A Behavioral Approach in the Treatment of Hypertension: Exercise Therapy and Relaxation Training

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A BEHAVIORAL APPROACH
IN THE TREATMENT OF HYPERTENSION:
EXERCISE THERAPY AND RELAXATION TRAINING

by

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A BEHAVIORAL APPROACH
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The purpose of this study was to investigate behavioral approaches to the control of hypertension and to provide practical guidelines for setting up such a behavioral program.

Five hypertensive subjects underwent a program consisting of one hour exercise and relaxation sessions, three times per week for 8 weeks. Changes in pretreatment and post treatment blood pressure readings and anti-hypertensive medications were recorded.

Possible mechanisms relating exercise and relaxation to blood pressure control were discussed.
ACKNOWLEDGEMENTS

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EXERCISE THERAPY AND RELAXATION TRAINING

WESTERN MICHIGAN UNIVERSITY

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CHAPTER 1

INTRODUCTION

Hypertension is a condition characterized by increased blood pressure, systolic, diastolic or both. In the United States, it is estimated that 20-25 million people or one out of every four adults have definite hypertension (Long, 1980).

The control of hypertension is important because it is a major associated risk factor in vascular diseases. In fact, compared to normotensives, hypertensives have almost three times the risk of coronary heart disease, seven times the risk of stroke, four times the risk of peripheral vascular disease and five times the risk of congestive heart failure.

The Problem

This study will investigate the effects of behavioral methods used to control blood pressure, specifically regular exercise and relaxation training, on individual hypertensive subjects. The effects will be measured by changes in pre and posttreatment blood pressure readings and levels of anti-hypertensive medications.
Purpose of the Study

Hypertension, if diagnosed, has been fairly well controlled since the 1950's with the introduction of ganglion blocking drugs, however, even with the success of some pharmaceutical methods, problems still remain: (a) the cumulative cost of drug therapy, which in many cases must be continued from the time of diagnosis for the rest of the patient's life, (b) complicating side effects, (c) lack of compliance, especially in asymptomatic cases, and (d) failure of drug therapy to encourage changes in the patient's lifestyle that may (1) reduce hypertension and the incidence of other diseases, and (2) enhance the health of the individual.

The purpose of this study is to investigate the possible effects of a behavioral approach to the control of hypertension and to provide practical guidelines for setting up such a behavioral program.

Significance of the Study

Several investigators have reported that the practice of biofeedback (Benson, 1971; Patel and North, 1975), relaxation (Stone and DeLeo, 1976; Datey, 1969), and meditation (Benson, 1974), has reduced blood pressure in some hypertensive subjects. It has also been reported that exercise can be effective in reducing blood pressure.
in hypertensives (Boyer and Kasch, 1970). However, there has not been a published study which has combined relaxation training and regular exercise as a treatment for reducing hypertension. It was the intention of this study to combine these methods and evaluate the results.

**Delimitations**

The delimitations of this study were as follows:
(a) The study was conducted with a single subject experimental design. There was no control group. (b) Only subjects with established primary hypertension were selected for the study. (c) Only one type of relaxation training was used. (d) Only very mild cardiovascular exercise training was part of the treatment. (e) The duration of treatment was 8 weeks which may not have been the optimum period of time needed to observe the desired effects.

**Limitations**

The limitations of this study were as follows: (a) Nutritional habits were not controlled. (b) The amount of home practice, although encouraged, was not controlled. (c) Emotional events in the lives of the subjects may have greatly affected blood pressure readings.
Assumptions

The assumptions of this study were as follows: (a) All subjects had the ability to attain some degree of relaxation during the relaxation training sessions. (b) All subjects were able to sustain their exercise heart rates for 20 minutes at a time. (c) The sphygmomanometer used to record blood pressure gave accurate and consistent readings.

Definition of Terms

Hypertension

Any systolic reading consistently greater than 140mmHg and any diastolic reading consistently greater than 90mmHg, or both.

Primary Hypertension

The condition of hypertension characterized by an inherited predisposition in which the initiating mechanism cannot be identified.

Relaxation Training

A general term to describe methods used to produce relaxation in an individual. The methods usually include an instructor's voice or tape that guides the subject.
through conscious muscle relaxation and rhythmic, coordi­nated breathing. Relaxation can be aided by biofeedback or not. Some yogic exercises such as "Shavasan" fall under the heading of relaxation training. In this investigation, relaxation training will refer to a specific exercise presented on a tape made by the investigator. A transcript of the tape may be found in Appendix A.

Exercise Therapy

A general term for the use of controlled, regular exercise as therapy or as rehabilitative treatment.
CHAPTER II

REVIEW OF LITERATURE

This study will investigate behavioral methods in controlling hypertension, specifically relaxation training and exercise therapy.

The review of literature is divided into two categories: (a) studies relating to relaxation training and hypertensive subjects, and (b) studies relating to exercise training and hypertensive subjects.

Relaxation Training and Hypertension

The "fight or flight" defense reaction (Canon, 1939) initiates several physiological changes including an increase in blood pressure. The ability to elicit a thorough relaxation or "anti-stress" response results in a condition which may be regarded as opposite in nature to the stress response. There is considerable evidence that biofeedback aided relaxation, meditation and other relaxation techniques can elicit this quieting response and reduce blood pressure in hypertensives (Jacobsen, 1939; Datey, 1969; Benson, 1971; Patel, 1973 & 1977; Patel and North, 1975).

Patel (1973) in a pilot study observed twenty sub-

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jects known to be hypertensive for a minimum of one year. The patients were seen individually for three, one-half hour sessions per week for three months. Relaxation was aided by a Galvonic Skin Response (GSR) biofeedback device which measures the electrical resistance of the skin and generally reflects the activity of the sympathetic nervous system. The patients were asked to pay attention to their breathing. After making sure that it was smooth and regular, they mentally went over the various parts of their bodies and made them completely limp and relaxed. They made sure no tension was left in their bodies. After three months of these sessions, the average systolic pressure reduction for the group was 26mmHg and the average diastolic pressure reduction was 14mmHg. In addition, the total drug requirement for the group was reduced by 41.9%. (Five of the subjects were able to eliminate their anti-hypertensive medications altogether; others varied in their ability to reduce their medication.)

In a following study, Patel and North (1975) observed 34 hypertensive patients using a randomized crossover experimental design. The subjects were assigned at random either to 6 weeks treatment (2 times/week) with yoga relaxation methods and biofeedback or to a placebo therapy control group (general relaxation).
Both groups showed changes in blood pressure; the treatment group reduction was 26/15 mmHg and the control group reduction was 9/5 mmHg. The treatment group reduction was highly significant. Two months later, the control group was trained in yoga and biofeedback relaxation and their blood pressure fell to that of the original treatment group (now used as controls).

Patel, in Figure 1, indicates by slash marks (______→) the points at which she thinks the relaxation treatment had altered sensitivity of the hypothalamic response in the pathway to high blood pressure.

Datey (1969) studied 47 hypertensive patients whose drug requirements had been stabilized. He taught them the yogic exercise "Shavasan". In this exercise, the patient was asked to lie down, close the eyes and begin slow, diaphragmatic breathing with a short pause after every inhalation and a longer one at the end of each exhalation. The patient was then asked to attend to the sensation at the nostrils, the coolness of the inspired air and the warmth of the expired air. Within one month of daily practice, a significant blood pressure reduction was obtained in 52% of the patients.

In another study, Datey observed 50 hypertensive subjects, all of which were receiving anti-hypertensive medication. He formed two treatment groups, one using
Fig. 1. Suggested pathogenesis of essential hypertension and behavior modification: 1, educational program; 2, breathing exercise; 3, muscle relaxation; 4, meditation; and 5, deconditioning.

Patel, 1975.
the yogic exercise "Shavasan", and one using biofeedback (GSR and temperature regulation). There were two control groups. Training frequency was 3 times per week for 3 months. Both treatment groups had significant blood pressure reductions and 25-30% reduction in drug requirements.

Jacob, Kraemer & Agras (1977) in a critical review of the literature concluded that relaxation treatment offers more than mere placebo in reducing blood pressure. However, other investigators including Frankel (1978) have not found blood pressure reductions with relaxation and biofeedback training compared to controls.

Exercise Therapy and Hypertension

Exercise has become an integral part of many cardiac rehabilitation programs. There appears to be at least circumstantial evidence that physical fitness is a preventive factor in recurring myocardial infarctions.

However, it is not clear whether exercise consistently lowers blood pressure in hypertensives.

The most successful study published involving hypertensives and regular exercise was by Boyer and Kasch (1970). They studied 23 subjects with established primary hypertension who exercised 2 times per week for 6 months. The average reduction after treatment was 13.5/11.8mmHg.
Hanson and Nedde (1968) worked with labile and established primary hypertensives and found reductions in blood pressure in both groups after 7 months of various exercises (3 times/week). The reduction in labile hypertensives was more significant.

Johnson and Grover (1967) found no blood pressure reductions in four established primary hypertensives after treadmill training 3 times per week for 10 weeks.

Sannerstedt (1969) also found no blood pressure reductions in two established primary hypertensives after bicycling 3 times per week for 6 weeks. However, he did find some blood pressure reductions in five labile hypertensives at the same level and frequency of training. He suggests that since labile and established primary hypertensives are distinct hemodynamically, exercise may help reduce blood pressure in the labile stage of hypertension and not in the established stage.

This observation is not consistent with the results of the Boyer (1970) study which showed significant decreases in blood pressure in established primary hypertensives who participated in an exercise program.
CHAPTER III

PROCEDURES

This study will investigate behavioral methods in controlling hypertension, specifically exercise and relaxation training.

The procedures are organized under the following headings: Subject Selection, Source of Data, Pretreatment Procedure, Treatment and Data Analysis Procedure.

Subject Selection

Five subjects were selected, each having met the following prerequisites: (a) the subject must have been stabilized on medication and (b) the subject must have been willing to follow the experimental protocol.

Source of Data

An ordinary mercury sphygmomanometer was used to determine blood pressures.

Pretreatment Procedure

The subjects participated in a three session introductory program at the location of the study, the Cardiac Rehabilitation Institute, Borgess Medical Center, Kalama-
zoo, Michigan. Topics included the physiology of hypertension, physiological responses to stress and relaxation, and the results of previous studies using behavioral approaches to hypertension. Subjects were introduced to a preliminary relaxation technique.

A baseline blood pressure was taken at each of these introductory sessions after a 15 minute rest by a staff member of the Cardiac Rehabilitation Institute.

Each subject performed a graded exercise test to determine his/her maximum heart rate and to assure a nonischemic cardiovascular response to exercise.

Treatment

The subjects participated in a supervised exercise and relaxation sessions 3 times per week for 8 weeks. Blood pressure was recorded before each session.

The sessions consisted of (a) a 10 minute warm-up including stretching and walking, (b) a 20 minute exercise period (walk/jog, stationary bicycle or rowing machine) in which the subjects maintained their exercise heart rate (40-50% of their maximum heart rate calculated by the Karvonen formula), (c) a 5 minute cool down including stretching (d) a 20 minute relaxation exercise in a quiet room.

A tape made by the author was used in the relaxation
segment to instruct the subjects. The subjects were asked to lie down with their arms and legs uncrossed. They were asked to pay attention to their breathing and regulate it to a slow even tempo. Next, the subjects were asked to turn their attention to their feet and let go of any tension there, making them limp and loose and heavy and warm and comfortable. This same relaxation and imagery of heaviness, warmth, comfort, etc. was repeated for the ankles, calves and the rest of the body. Then, imagery of a peaceful lake was described and subjects were given several minutes to enjoy that scene or create their own. A transcript of this relaxation exercise can be found in Appendix A.

The treatment length was 8 weeks. Home practice of mild exercise and relaxation was encouraged. Each subject was given a copy of the relaxation tape.

Data Analysis Procedure

Pre and posttreatment blood pressures and levels of anti-hypertensive medications were compared.
CHAPTER IV

RESULTS AND DISCUSSION

This study investigated the effects of behavioral methods used to control blood pressure, specifically regular exercise and relaxation training on individual hypertensive subjects.

The first part of this chapter will consist of the results of this investigation, reported in case study format, followed by general comments on the subjects as a group.

The second part of the chapter will be a discussion with the following headings: (a) General Discussion (b) Discussion of Contributing Factors in Primary Hypertension (c) Possible Mechanisms of Relaxation Training in Reducing Hypertension (d) Possible Mechanisms of Exercise Therapy in the Control of Hypertension (e) Similarities Between the Effects of Exercise and Relaxation Training.

Guidelines for starting a mild exercise and relaxation program for hypertensives are located in Appendix B.
Results

Case 1

Subject 1 is a 56 year old caucasian female. She started taking anti-hypertensive medication 16 months before the study began (pretreatment levels: 50 mg metoprolol tartate, BID and 50 mg triamterene, 25 mg hydrochlorothiazide, BID). At the same time, she began taking ibuprofen for pain due to arthritis. Subject 1 is overweight and had been on a 1000 calorie diet for 4 months before the study began. She is a supervisor in a hospital and has many demands on her at work. She does have a family history of hypertension.

![Graph showing blood pressure readings]

Figure 2. Blood pressure values for Subject 1

Data

Subject 1: Average pretreatment blood pressure

125/81 mmHg
Average posttreatment blood pressure
114/78mmHg

Medication: Between the first and second post-treatment readings (Fig. 2, points A and B), Subject 1's physician reduced her dosage of metoprolol tartrate by 50%.

Weight Loss: 6 lbs.

Subject 1 had a final blood pressure decrease of 11/3mmHg with the reduction of medication mentioned above.

Discussion

Looking at Figure 2, Subject 1's blood pressure readings levelled out after the third week of the study. This effect could have resulted from the use of the behavioral techniques and/or from her adaptation to the schedule and the routine of the sessions.

Subject 1 had a reduction in anti-hypertensive medication and a reduction in blood pressure. Her weight loss (6 lbs) could have been a major contributing factor in those reductions. Also, during the study, her pain medication was reduced by 50% because she was experiencing less pain.

At the first posttreatment session (Fig. 2, point
A), Subject 1 was involved in a work situation which was a peak of conflict and tension. This was her highest blood pressure reading (124/84mmHg) recorded in the previous 6 weeks. The next day, this conflict was resolved successfully and her medication was reduced. At the next posttreatment session (point B), her blood pressure had dropped significantly (104/72mmHg) despite the reduction of hypotensive medication.

At the end of the study, Subject 1 was very pleased with her progress. She felt that she was more in control of her physiologic responses to her environment and had learned some effective ways to handle stressful situations. Subject 1 worked a 3:00-11:00p.m. shift and at times she found it difficult to get to sleep when she got home. She started to use the relaxation tape at bedtime and subsequently had no trouble falling asleep.

Six Week Follow-up

Subject 1 has been recovering from a bilateral reduction mammoplasty. She is still practicing relaxation. She has had no change in medication.

Case 2

Subject 2 is a 56 year old caucasian male. He began taking anti-hypertensive medication 5 months before
the study began (50 mg triamterene, 25 mg hydrochlorothiazide, BID). He is a maintenance worker at a hospital with a physically active work and recreation schedule. He has no known family history of hypertension.

![Blood Pressure Graph](image)

**Figure 3. Blood pressure values for Subject 2.**

**Data**

Subject 2: Average pretreatment blood pressure
140/90mmHg
Average posttreatment blood pressure
140/90mmHg
Medication: No change
Weight Loss: 1 lb.

**Discussion**

Subject 2 had no final decrease in blood pressure,
however, his posttreatment readings (Fig. 3, points A, B, C) were higher than any of the readings taken in the previous 6 weeks. Perhaps this was related to the fact that he was leaving on a trip for his native country, Holland, just a few days after these last readings. The anticipation and tension involved in getting all the details in order could have contributed to these higher readings.

The peak in blood pressure during week 2 (Fig. 3, point D) corresponded with Subject 2 forgetting to take his medication that day. Figure 3 shows fairly consistent blood pressure readings from week 3 through week 8 at around 130/90mmHg.

Six Week Follow-up

Subject 2 has had no change in medication. He is still using relaxation techniques and reports how beneficial the study was for him. Under direction from his physician, he has almost stopped smoking and is in the process of losing weight. He reports his blood pressure to be 134/88mmHg.

Case 3

Subject 3 is a 26 year old caucasian male. He started taking anti-hypertensive medication 3 years be-
fore the study began (40mg nadolol, QD and 50mg triamterene, 25mg hydrochlorothiazide, QD). He is an x-ray technology student and works at a hospital. He reports a tendency to accumulate tension on the job. He does have a family history of hypertension.

![Graph showing blood pressure values for Subject 3.](image)

**Figure 4.** Blood pressure values for Subject 3.

**Data**

Subject 3: Average pretreatment blood pressure
134/91mmHg

Average posttreatment blood pressure
130/87mmHg

Medication: No change

Weight Loss: 1-1/2 lbs.

**Discussion**

Subject 3 had a small decrease in blood pressure...
(4/4mmHg). Looking at Figure 4, his blood pressure readings from week 3 through week 8 were approximately 125/84mmHg. However, the last two posttreatment readings were somewhat higher (points A and B).

Subject 3 felt that as a result of the study he developed the ability to integrate short relaxation and deep breathing breaks into his workday. He is convinced of the importance of exercise and relaxation and hopes to continue on his own.

**Six Week Follow-up**

Subject 3 has had no change in medication. He has lost 16 lbs. He reports his blood pressure to be 120/70mmHg. He continues to exercise regularly and use relaxation techniques. He feels that the study helped motivate him to take a more active role in his health.

**Case 4**

Subject 4 is a 67 year old caucasian female. She started taking anti-hypertensive medication 14 years before the study began (pretreatment level: 50mg chlorothalidone 3 times/week). She is a medical social worker at a hospital.
Figure 5. Blood pressure values for Subject 4.

Data

Subject 4: Average pretreatment blood pressure
136/84mmHg

Average posttreatment blood pressure
139/84mmHg

Medication: Subject 4's physician had instructed her to reduce her medication on her own if she found she had no edema in her legs and if her blood pressure was under control. By the end of the study, she was taking her medication 1-2 times/week (compared to 3 times/week). This represents a reduction in medication of approxi-
mately 33%.

Weight Loss: 2 lbs.

Discussion

Subject 4 was not able to attend the pretreatment sessions. Consequently, the last three readings taken at her physician's office were used for the pretreatment readings. The office readings were taken at 9:00 a.m. and the posttreatment blood pressure readings were taken at 5:30 p.m. Since this subject's blood pressure was inevitably higher after her workday, this difference probably accounts for the 3 mmHg rise in systolic pressure.

As a result of the study, Subject 4 felt more in control of her blood pressure. She was able to use the relaxation techniques she learned in a variety of situations. For example, in the waiting room of her dentist's office, she felt much more relaxed after practicing a short breathing and relaxation exercise. She also used these techniques successfully when she had trouble sleeping. She finds it especially helpful to practice relaxation at work and also uses it with her patients.

In the middle of week 2 (Figure 5, point A), Subject 4 registered a blood pressure of 168/90 mmHg. When asked
about her day, she reported that a friend of hers had died in the hospital. She didn't consciously feel upset because her friend had been sick for some time and her death was not a surprise. Yet, the weight of the event may have significantly affected her blood pressure.

**Six Week Follow-up**

Subject 4 has totally eliminated her medication. She has not taken any anti-hypertensive medication for 4 weeks. She reports that her blood pressure has averaged 130/78mmHg. She walks regularly and still practices relaxation. A major change from full time to part time work has decreased the amount of stress she experiences.

**Case 5**

Subject 5 is a 47 year old caucasian male. He started taking anti-hypertensive medication 4 years before the study began (40mg propanolol hydrochloride, BID, 50mg hydralazine hydrochloride, BID, hydrochlorothiazide, QD). He is a supervisor at a post office. He does have a family history of hypertension.
Figure 6. Blood pressure values for Subject 5.

Data

Subject 5: Average pretreatment blood pressure
131/96mmHg

Average posttreatment blood pressure
115/84mmHg

Medication: No change

Weight Loss: 5-1/2 lbs.

Discussion

Weight loss and the behavioral intervention probably contributed to Subject 5's significant blood pressure reduction (16/12mmHg). The posttreatment reading at point A, Figure 6, was lower than any previous reading. This may have been due to the combination of his day off and the mandatory 15 minute wait before the baseline
readings were taken. In general, the posttreatment baseline readings should be lower than the blood pressure readings taken during the study because of the 15 minute wait. During the study, the subjects' blood pressures were taken as they arrived. (In checking this subject's medical records, his office blood pressure readings were not as high as the ones recorded during the pretreatment sessions. In fact, during the same period, his blood pressures were recorded at around 120/84mmHg.)

Six Week Follow-up

Subject 5 has had no change in medication. He is still using relaxation techniques. He is particularly impressed with the possibility of using short relaxation and exercise breaks on the job, and may try to implement such a program at work. His blood pressure at his last office visit was 114/84mmHg.

General Comments on the Subjects as a Group

Blood pressure readings for all subjects tended to be lower on their days off except when the day was spent in some frustrating activity (like Christmas shopping). The subjects felt that they had attained a deep sense of relaxation during 75-100% of the sessions. The average compliance for home practice with the tape was 50-75%.
All of the subjects felt that a relaxation break at work would be very beneficial.

Each of the subjects expressed his/her enjoyment in participating in the study and everyone got along extremely well. At the end of each session, the subjects reported a heightened sense of well-being and calmness.

The subjects reported an enhanced ability to relax with the tape after exercise compared to relaxation without exercise.

All of the subjects suggested that the length of the study be extended.

All subjects lost some weight during the study. The loss could have been connected to an enhanced feeling of control resulting from the relaxation and mild exercise or from the fact they knew they would be weighing-in. Only two of the subjects lost enough weight (5-1/2 and 6 lbs) to affect blood pressure.
Discussion

General Discussion

Limits of the Design of the Study

The results of this study are not conclusive due to the single case design. However, they do point to the potential of exercise and relaxation therapy in the treatment of hypertension. Particularly impressive were the positive attitudes of the subjects at the six week followup. Before the study began, the subjects felt they had no active role in relation to their hypertensive condition. After the study, they knew they could affect their blood pressure with specific techniques and they felt more in control of other aspects of their health as well. As a result, they were more encouraged to make healthy lifestyle changes. This observation reinforces the need for optional behavioral programs to complement drug regimens in the treatment of hypertension. If behavioral programs do nothing more than convince the participants of their central role in their own health, they are well worth it.

Contradictory Findings in Behavioral Studies

The blood pressure reductions that hypertensive subjects have experienced in behavioral studies
(specifically exercise programs and relaxation programs) have been inconsistent. There are several reasons for this: (a) Most studies differ in technique, educational instruction and duration and frequency of sessions. (b) Even when two studies employ the same technique, many times the initial values of the subjects' blood pressures in one study are significantly higher or lower than those in the other study. Subjects with higher initial values tend to experience larger reductions in blood pressure (Taylor, Farquhar, Nelson & Agras, 1977). (c) In relaxation studies, the investigator's attitude influences the subjects' responses to the treatment. Some investigators like Patel (1982b), feel it is important to keep the subjects as the primary focus and the technology as accessory. The subjects perceive themselves as central in the process. The subjects' attitudes are particularly important in this type of therapy because the degree to which they feel comfortable and nonthreatened is the degree to which they can attain deep relaxation.

By contrast, many investigators are more concerned with technological efficiency than with their human subjects. This attitude could dampen the effectiveness of the relaxation technique. The environment that the investigator creates undoubtedly effects the responses of the subjects. Henry (1978) notes the difference between
these two approaches:

There is a classic dilemma here which haunts the design of clinical studies. The physician-patient relationship with its curative reorientation of neuroendocrine balance may demand a holistic approach in which the right hemisphere is involved. Practitioners who can induce a strong placebo effect transmit their confidence in themselves as well as the prescribed treatment. By contrast, a regimen that demands scientific precision could lose therapeutic effectiveness. (p. 274-275)

Treatment Effects: Men vs. Women

Patel (1982b) made the observation that overall, women tend to show more improvement in blood pressure control as a result of relaxation training than men. In this investigation, two women and three men were studied. Both women reduced their drug requirements, none of the men had a change in medication. One man showed a significant decrease in blood pressure, one man had a small reduction in blood pressure and one man showed no change. Taken collectively, the women responded more favorably as a group than the men. Perhaps differences in brain function are relevant here. There is evidence that the brains of males and females are organized differently. The male brain seems to be more laterally differentiated and highly structured compared to the female brain which tends to be more symmetrically organized and less tightly structured. While confronting a task, men tend to be more narrowly focused and less distractable. Women tend
to be more contextually oriented and able to process incidental information (Levy, 1982). Perhaps women respond more favorably to relaxation training because they are better able to integrate relaxation into their lives. For example, during daily tasks, perhaps women are able to monitor their levels of tension more effectively due to their ability to maintain body awareness and task awareness at the same time. Since the first step toward conscious intervention during a stress response is body awareness, the suggested enhanced ability to monitor tension by women could be significant.

Discussion of Contributing Factors in Primary Hypertension

Selected Physiological Aspects of Primary Hypertension

A brief description of some of the physiological changes that occur in primary hypertension will be given before the possible mechanisms of its reversal are discussed.

There is great controversy concerning the initiating factors in primary hypertension. The two basic perspectives can be described as (a) the "kidney perspective" whose supporters view that genetic alterations in renal sodium handling constitute a major "trigger" in primary hypertension, and (b) the "brain perspective" whose sup-
porters view that central nervous system control of pres-
sure, volume and heart rate along with autonomic system
reactivity to environmental stimuli and consequent neur-
ohormonal activity are involved in major "trigger" events
in primary hypertension.

The physiological aspects of hypertension, including
the perspectives mentioned above, are thoroughly discus-
sed in an enlightening article by Folkow (1982). Despite
the controversy concerning the initiating factors, Folk-
ow outlines the basic interrelated causative factors in
primary hypertension that have been agreed upon gener-
ally: (a) a polygenetically transferred predisposition
(b) environmental factors (psychoemotional stimuli and
habitual salt intake) which reinforce, or perhaps even
precipitate, the manifestations of the hypertensive pre-
disposition and (c) secondary adjustments, particularly
early structural adaptation of heart and vessels, which
may also be genetically reinforced. The first two fac-
tors which interact as trigger elements would likely be
less important if they did not gradually initiate the
third. Once the structural changes begin to take place,
physical factors are able to maintain a chronic hyperten-
sive state so that initial triggers may be hard to iden-
tify.

In rats, high levels of blood pressure need not be
maintained for a prolonged period of time in order to initiate hypertrophy of heart tissue. Investigators have shown that as early as 48 hours after producing hypertension in rats, there is biochemical evidence of increased cell metabolism leading to hypertrophy. The changes include an increase in RNA and protein synthesis by myocardial cells and an increase in DNA and collagen synthesis by the interstitial cells of the myocardium (Koide & Rabinowitz, 1969).

Epidemiological Factors

Cultures with habitually low salt intake (Page, 1976) and cultures with preserved traditional lifestyles, values and close family ties (Henry & Cassel, 1969) tend to have lower, and more constant, blood pressure with age when compared to industrialized societies. These populations, however, tend to lose their lower blood pressures when they begin to live within the Western society framework. This point suggests that the genetic predisposition for primary hypertension in humans is, in many cases, not sufficient to serve as a trigger and that environmental influences are necessary for the predisposition to manifest itself.

The problem in looking for more specific causes form the epidemiological perspective is that when these
populations from stable traditional environments come in contact with modern society, they experience both an increase in salt intake and emotional strain because of severe changes in habits, different values and an accelerated pace of living.

**A Multifactorial Approach**

As a result of the complexity of this issue, the only reasonable way to approach the problem of primary hypertension is with a multifactorial perspective. For the purposes of this study, however, only neurogenic mechanisms will be discussed because they seem more likely to be directly affected by relaxation and mild exercise than renal mechanisms.

**Neurogenic Factors**

One observation which seems consistent with central nervous system mediation of primary hypertension is that often, the hemodynamic pattern of early human hypertension (increased cardiac output, heart rate and blood pressure) is very similar to that of a mild defense reaction. This pattern would include increased sympathetic activity in heart, renal and splanchnic vascular beds but not in skeletal muscle vascular beds (Brod, 1962).

However, neurogenic factors are hard to quantify
because the interaction of the nervous and neurohormonal control of the cardiovascular system in the central nervous system is so great and because methods of acquiring accurate information about specific autonomic functions have not been clearly identified.

For example, one confusing topic has been the correlation between increased sympathetic nervous system activity and increased plasma norepinephrine levels. The major neurotransmitter for autonomic neurons is norepinephrine. It is presumed that if sympathetic nervous system activity increases then the "washout" of norepinephrine from the synaptic terminals will be increased and can be measured in plasma. The results from studies measuring plasma norepinephrine levels in hypertensives have been contradictory. This ambiguity has caused some skepticism about the role of the sympathetic nervous system in primary hypertension, however, the assumption that plasma norepinephrine levels are true indices of sympathetic activity needs to be examined more closely. As mentioned before, sympathetic activity to the large muscle vascular beds is not increased in early human hypertension which would be a major source of plasma norepinephrine. Sites of increased sympathetic activity, mainly the heart and kidneys, even if greatly stimulated would account for a much smaller percentage of total plasma
norepinephrine.

Folkow (1982) illustrates this point with the observation that provoked defense reactions in humans with significant neurogenic increases of blood pressure and cardiac output did not cause a substantial rise in plasma norepinephrine levels, whereas they rose considerably in the same subjects after tilting (Hjemdahl & Eliasson, 1979). Tilting is known to produce widespread reflex vasoconstriction especially in skeletal muscle (Abboud, Heistad, Mark & Schmid).

Another researcher found that the concentration of norepinephrine in cerebrospinal fluid was higher in humans with primary hypertension compared to normotensive controls, while the concentration of plasma norepinephrine in the subjects of both groups was similar (Lake, 1981). The proposed explanation was that the areas of the brainstem thought to be directly involved in regulation of blood pressure are heavily innervated with neurons containing norepinephrine. Cerebrospinal fluid should reflect noradrenergic neurotransmission in cardiovascular regulatory centers because they are anatomically adjacent to cerebrospinal fluid. Since norepinephrine does not cross the blood brain barrier, measurements of plasma norepinephrine would not reflect cerebrospinal fluid levels of norepinephrine. So, yet another explana-
tion is possible, i.e. if a common abnormality exists for
norepinephrine neurotransmission in primary hypertension,
it may be evident in the central nervous system, not the
peripheral nervous system.

Hemodynamic analysis has proved to be a more accu­
rate indicator of increased sympathetic activity in human
borderline hypertensives. A growing body of literature
involving this technique points to the common participa­
tion of an increased sympathetic drive on the cardiovas­
cular system in early human hypertension. Studies using
strains of spontaneously hypertensive rats suggest that
this element may be genetically linked (Folkow, 1982).

Folkow and Rubinstein (1969) showed that weak topi­
cal stimulations of the hypothalamic defense area in rats
induced an alerting response which was regularly
accompanied by blood pressure and heart rate increases,
increased muscle blood flow and decreased renal and gas­
trointestinal blood flows. When these weak intermittent
stimulations of the defense area were continued for 12
hours daily during approximately 4 months, the blood
pressure of a stimulated group of rats gradually rose to
become significantly different from controls. The stimu­
lations were interrupted for 2 weeks and the blood pres­
sures of the previously stimulated rats approached the
pressure levels of the controls. When stimulations
started again, the blood pressure levels of the rats were raised to the level just previous to the 2 week interruption.

Many factors interact to create the increase in blood pressure including increased secretion of adrenocortical hormone, catecholamines and aldosterone, hormonally mediated effects on the water-salt balance (and therefore blood volume) and alterations in membrane permeability effecting the reactivity of smooth muscle and nerve cells.

Another factor in hypothalamic stimulation induced hypertension may be the resetting of cardiovascular proprioceptor reflexes and baroreceptor nerve endings in response to persistent increases in blood pressure. Normally, arterial baroreceptors would mediate a reduction in heart rate (and therefore a reduction in cardiac output and blood pressure) if a blood pressure increase occurred. However, it has been shown that in cats, hypothalamic activation during a defense reaction interrupts the baroreceptor mediated cardiac inhibition allowing increases in cardiac output, heart rate and blood pressure to be maintained (Gebber, 1970).

A question comes to mind, "Why does hypothalamic stimulation inhibit the cardiac reflex?" Logically, the only reason for the body to allow abnormally high blood
pressure, cardiac output and heart rate during a defense reaction is to prepare for exercise. In other circumstances when blood pressure may rise, for example when the body changes position, it is instantaneously regulated within the normal range. However, if the body is signalled to be on the alert for "fight or flight", then blood pressure, heart rate and cardiac output increases are tolerated in order to "prime" the skeletal muscles for the anticipated exercise state. If we were to "act out" our defense reactions by exercising, the following vasodilation would tend to curtail pressor bouts and perhaps minimize the neurohormonal discharge by reducing the mental charge (Folkow, 1982). If the body does not anticipate exercise, then there would be no reason for the rise in blood pressure, heart rate and cardiac output.

Our cardiovascular response to a threat is not the problem. In fact, our defense reaction is a significant physiological mechanism which may have saved us from extinction when we had to fight or flee for our lives. The problem is our unconscious and inappropriate use of that defense response in our daily affairs (and our subsequent denial of exercise which we have instructed our bodies to prepare for), creating among other effects, temporarily increased blood pressure. This contradictory behavior is
...a bit like pressing on the gas pedal and the brakes of a car at the same time. The harmful effects of these inappropriate physiological responses manifest when frequent increases in blood pressure are tolerated by those predisposed toward hypertension and adaptive changes in the left heart and arterial walls are allowed to take place.

Another clue that points to primary central nervous system involvement in hypertension is the action of antihypertensive drugs themselves. Many hypotensive drugs may act through the central nervous system and are thought to have various effects on sympathetic nerve transmission such as depleting storage of norepinephrine, inhibiting norepinephrine reuptake, blocking receptor sites, etc. Vasodilators reverse the vasoconstricting effects of sympathetic activity in the vessels. Diuretics have no known central nervous system effects.

There have been several reports of a specific natriuretic hormone that causes prolonged diuresis and increased sodium excretion (Blaustein, 1977; DeWardener, 1980). Major stimuli for release of this plasma factor seem to be volume expansion or volume centralization of a normal blood volume. The natriuretic hormone is presumed to originate in the central nervous system and act to slow down electrogenic sodium-potassium membrane pumps. Higher intracellular concentration of sodium in the kidneys
causes tubular sodium reuptake to be reduced, favoring volume reduction. However, this same effect on arteriolar smooth muscle cells and sympathetic neurons could increase their excitability. Arteriolar smooth muscle activity is determined by intracellular calcium concentration. Intracellular sodium increases inhibit a calcium-sodium exchange that normally moves calcium out and sodium into the cell (Reuter, Blaustein & Haeusler, 1973). Therefore, intracellular calcium concentration is increased and smooth muscle tension is enhanced.

Possible Mechanisms of Relaxation Training in Reducing Hypertension

One possible way in which relaxation could effect blood pressure is by decreasing the sensitivity of the central hypothalamic response and thereby reducing overall sympathetic activity. This reduction in sympathetic activity would allow significant physiological changes to take place such as reduction of heart rate, cardiac output and respiration rate, vasodilation in skin and viscera, synchronization of electroencephalogram patterns and muscle relaxation, all of which contribute to decreasing blood pressure levels.

As mentioned before, many of us regularly elicit mild defense reactions as we are "on the alert" while
driving, making decisions, working, worrying, hearing the news, etc. We load our autonomic system with messages of "readiness". Often there are no clear cut targets of our "readiness" and we exist in a free-floating chronic state of tension with no significant interruptions. Over a period of time, and with the right genetic predisposition, our whole cardiovascular system may accelerate its pace to try to accommodate this perpetual arousal. The natural endpoint to the arousal is exercise, but since we rarely act out that endpoint, the effects of the "alert" responses accumulate. Our reactions to less significant events become exaggerated and help to maintain this hypermetabolic state.

Relaxation can interrupt this chronic pattern of tension and can return the body to a baseline level of low arousal. The cumulative effects of stress are dampened and our response to events which previously could reinforce a tension state, now cannot.

An important question about relaxation training is whether the beneficial treatment effects remain specific to the laboratory setting or whether they are carried over to other life situations. It appears that creating an endpoint to tension states by returning to a low arousal baseline level periodically through relaxation can affect blood pressure in other life situations, in-
cluding sleeping. Agras (1980) found that hypertensive patients who practiced relaxation three times per day on particular days, recorded lower blood pressures while asleep on those particular nights.

Without intermittent calibration of the autonomic system, the cardiovascular systems of people with a predisposition toward hypertension can eventually become hypersensitive and more easily shifted to an aroused state. It had been shown that hypertensive subjects react with larger blood pressure increases and greater recovery times when exposed to forced mental arithmetic or the cold pressor test (a stress inducing test in which the subject's hand is immersed in ice cold water) compared to normotensive subjects (Brod, Fencel, Hejl & Jirka, 1959).

Patel (1977) showed that hypertensive patients could learn to control exaggerated blood pressure increases during stressful episodes. Two randomly assigned groups of hypertensive subjects were subjected to the cold pressor test. Both groups responded with similar rises in blood pressure. After 6 weeks of relaxation training, the treatment group responded to the second cold pressor test with significantly smaller increases in blood pressure and recovery times. One explanation is that this group became familiar with the task and therefore
elicited a less significant pressor response. However, the control group responded with a blood pressure increase even greater than their initial one. Apparently, the behavioral intervention helped the subjects reduce their level of anxiety toward the stimulus whereas the control group has not learned how to disengage from a pattern of tension and anxiety associated with the stimulus.

Breathing techniques, muscle relaxation, mental focusing and a positive outlook are major components of Patel's relaxation training technique. Certain breathing patterns tend to correspond with certain physiological and emotional states. When we are tense or angry, our breathing becomes erratic. When we are calm, our breathing is slow and regular. By consciously practicing slow and rhythmic breathing, we can encourage the interruption of a chronic tension state. An increase in muscle tension (which is actually isometric exercise) is one symptom of being in an "alert" state. If this state is not followed by its intended counterpart, dynamic exercise, then unrelieved muscle tension can affect blood pressure. Isometric exercise has been shown to cause exaggerated elevations of blood pressure for the amount of work done (Lind, Taylor & Humphreys, 1964). The conscious relaxation of muscles could dampen the severity of a stress re-
response and again help interrupt the accumulation of symptoms from stress. In animal experiments, it has been shown that if proprioceptive impulses are reduced by the administration of curare, the rise in blood pressure upon electrical hypothalamic stimulation is reduced (Gellhorn, 1958).

Relaxation is similar to a circuit breaker, discharging the accumulated effects of daily stress responses. It quiets our exchange with the stimulus packed environment and encourages us to shut down our overworked alarm system. The body sinks into a hypometabolic, calm state (characterized by lower blood pressure, decreased heart rate, etc.) where a sense of internal awareness is developed. Ideally, we are able to reexperience this internal awareness during our daily activities through brief relaxation, breathing or focusing techniques. Presumably, by regularly shifting our attention to this internal awareness, and eliciting the accompanying physiological changes, we will lose some of our reactivity to stressful stimuli and perhaps decrease the frequency of pressor responses.

The pressure load on the left ventricle and vessel walls is neither a resting pressure nor an occasional peak of pressure, but an integrated average pressure over long periods. If frequency, intensity and duration of these pressor responses could be reduced, the cumulative benefit over a number of years could be very substantial. (Patel, 1982a, p. 8)
Finally, the practice of relaxation could have the effect of decreasing blood volume centralization thereby decreasing natriuretic hormone activity. Sodium-potassium pump activity would not be hampered and the sodium-calcium exchange would be allowed to function normally. Consequently, intracellular calcium levels which control muscle contraction would not be increased. In addition, if, as a result of relaxation, free calcium levels are reduced by migration to the sarcoplasmic reticulum in skeletal muscle cells (and perhaps smooth muscle cells) then perhaps this decrease in free calcium could affect intracellular sodium levels and/or sodium excretion in general.

Possible Mechanisms of Exercise Therapy in the Control of Hypertension

The specific training effects from exercise in this study are presumed to be very limited. The reasons for this are two-fold: (a) the intensity of the exercise performed (approximately 40-50% of maximum heart rate, calculated by the Karvonen formula) is at the very low end of the range where training effects take place and (b) the frequency and length of exercise at this low intensity was not sufficient to produce any significant training effects. However, the supportive role of exer-
cise before the relaxation was important in bringing about these changes in the body: (a) vasodilation of vessels in muscle and skin, (b) slight blood pressure reduction just following exercise, (c) development of a kinesthetic sense; i.e. getting one's mind off issues of the day and focusing on one's body, and (d) reduction of skeletal muscle tension (DeVries, 1968).

These bodily conditions are significant because they provide a transition from daily activities to a relaxation state. Jacobsen (1939), a pioneer in relaxation therapy, discovered that small blood pressure reductions in hypertensives initially occurred with large reductions in muscle tension until a critical point. At that point, any small reduction in muscle tension corresponded with a large reduction in blood pressure. Thus, using exercise to bring about favorable physiological changes toward relaxation like lower muscle tension, vasodilation, etc. could help people reach that critical point sooner or perhaps could make the difference in reaching that critical point at all. In agreement with this suggestion are the subjects' reports of a definitely enhanced ability to relax after exercise compared to relaxation without exercise.

Although this study did not use exercise at an intensity great enough to produce training effects, I
would like to discuss the effects of exercise including training effects which may be relevant to blood pressure control.

Training can improve the efficiency of the cardiovascular system. One of the effects of training is the ability of the heart to respond to moderate stress by increasing stroke volume initially rather than increasing heart rate (Chapman, 1965). This type of response is associated with a release of smaller amounts of adrenaline than would occur with increased heart rate and does not lead to a stress associated cue, a racing heart. This hemodynamic adjustment as a result of training becomes significant when it is observed that tachycardia and cardiac arrhythmias are associated with activities such as routine tasks (Hinkle, Carver & Stevens, 1969), delivering a speech (Taggart, Carruthers & Somerville, 1973), taking a quiz (Schiffer, Hartly, Schulman & Abelmann, 1976) and driving in traffic (Bellet, Roman, Kostis & Slater, 1968).

Bradycardia is another training effect that may help the cardiovascular system function more efficiently during stress. Proposed explanations for the bradycardia exhibited as a result of training include (a) trained rats have more cardiac bound non-neural acetylcholine (or other cholinergic substance) available than do control
animals (Taylor & Tipton, 1965), and (b) decreased sympathetic stimulation of the heart causes a reduction of resting heart rate from training. There is evidence of decreased catecholamine concentration in the myocardium of trained rats (DeSchryver, DeHerdt & Lammerant, 1967) and decreased secretion of catecholamines by the myocardium in man after training (Cousineau, Ferguson, deChamplain, Gauthier, Cote & Bourassa, 1977).

Skeletal muscle response to training include hypertrophy, increased vascularization and increased capacity to generate ATP aerobically. The more efficient use of oxygen by the muscles permits the heart to supply adequate oxygen to muscles that are working harder without working harder itself.

All of these changes are very important benefits of exercise. However, in relation to hypertension, they may not be the most important benefits. I suggest that one of the most important effects of exercise as it pertains to hypertension is that it relieves the system of the accumulated effects of pre-exercise arousal. The importance of the post-exercise state of muscle relaxation, vasodilation, temporary decrease in blood pressure, regular breathing and renewed mental attitude, has been overlooked. It is here in the physiological calm after the storm of exercise that our nervous,
circulatory, hormonal and muscular systems are allowed to self-regulate.

To illustrate this point, consider the following analogy using a fictitious character, "Harry". Suppose Harry gave his body the message that he was going to sit down. His body would respond with appropriate messages to the knee and ankle joint to start to flex, to the quadriceps to extend, to the hamstrings and gastrocnemius muscles to flex, to the hip joint to flex, etc. But suppose Harry didn't sit down, and his body was left in the "get ready to sit down" position. Gradually his body would return to its initial position of normal posture if it didn't receive another message to "get ready to sit down". However, suppose he kept signalling his body to "get ready to sit down" but he continually refused to sit down. He wasn't really doing this consciously, but whenever he saw a chair, his primitive brain center reacted by sending the signal, "get ready to sit down". Eventually his knees began to show signs of chronic flexion, his quadriceps became chronically tense and an imbalance in his posture was created that his whole body had to adapt to. At that point, his body had lost its usually automatic ability to regulate its own posture and maintain a normal standing position. Now he was ready for the world of muscle relaxants, tranquilizers, pain
relievers and a host of other drugs that would help him live with the symptoms of his abnormal state. However, suppose Harry started a regular sitting program and he practiced sitting every day. Sitting has many important benefits of its own, but for Harry, perhaps the most important benefit is that after he sits down, it is easier for him to stand up straight again. In other words, because he had followed through with the intended action, sitting, he could return more easily to an initial baseline position of standing. Now, he wasn't able to achieve perfect posture right away, but as he kept up with his sitting program (and subsequent standing), the structural problems had a chance to correct themselves. His regular sitting eliminated the build-up of uninterrupted messages of "get ready to sit" and relieved the somatic consequences of those messages. In addition, Harry learned techniques that helped him regulate his posture without sitting. He began to be aware of his body when it was unbalanced and could consciously readjust his position.

In this example, "sitting" represents exercise. The "get ready to sit" message represents the "get ready to exercise" or the defense reaction. Exercise is an important way for the body to self-regulate, by providing an endpoint to arousal messages and allowing the body to
return to a lower arousal baseline state.

There are scores of studies documenting the mental benefits of regular exercise, including reduction in anxiety (Karbe, 1975), tension (Cureton, 1953), depression and hostility (Folkins, Lynch & Gardner, 1972), more restful sleep (Baekeland, 1970) and enhanced self confidence (Folkins, Lynch & Gardner, 1972). All of these benefits serve to bolster one's resources needed to deal with stress and tension, and therefore reduce one's tendency toward feeling threatened and eliciting the consequential physiological response. In this way, the effects of exercise could influence blood pressure by reducing the frequency of defense reactions and eliminating the debilitating accumulation of those that do occur.

**Similarities Between the Effects of Exercise and Relaxation Training**

Referring to Harry's situation, the ability to correct his posture without sitting down represents relaxation. To develop this ability, Harry needed to learn to be aware of his abnormal posture and then learn to consciously readjust the body parts that were out of line. Either way the situation was handled, by sitting down and then standing up, or by just readjusting his posture, the result was the same, i.e. he returned to a
baseline standing position. Similarly, I contend that exercise and relaxation both serve to return the body to a low arousal baseline state.

In fact, the post-exercise state and the relaxation state have physiological similarities (vasodilation, decrease of muscle tension, decrease in blood pressure, etc.). It is no surprise that breathing techniques, meditation and relaxation have been reported to produce many of the same mental benefits already mentioned from exercise, namely reduction in anxiety (Linden, 1973), tension (Benson, 1975), depression and hostility (Luthe, 1969), more restful sleep (Stough, 1970), improved concentration (Lindemann, 1973) and enhanced "self-actualization" (Nidich, Seeman & Dreskin, 1973).

The combination therapy used in this study attempted to prolong and deepen the relaxation of the post-exercise state, and encourage conscious awareness of that experience. In Harry's case, this would be similar to sitting down (exercising), standing up as straight as possible (self-regulating from exercise) and then consciously balancing and readjusting his posture to achieve the most stable, efficient position possible (further self-regulation through relaxation).

Both exercise and relaxation alone are important for practical reasons. It is not practical, possible or
desirable to exercise every time a mild defense reaction is experienced, whereas practicing a short relaxation exercise in the dentist's office or in the car may be appropriate. Also, relaxation training increases awareness of responses to stressful stimuli making conscious intervention possible. Exercise, on the other hand is a vitally important way to interrupt chronic arousal as well as a way to keep the cardiovascular, musculo-skeletal and nervous system functioning efficiently.

These two behavioral methods for encouraging self-regulation are natural complements to each other. Each serves to enhance the ability to perform the other. Sports teams are beginning to introduce relaxation and meditation into their practice regimens to enhance performance and by exercising, an ideal physiological state is created for practicing deep relaxation.
CHAPTER V

SUMMARY, IMPLEMENTATIONS, CONCLUSION AND RECOMMENDATIONS

Summary

This study has investigated the possibility of using behavioral methods, specifically exercise and relaxation training sessions, in the treatment of hypertension. Five subjects (three men and two women) were used in a single case study experimental design. Three pretreatment baseline blood pressure readings were taken at three introductory educational sessions. The intervention consisted of one hour mild exercise and relaxation sessions, 3 times per week for 8 weeks. Three posttreatment baseline blood pressure readings were taken in the ninth week.

Two subjects were able to reduce their anti-hypertensive medication. One subject had a significant blood pressure reduction, one subject had a small blood pressure reduction and one subject showed no change. At the six week follow-up, all the subjects maintained their posttreatment blood pressures or recorded lower readings. One subject who had reduced her medication during the study had totally eliminated her anti-hypertensive medication. Another subject had lost 16 lbs at the six week

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follow-up. Each of the subjects felt very positively about the program and hoped to continue practicing the techniques they had learned.

Implementations

Behavioral programs designed to help people with hypertension control their blood pressure should be available to those who want them. It is through these types of programs that people begin to understand the central, active role they play in their own health.

The techniques are simple, they do not require special equipment, and they incur minimal costs. Unlimited possibilities for implementation of these types of programs exist in health care settings, factories, businesses, etc.

Conclusion

This study shows the potential of exercise and relaxation training to help people with hypertension control their blood pressure more effectively and perhaps reduce their need for medication.

The discussion section described the body's overworked alarm system as one possible factor among many that interact to manifest the human hypertensive state. The role of the kidneys in primary hypertension has not
been elaborated in this paper, however, its absence does not imply that alteration of renal function is any less than a major factor in many cases of hypertension.

The investigator's thoughts about our inappropriate responses to our environment are summarized by Malmo (1975):

Nature seems to have designed the cortical hypothalamic midbrain mechanisms for emergencies of relatively short duration. Among mammals, it is man who has managed to produce long stressful periods for himself. (p. 95).

I would like to close with the observation that we, in the Western industrialized world too often respond to the competitive, sensory loaded, uncertain environment we have created by chronically existing in an unnatural, in-between state: not relaxed, but not exercising. No wonder problems of physiological regulation abound. We must learn along with "Harry" to get out of our half crouched position and sit down, or stand up...or better yet, do both!

Recommendations for Further Research

Many more studies relating behavioral modification to the improvement of hypertension are needed before behavioral programs will be integrated into the mainstream of modern medicine.

A suggested study is one the investigator had
originally proposed for this master's thesis which included four groups of hypertensives: one exercise therapy group, one relaxation training group, one combination exercise and relaxation training group and one control group. Unfortunately, time and money were not of abundance and the proposal was dropped.

Single case studies and group studies are both important. Single case studies are important because they can give clues as to what techniques are suitable for certain types of subjects. Also, they give insight into the individual circumstances and attitudes that may influence responses to treatment. Group studies are very important because the results can be generalized back to the specific population from which the subjects were sampled. Subjects matched on as many variables as possible are desirable. Control group procedures should be carefully designed so that type, length and number of assessment sessions are identical to other groups.

For both single case and group designs, if possible, baseline blood pressure readings should be taken until they stabilize. Also, within session and across session blood pressure measures are desirable. Home practice frequencies and follow-up data should be reported.

Work situations seem to be ideal sites for training since many people experience extreme tension at work.
Many more studies involving behavioral intervention in the workplace are needed. Also, more studies incorporating "stress tests" (mental arithmetic, etc.) are needed to clarify the role of behavioral intervention in improving responses to stressors.

Finally, more studies investigating the carry over effects of behavioral methods in the treatment of hypertension are critical because if the effects do not generalize to real life situations, they cannot impact the average daily pressure load on the cardiovascular system.
APPENDIX A

TRANSCRIPT OF THE RELAXATION EXERCISE
"Let's begin. Make sure your head is in a comfortable position, your arms and legs are uncrossed and your palms are facing up. Once you're comfortably settled, take a slow moderate breath into your lungs and as you exhale, just quietly think to yourself, letting go, letting go.

Keep breathing comfortably. Each time you exhale feel all of the tensions, pressures and strains beginning to flow out of your body. Allow the air to come easily into your lungs and as you exhale, quietly think, letting go, feeling your whole body beginning to settle even more deeply into your relaxed, comfortable position. Let your stomach rise comfortably as you inhale and fall comfortably as you exhale.

Inhale slowly and this time as you exhale, say to yourself, 'I am calm.' Begin to find a calm place within you and center yourself. Feel yourself balanced and secure. For the next few moments, stay in this calm place within you and also pay attention to your breathing. Be aware of the cool air coming into your nose and the warm air going out of your nose. If you notice that your mind tends to wander to other thoughts, very gently bring your attention back once more to your breathing, feeling the cool air coming in and the warm air going out of your nose. Be aware of your breathing as you focus on
yourself. Begin to remove your attention from the world around you to spend these few moments simply with yourself, relaxing and enjoying every moment. (Pause 1 minute)

Now we're going to travel the length of your body with a wave of letting go. As we move through each area of your body, focus your attention on that area and be aware of any sensations that develop.

Let's begin with your feet. Make mental contact with your feet. Be aware of any tenseness in that area and quietly think to yourself, letting go. Let all of the muscles in your feet become limp and loose and heavy and warm and comfortable. With each exhalation you can feel the tenseness and tightness flow out of your body. Your toes, balls of your feet, arches, heels and tops of your feet are now very relaxed and comfortable. Let this wave of relaxation move up to your ankles, your calves, your shins and your knees. Feel any tightness in your lower legs disappear as you quietly think to yourself, letting go, letting go.

Now the wave of letting go begins to move up through your knees to the muscles just above your knees and to your thighs. Feel the relaxation growing as both your legs become limp and loose and heavy and warm and comfortable. Quietly think to yourself, letting go, letting
And now the wave of letting go begins to move to your buttocks and the lower part of your abdomen. If you feel any tension in these areas, gently release it. Safely, securely and comfortably, letting go...safely, securely and comfortably, letting go.

The wave of deep relaxation now penetrates the lower part of your back around your waist to your stomach. All of the tightness stored in your back and stomach now flows out of your body with each exhalation. Limp and loose and heavy and warm and comfortable. Safely, securely and comfortably, letting go, letting go.

Now the whole lower half of your body is in a state of deep relaxation.

Focus on the very bottom of your spine. Let your spine relax, vertabrae by vertabrae, as your back merges with the floor.

The wave of letting go continues to flow upward into the higher areas of your back and into your chest. All of these muscles now become limp and loose and heavy and warm and comfortable as you quietly think to yourself, letting go.

Now the wave moves out toward your shoulders and you might even feel them drop a bit as the wave of letting go helps all those muscles become limp and loose and heavy.
and warm and comfortable.

The wave of relaxation flows into your upper arms, down through your elbows to your forearms and wrists. Make mental contact with your hands as you release all the tightness in your wrists, palms, thumbs, fingers and the backs of your hands. Now your arms and hands are limp and loose and heavy and warm and comfortable.

Now that wave of letting go penetrates your neck. Feel all the muscles in your throat and all the little muscles in the back of your neck begin to let go. Safely, securely and comfortably, letting go, letting go.

As the wave of letting go flows up over the top of your head, you can feel your scalp muscles becoming smooth. You are aware of the area around your ears and around your hairline as your whole scalp becomes limp and loose and heavy and warm and comfortable. Safely, securely and comfortably, letting go.

Now the wave of relaxation moves into your forehead. All the tenseness and tightness in your forehead flow out of your body with each breath. Your forehead is smooth and relaxed. The areas around your eyes now begin to let go and even your eyelids are very gently shut and relaxed. The wave continues to flow toward your nose and cheeks. Let all these facial muscles and the skin covering them become limp and loose and heavy and warm.
and comfortable. The area around your mouth softens as you let go of any tension there. Now you feel the wave of letting go moving into your jaw and chin. Your lower jaw drops slightly as the muscles supporting it begin to let go. And inside your mouth, your tongue is also letting go and is sort of floating there in your lower jaw. Safely, securely and comfortably, letting go.

Spend just a few moments with yourself now, enjoying the feeling of totally letting go and being aware of the healthy sensations that can arise when you let go in such a comfortable, safe and secure way. (Pause 1-2 minutes)

Imagine, a clear, calm lake. The sun is shining quietly down on it. The lake is your mind, peaceful, tranquil. The lake is very deep and you can see quite far down into it, but you cannot see the bottom. This depth is your soul.

Most of the time, the lake is full of choppy waves caused by endless distractions and details. The sun cannot penetrate it. But now, all the disturbing ripples caused by bothersome thoughts have disappeared and the surface of the lake, your mind, is smooth and serene. The sun shines through it easily, effortlessly. Its warm light nourishes and re-energizes the deepest parts of you.

For the rest of the time we have, experience this
openness, calmness and clarity as you breathe in tranquility and peace, and breath out tension and distraction. (Pause about 7-8 minutes)

Slowly and gently collect yourself. Take a little time to return your attention to the world around you, keeping that relaxed feeling inside."
APPENDIX B

GUIDELINES FOR A MILD EXERCISE AND RELAXATION THERAPY PROGRAM FOR HYPERTENSIVES
I. Supervision
   A. If you are not a physician, I suggest that you find a physician to supervise the program.
   B. You must have medical approval for the program.

II. Location
   A. For the exercise portion, a gym is ideal because there is room to walk, run, stretch, etc. However, any large room is adequate.
   B. For the relaxation portion, a gym can also be used if light from the windows is not distracting and if it is quiet enough.
   C. You may want to provide mats or blankets.
   D. The location may limit the number of participants.
   E. The exercise and relaxation portions of the program should take place in the same building.

III. Participants
   A. The program can be aimed at a certain subgroup of hypertensives (e.g. labile hypertensives) or open to all hypertensives.
   B. There is no theoretical limit to the number of participants providing there is space available, however, I suggest starting with a small group (8-12 people).
C. Permission must be obtained from each participant's personal physician before he/she enters the program. Medical histories should be reviewed so that all the medical problems of the participants are known.

D. Records of the participants' present medications should be kept at the location of the program in case of an emergency.

E. I suggest screening the participants to include only those who are sincerely interested and willing to commit themselves to a minimum number of sessions.

IV. Length of Program

A. I suggest 2 or 3 sessions per week for at least 8 weeks, preferably 12 or 16 weeks.

B. The total number of session should be greater than 24.

V. Preliminary testing

A. If you are planning to use low intensity exercise (40–50% of maximum heart rate), then a graded exercise test may not be necessary. The step test (McArdle, Katch & Katch, pp. 147-149) can be used as an alternative.

B. If you are planning to use more intense levels of exercise, (55–85% of maximum heart rate),
then the participants should undergo a graded exercise test (electrocardiogram stress test). High intensity exercise creates the problem of sweating and might complicate the following relaxation procedure if some participants have to shower, etc.

C. Exercise heart rate is calculated by the Karvonen formula:

\[
\text{ExHR} = (\text{MaxHR} - \text{RestHR}) \times 0.50 + \text{RestHR}
\]

D. Be sure to consult the supervising physician and the personal physicians of your participants for their opinions on exercise testing.

E. Baseline blood pressure readings should be recorded.

VI. Educational sessions

A. Educational sessions are important. There can be just one session or several sessions. They should include:

1. The aim of the program.
2. Complete details of the mechanics of the program.
3. Practice time in which the participants learn to take their own heart rates,
either from the carotid or radial pulse. The beats per 10 seconds is the easiest way to note the heart rate.

4. Assignment of individual target heart rates given in beats per 10 seconds.

B. In the present study, the educational sessions (3) included the following points and materials:

1. All of our systems, physical, emotional and mental are connected. (An excellent movie on this subject is Understanding Stresses and Strains produced by the Upjohn Co. and Walt Disney.)

2. We have or can develop more control of our internal processes than we think (Miller & DiCara, 1970).

3. A rise in blood pressure with age is not necessarily normal. Some societies do not show significant increases in blood pressure with age (Henry & Cassel, 1969). Compare lifestyles.

4. Modern life may present more uncertainty in human relationships (Ostfield, 1967), isolation and vulnerability which may trigger more frequent "defense" or
"alert" reactions.

5. Physiology of the defense or flight or flight reaction (Canon, 1939).

6. Hypertensive people have exaggerated blood pressure responses to stress and longer recovery times (Brod, 1959).

7. Tempering this blood pressure responsiveness and consistently returning the body to a low arousal state can lead to lower blood pressures (Patel, 1975).

V. Behavioral Program

A. Each session should include these activities:

1. Blood pressure recording

2. Warm-up (8-10 min)
   a. joint flexibility exercises
   b. short period of mild dynamic activity (e.g. walking).
   c. static stretching
   d. pay specific attention to the hamstrings, quadriceps, gastrocnemius muscles, achilles tendons, knee and ankle joints.

3. Exercise (20 min)
   a. In a gym, participants may walk, jog, ride a stationary bicycle, etc.
b. In a large room, planned aerobic exercises can be performed with an exercise leader.

c. To stay within their target heart ranges, participants should increase or decrease the intensity of their activity.

4. Cool down (5 min)
   a. joint flexibility exercises
   b. static stretching

5. Relaxation (20-25 min)
   a. participants should be in the supine position
   b. use a simple relaxation technique
      (see Appendix A)

B. As the study progresses, keep reminding the participants that these techniques are most effective when they are integrated into daily life. Be open to discussion, questions.

VII. Conclusion

A. When the program has ended, graph the blood pressure readings and send a copy to the participants' personal physicians.

B. Follow-up sessions or continuation of the program may be desirable.
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