Left Ventricular Mass Regression with the *Transcendental Meditation* Technique and a Health Education Program in Hypertensive African Americans

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Increased left ventricular mass index (LVMI) is a key indicator of hypertensive heart disease (HHD) and is present disproportionately higher in African Americans. The Transcendental Meditation (TM) technique reduces blood pressure, sympathetic arousal and psychosocial stressors associated with HHD. This randomized clinical controlled trial investigated the effect of TM (N = 19) and health education (HE) (N = 15) on LVMI in hypertensive African Americans. Paired t-test and ANCOVA showed significant within group reduction in LVMI after one year (TM = 10.3%, $p < .01$) and (HE = 14.5%, $p < .01$). TM compared to HE showed additional side benefits of increased energy, positive affect, and behavioral /emotional control, and decreased sleep dysfunction, physical symptoms of distress, anxiety, and depression. Further studies investigating and combining these nonpharmacological treatment modalities should be investigated.

In African American hypertensives, the prevalence of left ventricular hypertrophy (LVH) is reported to be more than twice that of whites (41% compared to 19%) (Koren, Mensah, Blake, Laragh, & Devereux, 1993). The high prevalence of LVH among African Americans may account for much of the Black-White difference in cardiovascular morbidity and mortality (Koren et al., 1993; Liao, Cooper, McGee, Mensah, & Ghali, 1995). With similar high blood pressure levels, African Americans are more likely to exhibit adverse changes in left ventricular mass (LVM) than whites. Cardiac hyperreactivity to increased blood pressure may contribute to the increased prevalence of sudden cardiac death and myocardial infarction reported in African Americans (Koren et al., 1993).

Regression of LVM in animal models and humans has been associated with improvement in diastolic function, reduced arrhythmias, and the preservation of systolic function (Koren, Devereux, Casale, Savage, & Laragh, 1991). Evidence from studies of animals suggests that LVH reversal has beneficial effects on coronary blood flow, flow reserve, and cardiac performance (Schmieder, Messerli, Sturgill, Garavagila, & Nunez, 1989). It is expected, but not conclusively determined, that reversal of LVH could result in an overall reduction in coronary heart disease (CHD) and other cardiovascular events (Weber et al., 1992; Yurenev et al., 1992).

The efficacy of LVM regression to reduce risk of morbidity and mortality cannot be confirmed until more large-scale clinical trials are conducted (Dahlof, 1990; Dahlof, Pennert, & Hansson, 1992; Yurenev et al., 1992). Even so, some researchers strongly suggest that when LVH is detected in addition to high blood pressure, regression of LVH should be the primary therapeutic goal (Messerli, 1990; Motz, Klepzig, & Strauer, 1987; Weber et al., 1992; Yurenev et al., 1992).

Pharmacologic and non-pharmacologic approaches to reducing blood pressure have varying effects on regression of LVM. In two separate meta-analyses, regression of LVM using antihypertensive medications range from 13% with ace inhibitors to 6% with beta blockers (Dahlof et al., 1992; Schmieder, Martus, & Klingbeil, 1996). Non-pharmacologic approaches, collectively referred to as "lifestyle modification" strategies have also been shown to reduce blood pressure, and in some cases regress left ventricular mass (NHLBI, 1988; NHLBI, 1995; NHLBI, 1997). Weight reduction, sodium restriction and exercise studies with follow-up periods ranging from 21 weeks to one year have shown evidence for regression of LVM up to 20% (Jula & Karanko, 1994; Kokkinos et al., 1995; MacMahon, Wilchen, & MacDonald, 1986).

Successive reports of the Joint National Committee on the Detection, Evaluation and Treatment of High Blood Pressure (JNC IV, V and VI) continue to recommend a program of increased physical activity, improved diet including supplements, as well as relaxation and stress management techniques to prevent and treat hypertension. The JNC reports continue to recommend that clinicians vigorously encourage their patients to adopt "lifestyle modification" both before medication is prescribed and in conjunction with antihypertensive medication regimens. The reports cautioned, however, that more clinical trials are needed to validate the efficacy of relaxation and stress management procedures. Two stress management approaches using the Transcendental Meditation (TM) technique and progressive muscle relaxation (PMR) are cited in JNC VI reporting reduced blood pressure (Alexander et al., 1996; Barnes, Schneider, Alexander, Staggers, & Clayborne, 1996; Barnes, Schneider, Alexander, & Staggers, 1997; Schneider et al., 1995). In that study, TM was found to be twice as effective as PMR in lowering systolic and diastolic blood pressure. To date, the influence of TM or PMR on LVM has not been investigated in a randomized clinic trial. Since TM had twice the effect size as PMR, this study will focus on the TM technique as an intervention.

The TM technique is described as a simple, natural technique, practiced 20 minutes twice daily (Roth, 1994). Research indicates a distinctive state of restful alertness results from systematic practice of the TM technique, which differs from waking, sleeping and dreaming in over 20 parameters including electroencephalographic, autonomic and biochemical parameters (Alexander, Cranson, Boyer, & Orme-Johnson, 1987; Alexander, Langer, Newman, Chandler, & Davies, 1989; Alexander, Rainforth, & Gelderloos, 1991). The TM technique has been shown to reduce a variety of cardiovascular risk factors in four meta-analyses including increased acceptance of self, others and nature

(Alexander et al., 1991), reduced anxiety (Eppley, Abrams, & Shear, 1989), decreased use of alcohol, cigarettes, and illicit drugs (Alexander, Robinson, & Rainforth, 1994), and reduced baseline sympathetic arousal as indicated by lower resting levels outside of meditation of heart rate, respiration rate, plasma lactate, and spontaneous skin resistance responses (Dillbeck & Orme-Johnson, 1987).

Two retrospective follow-up studies indicate a long-term effect of the TM technique on morbidity. In a group of 2,000 individuals who practiced the TM technique, the TM group had a hospitalization rate 87% less for heart disease compared to controls (Orme-Johnson, 1987). The same study found the group that practiced the TM technique had less than half the doctor visits and hospitalization rates over a five-year period compared to other groups of similar age, gender, profession and insurance coverage (Orme-Johnson, 1987). In the second retrospective follow-up study, Orme-Johnson assessed Blue Cross/Blue Shield insurance data for Iowa (Orme-Johnson, 1997). Orme-Johnson found that over an 11-year period the mean reduction in medical expenditures for the TM group was 63% less than the state's average. In addition, there was an 11.4 times lower hospitalization rate for cardiovascular disease in the group that practiced TM and other preventative strategies as compared to matched controls.

These published studies support the use of the TM technique to reduce blood pressure and prevent cardiovascular morbidity and mortality. These studies further suggest that all stress management and relaxation techniques are not equipotent in their ability to induce psychological and physiological health benefits (Orme-Johnson & Walton, 1998). The mechanism of the reported reduction in cardiovascular events in the groups that practiced the TM technique may be mediated in part by the lowering of blood pressure and the regression of LVM. However, prior to this study, no investigation had been conducted on the direct effect of the TM technique on LVM.

This investigation examines the effect of the TM technique and a health education (HE) program on LVM and diastolic function in hypertensive African Americans. We hypothesize that both TM and health education will have a significant effect in the reduction of LVM.

METHOD

Design

This investigation was a randomized, controlled, single blind trial comparing the TM technique with a health education (HE) program. The site of this trial was the West Oakland Health Center, an inner city, primary care, community health clinic in Oakland, California. This sub study was

approved by institutional review boards at the West Oakland Health Center and Maharishi University of Management. The trial was conducted between June 1992 and June 1996. All eligible participants underwent five baseline visits to assess blood pressure, LVM and other psychological and psychosocial testing before randomization to a treatment group occurred. The follow-up period was one year after treatment began.

The primary outcome measure was left ventricular mass indexed by body surface area (LVMI in g/m^2) measured by M-mode echocardiography. Systolic and diastolic blood pressure, left ventricular diastolic function (E/A ratio) and compliance were secondary outcome variables. Psychological, behavioral, and dietary characteristics were assessed at baseline to determine the equivalence of groups.

Study Population

The target population included men and women, self-identified as African Americans over the age of 18, with a history of mild hypertension, defined as diastolic blood pressure of 90-104 mmHg on at least the last two of five baseline visits. Participants were recruited from local community clinics, churches and other community forums in addition to newspaper, TV, and radio advertisements. Participants must have reviewed and signed a consent form and submitted a signed physician consent form.

Participants were eligible to enter the trial whether or not they were on antihypertensive medication, provided their blood pressure was within the inclusion range previously described. If participants and their primary physician consented, participants could elect to taper off their antihypertensive medication under their physician's guidance for the purpose of enrolling in the study. If, after a one-month washout period these participants' blood pressure fell within the entry criteria, they were eligible for inclusion. Participants who remained on antihypertensive medication were asked to report any change in their dosage throughout the study. Participants were not excluded if they had a history of cardiovascular disease, renal disease or other medical conditions.

Exclusion criteria were minimized because patients could remain under the care of their primary physician. Furthermore, a participant's own physician could decide that a patient should not participate when deemed medically inadvisable. Individuals were excluded from the study if they evidenced gross psychiatric impairments (e.g., dementia or psychosis) which would interfere with their ability to follow instructions. If participants' diastolic blood pressure exceeded 104 mmHg or systolic exceeded 179 mmHg in any two consecutive visits, they were excluded from the trial and immediately referred to their primary physician.

After initial screening for blood pressure and verification of eligibility, participants continued to return for psychometric testing and blood pressure measurements every 1 to 2 weeks for a total of five visits. Baseline blood pressure levels were determined by the mean of the measurements in visits four and five. After completion of baseline evaluation, participants were randomized in a stratified manner. Participants were matched based on the following stratifications: (a) antihypertensive medication, either on or off, (b) gender, and (c) range of blood pressure determined by dividing diastolic blood pressure into thirds for each treatment group. Then each participant was randomly assigned to the TM, PMR, or Health Education group. Once participants were randomized into the treatment groups, participants from the TM and Health Education groups were asked to participate in this LVM sub study.

Treatment Groups

The treatment providers for the TM group and the Health Education group were highly qualified African Americans, who were professionals in their areas of expertise. A consultant taught the TM technique from the Maharishi Vedic Education Development Corporation. A health educator concurrently employed by the community-based West Oakland Health Center taught the Health Education group. Other than the steps to learning the TM technique described below, the two groups were matched for follow-up meetings, time with instructor, and required home practice time.

Transcendental Meditation (TM) program. A detailed description of the TM technique protocol and its benefits is published elsewhere (Nader, 1995; Roth, 1994; Wallace, 1977). Participants assigned to the TM group attended an introductory lecture on the TM technique and had a brief personal interview with the instructor. Personal instruction in the TM technique and three days of group follow-up occurred over four consecutive days. Each session was approximately 1.5 hours long. Follow-up sessions were conducted once a week for the first month and once per month thereafter for a period of twelve months.

Health Education (HE) program. The Health Education group received information, demonstrations, and guidance on lifestyle modification known to reduce blood pressure and regress LVM (Kokkinos et al., 1995; MacMahon et al., 1986). The 1.5-hour meetings included group discussions, light aerobic exercise, meal preparation demonstrations and handout materials. The sessions followed nationally recognized guidelines for diet and exercise provided by pamphlets, brochures and information from organizations such as the California Medical Education and Research Foundation, California Medical Association, National Dairy Council, American Academy of Family Physicians, and the President's Council on Physical Fitness and Sports. These sessions were conducted once a week for the first month and once per month thereafter for a period of 12 months.

Measures

Blood pressure, heart rate, height and weight. All clinical blood pressure and heart rate measurements were taken by an SB700 IBS automatic blood pressure monitor. Blood pressure and heart rate measurements were taken with the participants seated and the right arm supported at heart level after resting quietly for 3–5 minutes. Three successive readings five minutes apart were taken. The last two readings were averaged and recorded as the session's measurement. The fifth Korotkoff sound was recorded as diastolic pressure. Weight and height were measured in pounds and inches and converted into kilograms (rounded to nearest 0.1 kg) and meters (rounded to the nearest centimeter).

Left ventricular dimension, mass and diastolic function. The echocardiography apparatus used was the 1990 model of the Ultramark 7 Ultrasound system, manufactured by Advance Technology Laboratory, Inc. from Washington State. The type of recording system used was a Panasonic professional/industrial video camera recorder on 1/2-inch videotape, model number AG-7300. A Phased Array scanhead transducer was used with a range of 2.5 MHz and a maximum depth of 24 cm. M-mode echocardiograms were recorded with participants in the left lateral decubitus position. Interventricular septal thickness (IVST), left ventricular internal dimension at diastole (LVIDd), left ventricular internal dimension at systole (LVIDs), and posterior wall thickness (PWT) were measured in millimeters (Devereux et al., 1984; Feigenbaum, 1994). LVM was calculated using the conventional corrected ASE method (LVM = 0.80{1.04[(IVST + LVIDd +PWT)3 - (LVIDd)3] + 0.6 g) (Devereux & Reichek, 1977). This formula was divided by body surface area (BSA = Weight0.425 kg × Height0.725 cm × 71.84) (DuBois & DuBois, 1916) to give the LV mass index (LVMI) (Devereux et al., 1984). LVH was defined for men as LVM< 134 g/m^2 and LVM < 110 g/m^2 for the women (Julius et al., 1990).

To record left ventricular diastolic functioning, Doppler mode echocardiography was used (Feigenbaum, 1994). Doppler echocardiography assessed left ventricular function as peak velocity of early rapid filling of the left ventricle (E wave) and atrial contribution to late filling of the left ventricle (A-wave). The E/A ratio in cm/sec was used as an estimate of LV diastolic function (Feigenbaum, 1994).

Psychological, dietary, exercise and risk factors. Mental health and quality of life was assessed by the Mental Health Inventory (MHI) and the General Well-Being (GWB) questionnaires. The MHI provides a global index of subjective well-being or distress. The MHI index consists of 38 items comprising 5 subscales measuring anxiety, depression, loss of behavioral/emotional control, general positive affect and emotional ties. GWB measures general health, vitality, physical symptoms of distress and sleep dysfunction. These measures were validated in an African American hypertension clinical trial on the effects of drug regimes on quality of life in adults (Croog et al., 1990).

Calories, fat, sodium and potassium intake were assessed by questionnaires at pretest and posttest. Cardiovascular lifestyle factors were assessed at baseline and after 12 months of intervention. A short questionnaire modeled after the MRFIT instrument was used to assess duration, intensity, or frequency patterns of: (a) alcohol intake, (b) smoking, and (c) exercise (MRFITR Group, 1982).

Regularity and compliance. Regularity in the TM group was measured by self report of the participants' practice of TM—2 times per day, 1 time per day, less than 1 time per day, or not at all. Regularity in the Health Education group was assessed by asking how frequently the individual followed the lifestyle modification guidelines—every day, most days, some days, or not at all. Each treatment instructor measured compliance by attendance records at group meetings, class participation and self-reports of home practice.

Statistical Analysis

Baseline characteristics of the TM and Health Education groups were compared using t-tests for independent groups. Baseline factors included age, gender, weight, height, body surface area, body mass index, systolic and diastolic blood pressure, heart rate, medication status, and psychological and lifestyle characteristics. Since both treatment interventions are active and served as their own control, a one-sample, paired t-test was used to compare post treatment versus baseline for each treatment group taken separately. Two American Society of Echocardiography (ASE) qualified technicians, blind to treatment status, evaluated the echocardiographs independently. Their measurements were averaged to determine final outcome values. Between groups treatment outcomes were assessed by ANCOVA with the posttest score as the outcome variables and the pretest score as the covariate. Change scores on LVMI and E/A ratio were defined as post treatment values minus baseline values. The criterion for statistical significance was set at $p < .05$. All tests were two-tailed except the predicted weight loss in the Health Education group. Systat version 5.2.1 for Macintosh was used for all analyses.

RESULTS

Baseline Characteristics

Forty-two volunteers were randomized to this study (22 in the TM group and 20 in the Health Education group). Of the 42, seven participants (1 male and 2 females in the TM group; and 3 males and 1 female in the Health Education group) did not complete the study. One other male HE participant had a baseline LVM over 5 standard deviations from the mean of the two groups combined and was excluded.

The baseline clinical characteristics (Table 1) of the TM (n = 19) and HE (n = 15) groups were not significantly different ($p > .05$) in age, weight, height and systolic or diastolic blood pressure. At baseline, 57.9% of the TM group and 66.7% of the HE group were on antihyper-

TABLE 1 Baseline Characteristics and p-values of the TM and HE Groups

	Transcendental Meditation (n=19)	*Health Education (n=15)*	*p-value between groups*
Age (years)	52.3±7.2	48.7±10.7	.27
Gender (M/F)	10/9	5/10	.27
Weight (kg)	83.3±12.2	79.9±16.1	.50
Height (m)	1.73±0.11	1.66±0.14	.14
BSA (m)	1.97±1.7	1.92±0.25	.48
BMI (kg/ m)	28.0±5.3	28.7±4.2	.68
SBP (mmHg)	145.4±16.7	140.73±18.2	.78
DBP (mmHg)	95.7±4.4	94.4±3.4	.34
HR (beats/min)	82.8±12.5	78.2±13.9	.34
% on antihypertensives	58	67	.61
LVM (g)	187.1±46	210.57±50	.17
LVMI (g/m^2)	94.6±20	113.4±32	.06
E/A ratio	0.95±0.30	1.04±0.33	.46

BSA= body surface area, BMI= body mass index, SBP= systolic blood pressure, DBP=diastolic blood pressure, HR= heart rate. LVM=left ventricular mass, LVMI=left ventricular mass index by body surface area, E/A ratio=early filling divided by atrial constriction.

tensive medication. The difference in medication status was not significant (p = .61).

Baseline echocardiograph measurements were not significantly different between groups (Table 1). There was a trend for LVMI to be higher in the HE group (p = .06). Of the 34 participants who completed the study, 3 of 19 in the TM group (15.8%) and 4 of 15 in the HE group (26%) had LVH defined for men as LVM< 134 g/m^2 and LVM < 110 g/m^2 for the women. The correlation coefficient between the two ASE readers unaware of treatment status was r = .69.

No significant differences were found at baseline in the following exercise categories: vigorous, moderate, light, times per week, or type of activity. Baseline analysis of participants' calories, sodium, potassium and fat intake also showed no significant difference between groups. There were no significant differences at baseline for any of the psychological measurements on the Mental Health Inventory: trait anger, anxiety, self-efficacy, internal health locus of control, depression, or tendency to respond in a socially desirable manner. Nor were there any differences between groups at pretest on the General Well-Being questionnaire: energy, sleep, physical symptoms of stress (stress impact A and B), emotional ties or behavioral control.

Within-Group Analyses

Transcendental Meditation program. Table 2 reports the within-group analysis. The TM group showed a significant mean decrease of 0.114 mm in the IVST (p = .009). LVM in the TM group showed a mean decrease of 18.9 g (p = .01) and LVMI showed a mean decrease of 9.75 g/m^2 (p = .013) equivalent to a 10.3% reduction in LVMI. All other structural parameters showed no significant within-group change. The TM group showed a significant mean decrease of 3.70 mmHg in diastolic blood pressure (p = .009).

Within-group analysis of the general well-being and psychological variables showed that the TM group increased significantly in energy, positive affect, behavioral/emotional control, and decreased in sleep dysfunction, symptoms of distress, anxiety, and trait anger. They did not change on the social desirability scale (See Table 3).

Health Education program. The HE group showed a significant mean decrease of 0.176 mm in the PWT (p = .001). LVM in the HE group showed a mean decrease of 31.5 g (p = .01) and LVMI showed a decrease of 16.49 g/m^2 (p = .01) equivalent to a 14.5% reduction in LVMI. All other echocardiogram parameters showed no significant within-group change. The HE within-group changes in systolic and diastolic blood pressure were not significant.

TABLE 2 Physiological Outcomes: Within-Group Mean Difference, Standard Deviation of Mean Difference and Within- and Between-Group p = values for the TM and HE Groups

	Transcendental Meditation (n = 19)			*Health Education (n = 15)*			*Between-Group p-value*
	Mean difference	*SD of the difference*	*p-value within*	*Mean difference*	*SD of the difference*	*p-value within*	
Weight (kg)	-1.22	9.28	.58	-1.48	3.97	.17	.72
SBP (mmHg)	1.82	12.44	.53	-2.17	11.92	.50	.30
DBP (mmHg)	-3.70	5.49	.01	-3.62	9.84	.18	.93
HR (beats/min)	-2.87	15.26	.31	4.2	15.52	.31	.28
IVST (mm)	-.11	.17	.01	-.10	.22	.11	.62
PWT (mm)	-.05	.17	.18	-.18	.16	.001	.11
LVIDD (mm)	-.02	.36	.77	.02	.48	.88	.57
LVIDS (mm)	.00	.48	1.00	.02	.50	.86	.80
LVM (g)	-18.9	30.35	.01	-31.54	39.10	.01	.56
LVMI (g/m^2)	-9.75	15.48	.01	-16.49	22.77	.01	.78
E/A ratio	.08	.40	.39	.15	.63	.52	.28

SBP = systolic blood pressure, DBP = diastolic blood pressure, HR = heart rate, IVST = intraventricular septal thickness, PWT = posterior wall thickness, LVIDD = left ventricular internal dimension at diastole, LVIDS = left ventricular internal dimension at systole, LVM = left ventricular mass, LVMI = left ventricular mass index by body surface area, E/A ratio = early filling divided by atrial constriction.

TABLE 3 Psychological Outcomes: Within-Group Mean Difference, Standard Deviation of Mean Difference and Within- and Between-Group p = values for the TM and HEGroups

	Transcendental Meditation (n = 19)			*Health Education (n = 15)*			*Between-Group p-value*[b]
	Mean difference	*SD of the difference*	*p-value within*[a]	*Mean difference*	*SD of the difference*	*p-value within*[a]	
Energy	.66	.85	.01	.13	1.00	.62	.01
Sleep Dysfunction	-.63	1.23	.05	.30	.95	.24	.00
Symptoms of Distress A	-.51	1.10	.07	.13	1.34	.71	.17
Physical Symptoms of Distress B	-.54	.95	.04	.27	.82	.22	.02
Positive Affect	.53	.74	.01	-.05	.91	.84	.01
Emotional Ties	.00	1.03	1.00	.07	1.47	.86	.39
Behavioral/Emotional Control	.35	.59	.03	-.28	.78	.18	.00
Anxiety	-.58	.89	.02	-.12	.82	.58	.03
Depression	-.30	.69	.09	.43	1.19	.18	.02
Trait Anger	-.43	.76	.04	-.11	.69	.56	.10
Self Efficacy	.22	1.18	.47	.07	1.46	.86	.18
Internal Health Locus of Control	.25	.74	.18	.08	.45	.52	.72
Social Desirability	-.01	.38	.90	-.08	.20	.14	.30

[a] *t-test*
[b] *ANCOVA*

Within-group analysis showed that the HE group did not change significantly on any well-being or psychological variables (Table 3).

Between-Group Analysis

Blood pressure, heart rate, height and weight. Table 2 presents mean changes and p-values adjusted for baseline measures in weight, systolic and diastolic blood pressure and heart rate. There were no significant differences between groups on change in these measures after 12 months of intervention. After the 12-month intervention, DBP was 92 mmHg for TM and 90.8 for HE.

Left ventricular dimension, mass and diastolic function. Table 2 also reports mean change and adjusted p-values for change on left ventricular measurements. There was no significant between-group difference on LVMI or E/A ratio in the TM and HE groups when adjusting for pretest values. After the 12-month intervention, LVM was 168.2 g for TM and 179.1 for HE. LVMI was 84.8 g/m2 for TM and 96.9 for HE.

Psychological, dietary and exercise. ANCOVA of the psychological measures (Table 3) showed significant differences between the TM and HE groups with the TM group reporting an increase in energy ($p = .01$), decreased sleep dysfunction ($p = .002$), decreased symptoms of distress B ($p = .02$), increased positive affect ($p = .006$), increased behavioral control ($p = .003$), decreased anxiety ($p = .03$), and decreased depression ($p = .02$). No significant differences were found between groups at posttest in any of the following dietary categories: calories, fat, sodium, and potassium. No significant changes in exercise were found.

Regularity and compliance. There was a significant difference in compliance between the two groups. The mean compliance average after 12 months in the TM group was 4.58 compared with 3.71 in the HE group ($p = .034$). There was a significant difference in regularity of the daily practice comparing the mean of 1.64 times per day in the TM group with .70 times per day in the HE group ($p = .01$).

There was no interaction effect between treatment status and regularity within groups. The median split on regularity did not show an interaction effect for change in BP, LVMI or E/A ratio. There was a significant difference in the change in E/A ratio as it related to the median on pretest weight ($p = .04$). Those above the median had an increase in E/A ratio while those below the median decreased in E/A ratio in both groups. Multivariate analysis using BMI and BP did not yield significant results.

An exploratory analysis showed that change in weight was not correlated with change in DBP but was inversely correlated with change in LVMI: all participants $r = -.37$, $p = .03$; TM group only, $r = -.48$, p =

.04; HE group only, r = -.39, p = .15. These results were not due to outliers, and are the opposite of what might be expected. Also, across all participants, those who used medication (n = 21) did not differ from participants who did not use medication (n = 13) on change in DBP or change in LVMI. There was no effect of gender on the effects of TM or Health Education.

DISCUSSION

The results of this study support the use of both non-drug "lifestyle modification" approaches used in this study for the reduction of left ventricular mass in African Americans with stage I hypertension. In a typical inner city primary health care facility, a 20-minute twice-daily practice of the Transcendental Meditation technique was compared with health education to improve physical exercise and dietary patterns. After the 12-month follow-up period, both approaches, TM (mental) and Health Education (diet and physical exercise), reduced left ventricular mass significantly. The posterior wall thickness decreased significantly within the Health Education group, whereas the interventricular septal thickness decreased significantly within the TM group. Furthermore, after the 12 months of follow-up, the TM group significantly decreased in diastolic blood pressure whereas the Health Education group showed no significant difference between pre and posttest. The statistical significance for TM on DBP and not for Health Education means that DBP reduction was a more consistent effect across TM participants than for Health Education participants. The final mean DBP's for the two groups were quite similar, 92 mmHg for TM and 90.8 for Health Education.

In reviewing methodological constraints it is important to note the following limitations:

(a) The sample size and therefore statistical power for this study was small, limiting the ability to detect differences within, and especially, between groups.

(b) There was no control group in this study. Both treatment interventions were active.

(c) There was no screening of left ventricular mass as a basis for entry into the study.

(d) Requirements for compliance for both groups, i.e., sitting with eyes closed 20 minutes twice daily in the TM group and complying with daily dietary and exercise recommendations in the Health Education group, cannot be evaluated as equals.

(e) LVMI in the two groups was nearly significantly different at baseline. This indicates that despite random assignment, the groups were not completely equivalent on the primary outcome variable, LVMI. The higher baseline LVMI in the Health Education group and corresponding posttest change could be a result of possible regression to the means.

The significant within-group decrease in diastolic blood pressure in the TM group after 12 months (3.7 mmHg) supports the earlier short-term (3 month) finding of decreased diastolic pressure and indicates a long-term effect of the TM technique on diastolic blood pressure (Alexander et al., 1996; Schneider et al., 1995). However, a decrease in systolic blood pressure was not found to be sustained over the entire 12-month period in either group.

Left ventricular mass in normotensive humans has been found to increase with age about 1.0–1.5 grams per year for those between the age of 30 and 90 (Dahlof, 1988). In this current study, both treatment groups reduced LVM over a one-year period, apparently slowing the biological progression of LVM found previously (Dahlof, 1988).

How the mass of the left ventricle is regressed, i.e., through medication, exercise or diet, and how quickly it regresses may influence functionality of the left ventricle and future prognosis. A slower paced, natural regression of the left ventricle induced by diet or low aerobic exercise, and in this study TM and Health Education, may improve prognosis whereas a drug-induced speedy regression could leave the left ventricle flabby and less efficient (Dunn, Bastian, Lawrie, & Lorimer, 1980; Wollam et al., 1983).

The TM group exhibited a mean difference reduction in heart rate of 2.87 beats per minute over the 12-month period. Though not statistically significant, this decrease indicates a possible decrease in resting sympathetic tone. The TM technique as an autonomic regulator is consistent with other findings of reduction in sympathetic tone (Dillbeck & Orme-Johnson, 1987; Jevning, Wallace & Beidebach, 1992) and improved autonomic stability (Orme-Johnson, 1973).

Health education and now the TM technique have been shown to be effective in reversing the increased progression of left ventricular mass, even when LVH was present and with marginal changes in blood pressure. This study suggests multiple non-drug pathways to regression of LVM. The two nonpharmacological approaches of the TM technique and health education may be complementary and may work synergistically together. This synergistic effect could be expected based on the apparently different pathways involved in the reduction of LVM found in this study. The TM group's LVM reduction came from a reduction in IVST whereas the Health Education group's LVM reduction resulted

from a reduction of PWT. In addition, the TM group showed a reduction in diastolic blood pressure and showed a trend in heart rate reduction.

The psychological relief measured by increased energy, improved sleep, reduced stress impact, positive affect, increased behavioral control, and decreased anxiety and depression, which was found to improve for the TM group, may have influenced the regression of LVM in that group through a mechanism associated with reduced reactivity to external stressors. Further research on the applications of the TM technique with the African American population could prove to be promising, as this population experiences excessive exposure and limited buffer resources to psychosocial stressors.

Significance and Practical Application of Findings

Both the TM and Health Education approaches to the reduction of LVM are consistent and supportive of the lifestyle recommendations of the JNC VI report (NHLBI, 1997) to prevent or reduce cardiovascular morbidity and mortality. These findings support the JNC's recommendations on health education, as the Health Education group did show a reduction in LVM even though the group did not maintain a reduction in blood pressure or body weight over the 12-month follow-up. In addition, this current study adds evidence towards a stronger recommendation for the use of one unique stress management program—the TM program. These findings further suggest that the psychophysiological approach of the TM technique can be effective in reducing elevated blood pressure and left ventricular mass in African Americans. The results of this study also support previous findings that exercise and diet can decrease left ventricular mass in an African American population.

The significance of these findings is physiological and behavioral in scope. Physiologically, both treatments appear to regress the predicted growth of LVM found with age. Thus the TM technique and Health Education are expected to improve prognosis and reduce risk of morbidity and mortality. According to Levy (Levy, Garrison, Savage, Kannel, & Castelli, 1990) for each increment of 50 grams per meter (height adjusted) growth in LVM, the relative risk factor for cardiovascular disease increases 1.49 for men and 1.20 for women.

CONCLUSION

Behaviorally, this study suggests three options centering around lifestyle choices for hypertensive African Americans interested in reducing the risk of cardiovascular events: (a) For those who want and can be physically active, light exercise and dietary restrictions on salt, calories, fats, and alcohol intake, can be recommended. (b) For those who are

unable or unwilling to exercise, the TM technique can be recommended. (c) Combining exercise, diet and the TM technique for a synergistic effect may provide more complete long-term preventive strategies for reduced cardiovascular morbidity. Both the TM and Health Education groups reduced left ventricular mass significantly in hypertensive African Americans over a 12-month follow-up period. Further investigation is warranted to determine the effect on LVM and cardiovascular events when the TM technique is combined with recommended health education strategies.

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