in black children. In: *Pathophysiology of Hypertension in Blacks*. Fray JCS, Douglas JG, eds. New York, NY: Oxford University Press; 1993:50-67.
2. Berenson GS, Voors AW, Dalferes ERJ, Webber LS, Schuler SE. Creatinine clearance, electrolytes, and plasma renin activity related to blood pressure of black and white children—The Bogalusa Heart Study. *J Lab Clin Med*. 1979;93:535-548.
3. Hypertension Detection and Follow-Up Program Cooperative Group. Race, education, and prevalence of hypertension. *Am J Epidemiol*. 1977;106:351-361.
4. Hildreth CJ, Saunders E. Hypertension in blacks. *Md Med J*. 1991;40:213-217.
5. Hypertension Detection and Follow-Up Program Cooperative Group. Five-year findings of the Hypertension Detection and Follow-Up Program: mortality by race, sex, and age, III: reduction in stroke incidence in persons with high blood pressure. *JAMA*. 1982;247:635-638.
6. Burt VL, Whelton P, Rocella EJ, Brown C, Cutler JA, Higgins M, et al. Prevalence of hypertension in the US adult population: results of the Third National Health and Nutritional Examination, 1988-1991. *Hypertension*. 1995;25:305-313.
7. Gillum RF. The epidemiology of cardiovascular disease: an American overview. In: *Handbook of Black America*. Livingston IL, ed. Westport, Conn: Greenwood Press; 1994.
8. Arnett DK, Rautaharju P, Crow R, Folsom AR, Ekelund LG, Hutchison R, Tyroler HA, Heiss G. Black-white differences in electrocardiographic left ventricular mass and its association with blood pressure (the ARIC study): atherosclerosis risk in communities. *Am J Cardiol*. 1994;74:247-252.
9. Saunders E. *Cardiovascular Diseases in Blacks*. Philadelphia, Pa: FA Davis Co; 1991.
10. National Center for Health. *Statistics Health United States 1988*. Washington, DC: Public Health Service, Government Printing Office; 1989. DHHS publication (PHS) 89-1232.
11. Deubner DC, Tyroler HA, Cassel JC, Hames CG, Becker C. Attributable risk, population attributable risk and population attributable fraction of death associated with hypertension in a biracial population. *Circulation*. 1975;52:901-908.
12. National Center for Health Statistics. *Health United States 1997*. Washington, DC: Public Health Service, Government Printing Office; 1992. DHHS publication (PHS) 89-1232.
13. Mortality of blacks and whites with end-stage renal disease attributed to hypertension. *Am J Kidney Dis*. 1992;20:27-31.
14. Williams DR. Black-white differences in blood pressure: the role of social factors. *Ethn Dis*. 1992;2:126-141.
15. Saunders E. Hypertension in blacks. *Cardiovascular Clinics*. 1991;18:607-622.
16. Frohlich ED. Hemodynamic differences between black patients and white patients with essential hypertension. *Hypertension*. 1990;15(part 2):675-680.
17. Falkner B. Differences in blacks and whites with essential hypertension: biochemistry and endocrine. State of the art lecture. *Hypertension*. 1990;15(part 2):681-686.
18. Hildreth C, Saunders E. Hypertension in blacks: clinical overview. In: Saunders E, ed. *Cardiovascular Diseases in Blacks*. Philadelphia, Pa: FA Davis Co; 1991;21:85-96.
19. Blaustein MP, Grim CE. The pathogenesis of hypertension: black-white differences. In: Saunders E, ed. *Cardiovascular Diseases in Blacks*. Philadelphia, Pa: FA Davis Co; 1991;21:97-114.
20. Kumanyika SK, Hebert PR, Cutler JA, Lasser VI, Sugars CP, Steffen-Batey, et al. Feasibility and efficacy of sodium retention in the trials of hypertension prevention, phase I: trials of Hypertension Prevention Collaborative Research Group. *Hypertension*. 1993;22:502-512.
21. Grim CE, Luft FC, Weinberger MH, Miller JZ, Rose RJ, Christian JC. Genetic, familial, and racial influences on blood pressure control systems in man. *Aust N Z J Med*. 1984;14:453-457.
22. Anderson NB, McNeilly M, Myers HF. Autonomic reactivity and hypertension in blacks: a review and proposed model. *Ethn Dis*. 1991;1:154-170.
23. Manuck SB. Cardiovascular reactivity in cardiovascular disease: 'once more unto the breach.' *International Journal or Behavioral Medicine*. 1994;1:4-31.
24. Anderson NB, McNeilly M. Autonomic reactivity and hypertension in blacks: toward a contextual model. In: JCS Fray, JG Douglas, eds. *Pathophysiology of Hypertension in Blacks*. New York, NY: Oxford University Press; 1993:107-139.
25. Johnson EH, Nazzaro P, Gilbert DC, Weder A, Jamerson K. Similarities in cardiovascular reactivity to behavioral stressors in African-American and white males. *Ethn Dis*. 1992;2:232-245.
26. Weissberg PL, Woods KL, West MJ, Beevers DG. Genetic and ethnic differences on the distribution of sodium and potassium in normotensive and hypertensive patients. *Journal of Clinical Hypertension*. 1987;3:20-25.
27. Touyz RM, Milne FJ, Reinach SG. Intracellular Mg²⁺, Ca²⁺, Na²⁺ and K⁺ in platelets and erythrocytes of essential hypertension patients: relation to blood pressure. *Clin Exp Hypertens*. 1992;14:1189-1209.
28. Langford HG, Langford FPJ, Tyler M. Dietary profile of sodium, potassium, and calcium in US blacks. In: Hall WD, Saunders E, Shulman NB, eds. *Hypertension in Blacks: Epidemiology, Pathophysiology, and Treatments*. Chicago, Ill: Year Book Medical Publishers; 1985:49-57.
29. Brier ME, Luft FC. Sodium kinetics in white and black normotensive subjects: possible relevance to salt-sensitive hypertension. *Am J Med Sci*. 1994;307(suppl 1):S38-S42.
30. Wilson TW, Grim CE. Biohistory of slavery and blood pressure differences in blacks: a hypothesis. *Hypertension*. 1991;17(suppl 1):I122-I128.
31. Clark LT. Improving compliance and increasing control of hypertension: needs of special hypertensive populations. *Am Heart J*. 1991;121:664-669.
32. Horan MJ, Lenfant CJM. Hypertension in blacks: future research directions. *Ethn Dis*. 1992;2:115-119.
33. Parmer RJ, Stone RA, Cervenká JH. Renal hemodynamics in essential hypertension: racial differences to changes in dietary sodium. *Hypertension*. 1994;24:752-757.
34. Lopes AAS, Hornbuckle K, James SA, Port FK. The joint effects of race and age on the risk of end-stage renal disease attributed to hypertension. *Am J Kidney Dis*. 1994;24:554-560.

35. Lopes AAS, Port FK, James SA, Agodoa L. The excess of treated end-stage renal disease in blacks in the United States. *J Am Soc Nephrol.* 1993;3:1961-1971.
36. Falkner B, Hulman S, Kushner H. Hyperinsulinemia and blood pressure sensitivity to sodium in young blacks. *J Am Soc Nephrol.* 1992;34:940-946
37. Fisher ND, Gleason RE, Moore TJ, Williams GH, Hollenberg NK. Regulation of aldosterone secretion in hypertensive blacks. *Hypertension.* 1994;23:179-184.
38. Gretler DD, Fumo MT, Nelson KS, Murphy MB. Ethnic differences in circadian hemodynamic profile. *Am J Hypertens.* 1994;7:7-14.
39. Fumo MT, Teeger S, Lang RM, Bednarz J, Sareli P, Murphy M. Diurnal blood pressure variation and cardiac mass in American blacks and whites and South African blacks. *Am J Hypertens.* 1992;5:111-116.
40. Wilson TW, Hollifield LR, Grim CE. Systolic blood pressure levels in black populations in sub-Sahara Africa, the West Indies, and the United States: a meta-analysis. *Hypertension.* 1991;18(suppl 3):I87-I98.
41. Cooper RS. Hypertension in blacks: a puzzle waiting to be solved. *Ethn Dis.* 1991;1:111-113.
42. Barley J, Carter ND, Cruickshank JK, Jeffery S, Smith A, Charlett A, et al. Renin and atrial natriuretic peptide restriction fragment length polymorphisms: association with ethnicity and blood pressure. *J Hypertens.* 1991;9:993-996.
43. Working Group on Research in Coronary Heart Disease in Blacks. *Report of the Working Group on Research in Coronary Heart Disease in Blacks.* National Heart, Lung, and Blood Institute; 1994.
44. Harshfield GA, Grim CE, Hwang C, Savage DD, Anderson SJ. Genetic and environmental influences on echocardiographically determined left ventricular mass in black twins. *Am J Hypertens.* 1990;3:538-543.
45. Grim CE, Wilson TW, Nicholson GD, Hassell TA, Fraser HS, Grim CM, et al. Blood pressure in blacks: twin studies in Barbados. *Hypertension.* 1990;15(part 2):803-809.
46. Kumanyika S, Adams-Campbell LL. Obesity, diet and psychosocial factors contributing to cardiovascular disease in blacks. In: Saunders E, ed. *Cardiovascular Diseases in Blacks.* Philadelphia, Pa: FA Davis Co; 1991;21:47-74.
47. Dimsdale JE, Pierce C, Schoenfeld D, Brown A, Zusman R, Graham R. Suppressed anger and blood pressure: the effects of race, sex, social class, obesity and age. *Psychosom Med.* 1986;48:430-436.
48. Myers BC. Hypertension and black female obesity: the role of psychosocial stressors. In: Saunders E, ed. *Cardiovascular Diseases in Blacks.* Philadelphia, Pa: FA Davis Co; 1991;21:171-177.
49. Weir MR. Impact of age, race, and obesity on hypertensive mechanisms and therapy. *Am J Med.* 1991;90:3S-5S.
50. Lackland DT, Orchard TJ, Keil JE, Saunders DE, Wheeler FC, Adams-Campbell LL, et al. Are race differences in the prevalence of hypertension explained by body mass and fat distribution? A survey in a biracial population. *Int J Epidemiol.* 1992;21:236-245.
51. Anderson NB, Myers HF, Pickering T, Jackson JS. Hypertension in blacks: psychosocial and biological perspectives. *J Hypertens.* 1989;7:161-172.
52. Anderson NB, Armstead CA. Toward understanding the association of socioeconomic status and health: a new challenge for biopsychosocial approach. *Psychosom Med.* 1995;57:213-225.
53. Calhoun DA. Hypertension in blacks: socioeconomic stress and sympathetic nervous system activity. *Am J Med Sci.* 1992;304:306-311.
54. Neighbors HW, Braithwaite RL, Thompson E. Health promotion and African Americans: from personal empowerment to community action. *American Journal of Health Promotion.* 1995;9:281-287.
55. James SA, Keenan NL, Strogatz DS, Browning SR, Garrett JM. Socioeconomic status, John Henryism, and blood pressure in black adults. *Am J Epidemiol.* 1992;135:59-67.
56. Dressler WW. Lifestyle, stress, and blood pressure in a southern black community. *Psychosom Med.* 1990;52:182-198.
57. Keil JE, Sutherland SE, Knapp RG, Tyroler HA. Does equal socioeconomic status in black and white men mean equal risk of mortality? *Am J Public Health.* 1992;82:1133-1136.
58. Sorlie P, Rogot E, Anderson R, Johnson NJ, Backlund E. Black-white mortality differences by family income. *Lancet.* 1992;340:346-350.
59. Klag MJ, Whelton PK, Coresh J, Grim CE, Kuller LH. The association of skin color with blood pressure in US blacks with low socioeconomic status. *JAMA.* 1991;265:599-602.
60. Moorman PG, Hames CG, Tyroler HA. Socioeconomic status and morbidity and mortality in hypertensive blacks. In: Saunders E, ed. *Cardiovascular Diseases in Blacks.* Philadelphia, Pa: FA Davis Co; 1991;21:179-194.
61. Waitzman NJ, Smith KR. The effects of occupational class transitions on hypertension: racial disparities among working-age men. *Am J Public Health.* 1994;84:945-950.
62. Krantz DS, Contrada RJ, Hill RO, Friedler E. Environmental stress and biobehavioral antecedents of coronary heart disease. *J Consult Clin Psychol.* 1988;56:333-341.
63. Krantz DS, DeQuattro V, Blackburn HW, Baker E, Haynes S, James SA, et al. Task force 1: psychosocial factors in hypertension. *Circulation.* 1987;76:I84-I88.
64. James SA, Strogatz DS, Wing SB, Ramsey DL. Socioeconomic status, John Henryism, and hypertension in blacks and whites. *Am J Epidemiol.* 1987;126:664-673.
65. James SA. Psychosocial precursors of hypertension: a review of the epidemiologic evidence. *Circulation.* 1987;76(suppl 1):I60-I66.
66. Delehanty SG, Dimsdale JE, Mills P. Psychosocial correlates of reactivity in black and white men. *J Psychosom Res.* 1991;35:451-460.
67. Durel LA, Carver C, Spitzer SB, Spitzer SB, Llabre MM, Weintraub JK, et al. Associations of blood pressure with self-report measures of anger and hostility among black and white men and women. *Health Psychol.* 1989;8:557-575.
68. Johnson EH, Schork NF, Spielberger CD. Emotional and familial determinants of elevated blood pressure in black and white adolescent females. *J Psychosom Res.* 1987;31:731.
69. Harburg E, Blakelock EE Jr, Roeper PJ. Resentful and reflective coping with arbitrary authority and blood pressure: Detroit. *Psychosom Med.* 1979;41:189-202.
70. Schneider RH, Egan BM, Johnson EH, Drobny H, Julius S. Anger and anxiety in borderline hypertension. *Psychosom Med.* 1986;48:242-248.
71. Gentry WD, Chesney AP, Gary HE, Hall RP, Harburg E. Habitual anger-coping styles: effect on mean blood pressure and risk for essential hypertension. *Psychosom Med.* 1982;44:195-202.
72. Pickering TG. Hypertension in blacks. *Curr Opin Nephrol Hypertens.* 1994;3:207-212.

73. Light KC, Obrist PA, Sherwood A, James SA, Strogatz DS. Effects of race and marginally elevated blood pressure on responses to stress. *Hypertension*. 1987;10:555-563.
74. Magnus MH. Cardiovascular health among African Americans: a review of the health status, risk reduction, and intervention strategies. *American Journal of Health Promotion*. 1991;5:282-290.
75. Hall WD, Kong W. Hypertension in blacks: nonpharmacologic and pharmacologic therapy. In: Saunders E, ed. *Cardiovascular Diseases in Blacks*. Philadelphia, Pa: FA Davis Co; 1991;21:157-170.
76. Dunbar-Jacob J, Dwyer K, Dunning EJ. Compliance with antihypertensive regimen: a review of the research in the 1980s. *Annals of Behavioral Medicine*. 1991;13:31-39.
77. Gillum RF, Gillum BS. Potential for control and prevention of essential hypertension in the black community. In: Matarazzo JD, Miller N, eds. *Behavioral Health: A Handbook of Health Enhancement and Disease Prevention*. New York, NY: Wiley; 1984:825-835.
78. Francis CK. Hypertension, cardiac disease, and compliance in minority patients. *Am J Med*. 1991;91(suppl):29S-36S.
79. Daniels DE, Rene AA, Daniels VR. Race: an explanation of patient compliance—fact or fiction? *J Natl Med Assoc*. 1994;86:20-25.
80. Pickering TG. Predicting the response to nonpharmacologic treatment in mild hypertension. *JAMA*. 1992;267:1256-1257.
81. Medical Research Council Working Party. Stroke and coronary heart disease in mild hypertension: risk factors and the value of treatment. *BMJ*. 1988;296:1565-1570.
82. Multiple Risk Factor Intervention Trial Research Group. Lifestyle alteration and the primary prevention of coronary heart disease: The Multiple Risk Factor Intervention Trial. In: Pollock ML, Schmidt DH, eds. *Heart Disease and Rehabilitation*. Boston, Mass: Houghton Mifflin; 1979:341-352.
83. Walker WG, Neaton JD, Cutler JA, Nuewirth R, Cohen JD. Renal function change in hypertension members of the Multiple Risk Factor Intervention Trial: racial and treatment effects. The MRFIT Research Group. *JAMA*. 1992;268:3085-3091.
84. Weir MR, Tuck ML. Essential hypertension in blacks: is it a metabolic disorder? *Am J Kidney Dis*. 1993;21:58-67.
85. Kannel WB, Wolf PA. Inferences from secular trend analysis of hypertension control. *Am J Public Health*. 1992;82:1593-1595.
86. Joint National Committee. Fifth report of the Joint National Committee On Detection, Evaluation, and Treatment of High Blood Pressure (JNC V). *Arch Intern Med*. 1993;153:154-186.
87. Cooper RS, Liao Y. Is hypertension among blacks more severe or simply more common? *Circulation*. 1992;85:12. Abstract.
88. Stamler R. Implications of the INTERSALT study. *Hypertension*. 1991;17(suppl 1):116-120.
89. Kumanyika SK, Obarzanek E, Stevens VJ, Hebert PR, Whelton PK. Weight-loss experience of black and white participants in NHLBI-sponsored trials. *Am J Clin Nutr*. 1991;53(suppl 6):1631S-1638S.
90. Trials of Hypertension Prevention Collaborative Research Group. The effects of nonpharmacological interventions on blood pressure of persons with high normal levels—results of the Trials of Hypertension Prevention, Phase I. *JAMA*. 1992;267:1213-1220.
91. Blafox MD, Langford H, Lee HB, Davis B, Oberman A, Smoller S. Renin predicts diastolic blood pressure to nonpharmacologic and pharmacologic therapy. *JAMA*. 1992;267:1221-1225.
92. Winkleby MA, Flora JA, Kraemer HC. A community-based heart disease intervention: predictors of change. *Am J Public Health*. 1994;84:767-772.
93. Johnston DW, Gold A, Kentish J, Smith D, Vallance P, Shah D, et al. Effect of stress management on blood pressure in mild primary hypertension. *BMJ*. 1993;306:963-965.
94. Eisenberg DM, Delbanco TL, Berkey CS, Kaptchuk TJ, Kupelnick B, Kuhl J, et al. Cognitive behavioral techniques for hypertension: are they effective? *Ann Intern Med*. 1993;118:964-972.
95. Eisenberg DM, Landsberg L, Allred EN, Saper RB, Delbanco TL. Inability to demonstrate physiologic correlates of subjective improvement among patients taught the relaxation response. *J Gen Int Med*. 1991;6:64-70.
96. Fodor JG, Chockalingam A. The Canadian consensus report on non-pharmacological approaches to the management of high blood pressure. *Clin Exp Hypertens*. 1990;A12:729-743.
97. Rumore MM. Non-pharmacological treatment of hypertension. *J Clin Pharm Ther*. 1992;17:373-382.
98. Gould KL, Ornish D, Kirkeeide R, Brown S, Stuart Y, Buchi M, et al. Improved stenosis geometry by quantitative coronary arteriography after vigorous risk factor modification. *Am J Cardiol*. 1992;69:845-853.
99. Haber D. Health promotion to reduce blood pressure level among older blacks. *Gerontologist*. 1986;26:119-121.
100. Harrison DD, Rao MS. Biofeedback and relaxation in blacks with hypertension: a preliminary study. *J Natl Med Assoc*. 1979;71:1223-1227.
101. McGrady A, Roberts G. Racial differences in the relaxation response of hypertensives. *Psychosom Med*. 1992;54:71-78.
102. van Montfrans GA, Karemaker JM, Weiling W, Dunning AJ. Relaxation therapy and continuous ambulatory blood pressure in mild hypertension: a controlled study. *BMJ*. 1990;300:1368-1372.
103. Eppley K, Abrams AI, Shear J. Differential effects of relaxation techniques on trait anxiety: a meta-analysis. *J Clin Psychol*. 1989;45:957-974.
104. Nader T. *Human Physiology—Expression of Veda and the Vedic Literature*. Vlodrop, Holland: Maharishi Vedic University Press; 1995.
105. Dillbeck MC, Orme-Johnson DW. Physiological differences between Transcendental Meditation and rest. *Am Psychol*. 1987;42:879-881.
106. Jacob RG, Chesney MA, Williams DM, Ding Y, Shapiro AP. Relaxation therapy for hypertension: design effects and treatment effects. *Annals of Behavioral Medicine*. 1991;13:5-17.
107. Agarwal BL, Kharbada A. In: *VIIIth Asian-Pacific Congress on Cardiology*, Bangkok, Thailand; 1979.
108. Benson H, Wallace RK. Decreased blood pressure in hypertensive subjects who practiced meditation. *Circulation*. 1972;45-46(suppl 2):516.
109. Blackwell B, Hanenson IB, Bloomfield SS, Magenheim HG, Nidich SI, Gartside P. Effects of Transcendental Meditation on blood pressure: a controlled pilot experiment. *Psychosom Med*. 1975;37:86. Abstract.
110. Wallace RK, Silver J, Mills PJ, Dillbeck MC, Wagoner DE. Systolic blood pressure and long-term practice of the

Transcendental Meditation and TM-Sidhi programs: effects of TM on systolic blood pressure. *Psychosom Med.* 1983;45:41-46.

111. Simon DB, Oparil S, Kimball CP. The transcendental meditation program and essential hypertension. In: Orme-Johnson DW, Farrow JT, eds. *Scientific Research on the Transcendental Meditation Program, Collected Papers*. Vol 1. Livingston Manor, NY: Maharishi European Research University Press; 1977.

112. Alexander CN, Langer EJ, Newman RI, Chandler HM, Davies JL. Transcendental Meditation, mindfulness, and longevity: an experimental study with the elderly. *J Pers Soc Psychol.* 1989;57:950-964.

113. Jevning R, Wallace RK, Beldebach M. The physiology of meditation: a review. Awakeful hypometabolic integrated response. *Neurosci Biobehav Rev.* 1992;16:415-424.

114. Mills PJ, Schneider RH, Dimsdale J. Anger assessment and reactivity to stress. *J Psychosom Med.* 1989;33:379-382.

115. Mills PJ, Schneider RH, Hill D, Walton K, Wallace RK. Lymphocyte beta adrenergic receptors and cardiovascular responsivity in TM participants and type A behavior. *Psychosom Med.* 1987;49:211.

116. Mills PJ, Schneider RH, Hill D, Walton KG, Wallace RK. Beta-adrenergic receptor sensitivity in subjects practicing Transcendental Meditation. *J Psychosom Res.* 1990;34:29-33.

117. Royer A. The role of the transcendental meditation technique in promoting smoking cessation; a longitudinal study. In: O'Connell DF, Alexander CN, eds. *Self Recovery-Treating Addictions Using Transcendental Meditation and Maharishi Ayur-Veda*. Binghamton, NY: Harrington Park Press; 1994:221-242.

118. Gelderloos P, Walton KG, Orme-Johnson DW, Alexander CN. The effectiveness of the Transcendental Meditation program in preventing and treating substance abuse: a review. *International Journal of the Addictions.* 1991;26:297-325.

119. MacLean CRK, Walton KG, Wenneberg SR, Levitsky DK, Mandarino JV, Waziri R, et al. Altered cortisol response to stress after 4 months practice of the Transcendental Meditation program. *Soc Neurosci Abstracts.* 1992;18:1541.

120. Alexander CN, Rainforth MY, Gelderloos P. Transcendental Meditation, self actualization and psychological health: a conceptual overview and statistical meta analysis. *Journal of Social Behavior and Personality.* 1991;6:189-247.

121. Alexander CN. Transcendental meditation. In: Corsini RJ, ed. *Encyclopedia of Psychology*. 2nd ed. New York, NY: Wiley Interscience; 1993.

122. Zamarrá JW, Schneider RH, Besseghini I, Robinson DK, Salerno JW. Usefulness of the Transcendental Meditation program in the treatment of patients with coronary artery disease. *Am J Cardiol.* 1996;77:867-870.

123. Abrams AI, Siegel LM. The Transcendental Meditation program and rehabilitation at Folsom State Prison: a cross-validation study. *Criminal Justice and Behavior.* 1978;5:3-20.

124. Brooks JS, Scarano T. Transcendental Meditation and the treatment of post-Vietnam adjustment. *Journal of Counseling and Development.* 1985;64:212-215.

125. Schneider RH, Staggars F, Alexander CN, Sheppard W, Rainforth M, Kondwani K, et al. A randomized controlled trial of

stress reduction for hypertension in older African Americans. *Hypertension.* 1995;26:820-827.

126. Alexander CN, Schneider RH, Staggars F, Sheppard W, Clayborne BM, Rainforth M, et al. Trial of stress reduction for hypertension in older African Americans, II: sex and risk subgroup analysis. *Hypertension.* 1996;28:228-237.

127. Barnes VA, Schneider RH, Alexander CN, Staggars F, Clayborne M. Randomized trial of stress reduction in older African American hypertensives: 5 year follow-up on all-cause and CVD mortality. In: *Proceedings of the 11th International Interdisciplinary Conference on Hypertension in Blacks*. New Orleans, La; 1996.

128. Alexander CN, Barnes VA, Schneider RH, Langer EJ, Newman RI, Chandler HM, et al. A randomized controlled trial of stress reduction on cardiovascular and all cause mortality: a 15 year follow-up on the effects of Transcendental Meditation, mindfulness and relaxation. *Circulation.* 1996;93:629. Abstract

129. Wenger NK, Mattson ME, Furberg CD, Elinson J, eds. *Assessment of Quality of Life in Clinical Trials of Cardiovascular Therapies*. Le Jacq, NY; 1984.

130. Kaplan NM. *Clinical Hypertension*. Baltimore, Md: Williams & Wilkins; 1994.

131. Taylor RJ, Chatters L. Family, friends, and church support networks of black Americans. In: Spilker B, ed. *Quality of Life Assessment in Clinical Trials*. New York, NY: Raven Press; 1990.

132. Alexander CN, Schneider RH, Staggars F, Sheppard W, Rainforth M, King C, et al. A randomized controlled trial of stress reduction for hypertension in African Americans: quality of life results. In: *Proceedings of the 10th International Interdisciplinary Conference on Hypertension in Blacks*. St Thomas, US Virgin Islands; 1995.

133. Herron RE, Schneider RH, Mandarino JV, Alexander CN, Walton KG. Cost effective hypertension management: comparison of drug therapies with an alternative program. *Am J Man Care.* 1996;2:427-437.

134. Schneider RH, Castillo-Richmond A, Alexander CN, Myers H, Laushik V, Norris K, et al. Rational and design of a randomized control trial of stress reduction in the treatment of hypertensive heart disease in African-Americans. *Online Journal of Current Clinical Trials*. In press.

135. Bloomfield R, Young LD, Graves J. Racial differences in perceptions concerning hypertension and its consequences. *South Med J.* 1993;86:767-770.

136. American Public Health Association. *Healthy Communities 2000, Model Standards: Guidelines for Attainment of the Year 2000 National Objectives*. 3rd ed. Washington, DC; 1991.

137. Institute of Medicine Committee for the Study of the Future of Public Health. *The Future of Public Health*. Washington, DC: National Academy Press; 1988.

138. US Dept of Health and Human Services. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. Washington, DC; 1990. DHHS publication PHS 91-50212.

139. Hildreth CJ, Saunders E. Heart disease, stroke, and hypertension in blacks. In: Braithwaite RL, Taylor SE, eds. *Health Issues in the Black Community*. San Francisco, Calif: Jossey-Bass Publishers; 1992.