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The effect of exercise combined with meditation on blood pressure

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THE EFFECT OF EXERCISE COMBINED WITH MEDITATION ON BLOOD PRESSURE

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CERTIFICATION OF APPROVAL

MASTER OF SCIENCE THESIS

This is to certify that the Master of Science Thesis of

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ABSTRACT

Hypertension (HTN) is a highly influential risk factor for developing chronic disease, particularly cardiovascular disease (CV). Exercise has both an acute and chronic effect on blood pressure (BP) and can cause hypotension 5 min post-activity that can last for hours. Meditation is another effective HTN treatment but there are no existing studies testing the acute effects of combining meditation with exercise on BP. The main purpose of this study was to examine the acute effect of practiced mindfulness meditation combined with exercise on both systolic blood pressure (SBP) and diastolic blood pressure (DBP). A secondary purpose was to evaluate the difference between experienced and non-experienced meditators. Thirty men and women volunteered for this study and were divided into experienced (E) and non-experienced (NE) meditators with NE practicing mindfulness meditation for two weeks. Both E and NE completed four conditions in a partially randomized, balanced order: Exercise plus meditation, exercise, meditation, and a control condition. BP was measured 10 min before and 5, 10, 15, 30, 45, and 60 min post-trial. Data were analyzed using a two-way repeated measure ANOVA. A significant interaction (time × condition) was found for both SBP and DBP. However, post-hoc analyses did not determine any significant differences between conditions. Yet, the control condition was the only condition that failed to show a significant reduction in DBP from baseline and also failed to show a reduction in BP longer than 5 min post intervention. To conclude, the intervention conditions both showed a similar reduction in blood pressure. In addition, the reduction in the meditation condition was seen with only a short-term learning phase. There was no advantage for integrating meditation into exercise.

DEDICATION

This thesis is dedicated to my wife, Yael Nisselbaum-Amit, who supported me all the way, to my son, Bar Amit, who brought joy and happiness to my life and to Healy Amit, whom we waited for so long. In addition, I am dedicating this thesis to my father, which without him this dream could not have been fulfilled and to my mother who always supports.

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Chapter 1

INTRODUCTION

Hypertension (HTN) is a highly influential risk factor for developing chronic disease, particularly cardiovascular (CV) disease and was considered the number one cause of overall death in the United States in 1999 (Center for Disease Control and Prevention, CDC.gov/blood pressure fact sheet. April, 2014). Exercise is a primary lifestyle change that can help treat and reduce HTN (CDC, 2014). Another effective HTN treatment is regular practice of meditation (Nidich et al., 2009). Meditation can decrease psychological stress, which might explain the decrease in blood pressure (BP) (Sawai, Ohshige, Naoki, & Tochikubo, 2008; Sparrenberger et al., 2009). When chronic mediation is compared to chronic exercise empirically, both appear to affect HTN similarly (Anderson, Liu & Kryscio, 2008).

Physical activity, especially CV exercise, has both an acute and chronic effect on HTN. Cardiovascular exercise can cause a hypotension effect 5 min post-activity, which can last from a few to several hours (MacDonald, MacDougall & Hogben, 2000). This effect is independent of duration and intensity of the exercise. Cardiovascular training also has a chronic effect, which, with regular practice, can decrease both SBP and DBP to normal levels in borderline hypertensive patients (Pitsavor et al., 2011).

Meditation, a technique known to reduce stress, is defined as a practice without any physical effort that is done on the floor or a chair (Maharishi Foundation USA, 2012). Dr. Herbert Benson and colleagues mention that meditation can cause a relaxation response, which they define as the opposite from the fight-or-flight response (Benson & Klipper, 2009). The relaxation response yields a decreased metabolism, heart rate (HR),

BP, and rate of breathing. Studies have found that daily practice of meditation for 20 min can decrease SBP by an average of 4.5 mmHg (Chiesa, 2008). The most meaningful effect of meditation on BP was seen among experienced meditators, which may be explained by the fact that meditation is considered a complicated technique.

Both CV exercise and meditation have beneficial chronic and acute effect on HTN. However, there does not seem to be any previous study testing the acute BP effects of combining meditation with CV exercise.

Statement of Purpose

The purpose of this study was to examine the acute effect of practiced mindfulness meditation combined with CV exercise on both SBP and DBP in normotensive subjects in the hour following treatment. In addition, this study aimed to examine the differences in BP reduction between experienced and non-experienced meditators.

Hypotheses

The hypotheses for this study are:

1. Meditation combined with exercise will demonstrate a greater reduction in SBP compared to control, exercise or meditation alone, 5, 10, 15, 30, 45, and 60 min after the end of the session.
2. DBP will be reduced equally in all conditions except the control condition.
3. Experienced meditators will demonstrate a bigger reduction in SBP after the sessions that included meditation compared to non-experienced.

Assumptions

For the purpose of this study the following assumptions are made:

1. Participants will all learn mindfulness meditation in a way that will help them create a meditative state during the CV exercise.

2. Experienced meditators have practiced meditation regularly in the past year.

Definitions of Terms

For the purpose of this study the following terms are defined:

1. Pre-hypertension: SBP 120-139 mmHg or DBP 80-89 mmHg

2. Hypertension: SBP above 140 mmHg or DBP above 90 mmHg

3. Stage 1 hypertension: SBP 140-159 mmHg or DBP 90-99 mmHg

4. Stage 2 hypertension: SBP $\geq$ 160 mmHg OR DBP $\geq$ 100 mmHg

5. Normotensive: SBP < 120 mmHg & DBP < 80 mmHg

6. Systolic blood pressure (SBP): blood pressure when the heart contracts.

7. Diastolic blood pressure (DBP): blood pressure when the heart is between beats.

8. Mindfulness meditation: self-regulatory skill that involves observing one's own thoughts and feelings without any judgment (Brown & Ryan, 2003).

9. Physical inactivity: less than 30 min of intentional or purposeful activity per week for the past three months.

10. Acute hypotension effect: the reduction in SBP and DBP in the hour after the end of the intervention.

11. Chronic hypotension effect: the reduction in SBP and DBP lasting for days after the intervention ceases.

12. Inexperienced meditator: participant who has not practiced regularly any type of meditation or any type of relaxation technique.

13. Experienced meditator: participant who practiced more than twice a week any type of meditation or relaxation technique at least a year prior to the beginning of the study.

Delimitations

The delimitations of the study are as follows:

1. Only pre-hypertensive and normotensive subjects will be chosen.

2. Only participants who do not consume HTN medications or suffer from any type of chronic disease will be selected.

3. Mindfulness meditation will be the only meditation practiced in this study.

4. Blood pressure will be measured immediately before and after the intervention.

5. Cardiovascular exercise will be done at 65% of heart rate maximum on a cycle ergometer for 20 min.

Limitations

The limitations of this study are as follows:

1. Results may only apply to pre-hypertensive and normotensive subjects.

2. Results may only apply to participants who do not consume any type of HTN medication.

3. Results may only apply to use of mindfulness meditation.

4. Results may only apply to CV exercise of moderate intensity and duration as used in this study.

5. Results may only apply to acute hypotension effect measured up to an hour after the intervention.

Chapter 2

LITERATURE REVIEW

Introduction

Hypertension, termed "the silent killer," often does not present symptoms. When symptoms do arise they can seem quite commonplace, making diagnosis difficult. Symptoms may include headache, nausea or vomiting, confusion, and vision changes (CDC, 2014). HTN may ultimately lead to a variety of disabling diseases such as myocardial infarction, stroke, peripheral arterial disease, cancer, and diabetes (CDC, 2014). The common treatment for patients with pre-hypertension involves lifestyle changes, whereas for patients with stage 1 and 2 hypertension medications should be included in addition to the lifestyle changes (CDC, 2014).

This chapter examines literature relevant to the study of treating HTN with exercise and meditation. Specifically, this chapter includes subsections covering: Prevalence of HTN, psychological stress and HTN, types of stress reduction techniques, the relaxation response, the acute and chronic effects of meditation on HTN, the acute and chronic effects of CV exercise on HTN, and the effects of resistance training on HTN.

Prevalence of HTN

The prevalence of HTN is estimated at 67 million people in the United States, which means that every one out of three adults suffer from HTN. Only 47% of these individuals have HTN under control. Women are about as likely as men to develop HTN, however, for people under 45 the condition effect men more than women. For people over 65 years old, HTN effect women more than man (CDC, 2014). About seven of every 10 people having their first heart attack have HTN and eight of every 10 people having their first stroke have HTN (CDC, 2014). Many factors can lead to HTN, including high

intake of saturated fat, alcohol and high glycemic carbohydrates, smoking, a BMI over 25, genetics, psychological stress and physical inactivity (CDC, 2014, Sawai et al., 2008; Sparrenberger et al., 2009). According to recommendations from the Joint National Committee (2000), lifestyle changes may include a reduction in BMI (below 25), a cessation in smoking, a reduction in alcohol intake and daily practice of CV exercise. In addition, studies found that relaxation techniques such as meditation reduce HTN, suggesting that stress is associated with HTN (Sawai et al., 2008; Sparrenberger et al., 2009).

Psychological Stress and HTN

Recent studies have found that psychological stress could increase HTN. A meta-analysis that tested the effect of psychosocial stress on HTN defined stress as a state where environmental demands overcome the ability of a human to adjust (Sparrenberger et al., 2009). These researchers evaluated 14 studies (with a total of 52,049 individuals) with an average study quality at 6.6 (on a 9-point scale). The researchers found that chronic stress, and especially the lack of ability to cope with stress, was significantly associated with an increase in BP. They also concluded that this elevation in BP damages endothelial cells, a precursor to arterial disease. In addition, they examined three studies that tested the acute effect of occupational stress on HTN. In one study, they found a significant association between occupational stress and HTN; however, in the other two they did not find any association (Sparrenberger et al., 2009). The researchers concluded that both acute and chronic stress might increase HTN. Accordingly, researchers have also tested the acute effect of mental stress on BP changes and heart rate (HR) in young men (Sawai et al., 2008). Sawai et al. (2008) examined 27 healthy males who were divided into a normal or HTN group (over 125 mm Hg SBP or 75 mm Hg DBP). Both

groups completed a few mental stress tests. BP and HR were measured pre and post the mental stress test. The researchers found that HR and SBP increased with mental stress tests in both groups, yet they increased more in the normotensive group. These results in combination with the results of the meta-analysis indicate that mental stress, both chronic and acute, might increase BP levels.

Stress Reduction Techniques

There are many alternative methods that could potentially reduce mental stress and thus, may reduce BP. The most common methods are: (1) yoga (2) tai chi, (3) biofeedback, and (4) meditation. Yoga is a relaxation technique that has some elements of meditation. In a study conducted by Niranjan et al (2009), the effect of yoga on hypertensive subjects was tested for nine months and found to reduce BP. Tai chi is a Chinese method that includes deep breathing and slow, controlled body movements (Yen, Wang, Wayne, & Phillips, 2009). A meta-analysis that tested the effect of Tai chi on BP (Yeh et al., 2008) examined twenty-six studies with and without CV conditions. Twenty-two of them reported a significant reduction in BP (3-22 mmHg in SBP and 2-18 mmHg in DBP). The researchers concluded that Tai Chi exercise might reduce BP and serve as practical tool in BP management. Biofeedback (BF) has a person visualize physiological indexes (e.g., BP and HR) while trying, possibly with help from an instructor or device, to control them (Palomba et al., 2011). Meditation is the focus in the present study and is fully reviewed below as an intervention for HTN.

Meditation is defined as the ability "To focus upon a sound, object, visualization, the breath, movement, or attention itself in order to increase awareness of the present moment" ("the free dictionary.com", 2012). It is a state in which one sits silent, breathes deeply, and tries to control thoughts. There are a few common types of meditation that

are documented in research: mindfulness meditation, Zen meditation, and transcendental meditation (TM). TM is an ancient technique that usually lasts between 10-20 min and it is practiced without any effort. The purpose of TM is to clear the mind and just focus on breathing (Maharishi Foundation USA, 2012). Zen meditation, a Japanese form, practiced while sitting silently and trying to avoid any thoughts (Project-meditation, Sept 11, 2012. http://www.project-meditation.org/mt/zen_meditation.html). Mindfulness meditation is a form of Zen meditation adjusted to the Western society. Mindfulness meditation is practiced when the meditator tries to clear his mind of thoughts without any judgments (Ditto, Eclache, & Goldman, 2006).

The Relaxation Response

Stress reduction programs stimulate a psycho-physiologic response known as the relaxation response (Dusek, Bucynski, Johnston, & Benson, 2008). Dusek et al. (2008) stated that diaphragmatic breathing, guided body scanning, repetition of a self-chosen word, and mindfulness meditation, all invoke the relaxation response. The relaxation response was found to decrease oxygen consumption, carbon dioxide production, respiratory rate, and minute ventilation (Benson & Klipper, 2009). In addition, the relaxation response was found to increase parasympathetic activity and thus reduce BP. Diaphragmatic breathing and self-awareness lie at the core of most stress reduction programs, like yoga, meditation and Tai Chi. This might be a possible link between the stress reduction programs and BP reduction.

Meditation and HTN

The curing effect of meditation has been well investigated. One aspect of this curing effect is the effect of meditation on HTN. In order to examine whether stress management decreased SBP in comparison to other lifestyle changes, researchers

conducted a randomized double-blind study (Dusek et al., 2008). In this study, 122 hypertensive older adults were divided into two groups: eight weeks of meditation (an hour of group sessions and 20 min alone each day at home) versus an education group (equal treatment time). The researchers found SBP decreased in both groups by 9 mmHg, with no significant difference between the two groups. In addition, 66% of participants removed medication treatment. They concluded that this reduction potentially decreases mortality from CVD by 7%. These results indicate that both meditation and health education have a positive effect on HTN.

To expand the knowledge regarding the chronic effect of meditaion on a younger population, Nidich et al. (2009) examined the effect of meditation on BP in 298 normotensive college students. Students were recruited to the study under the assumption that they were usually under continuous stress. The students were divided into two groups: a meditation group and a control group. The meditation group studied meditation for three days and then participated in weekly 30 min sessions for three months, whereas the control group continued their regular routine. The researchers found that the meditation group significantly reduced SBP and DBP, by 2 mmHg and 1.2 mmHg respectively, compared to an increase in SBP and DBP for the control group. They concluded that meditation was an effective tool in reducing BP when compared to a control group.

One population affected by HTN on a larger scale than other groups is African-American individuals. On the basis of this information, Gregoski et al. (2010) tested the effect of meditation in comparison to other lifestyle changes on ambulatory BP among African-American adolescents (Gregoski et al., 2010). A total of 166 ninth-graders, with

SBP between the 50th and 95th percentile for age and grade, were divided into three groups: meditation, health education control, and life skill training. The students did not suffer from any illnesses and did not plan to participate in any health program during the study. Meditation was practiced both at school for 10 min each week, every day at home, and also twice a day on weekends. The life skills training included 50 min of class discussion with a focus on problem-solving skills and health education for CV risk factors. Gregoski et al. (2010) found a significant decrease of 3 mmHg in SBP for meditation compared to the other two groups. They mentioned that the biggest decrease in BP was seen during school hours. They concluded that TM is useful as a long-term treatment for HTN and, at least in ninth-graders students, it is superior to health education and life skill training. In addition, base on this study, it is advised to integrate meditation class into the school daily routine.

Schneider et al. (2005) examined the effect of TM using older African-Americans with HTN (Schneider et al., 2005). In this study, 150 African-Americans, with no previous experience in relaxation techniques, were divided into three groups: TM, muscle relaxation, and health education. All groups practiced for 20 min twice a day. After one year, the TM group reduced SBP by 3.1 mmHg and DBP by 5.7 mmHg compared to a decrease of 0.5 in SBP and 2.9 mmHg in DBP in the two other groups. However, only the reduction in DBP in the meditation group was significant. Yet, when testing the differences between women, significant differences in both SBP and DBP were seen between TM and the other healthy groups. More importantly, TM showed a decrease in HTN medications compared to an increase for the two other groups.

In addition to ethnicity, stress during working hours is a factor related to HTN. A study tested the effect of meditation on ambulatory BP during working hours on 52 hypertensive subjects (Manikonda et al., 2008). The subjects practiced contemplative mediation (a type of Zen meditation) for 40 min, twice a day, for eight weeks. Manikonda et al. (2008) found that SBP decreased significantly by 11% with meditation, compared to no change in the control group (waiting list). They found average DBP decreased 13% with meditation, compared to a 2% decrease in the control group, and concluded that contemplative mediation may be useful as a daily practice for workers (Manikonda et al., 2008).

Similarly, another study that tested the effect of meditation on ambulatory BP was conducted in a random, single blind design study. Sixty healthy young males were divided into a TM or stress education group (Wenneberg et al., 1997). The participants practiced TM three times per week for four months, 15 min in the morning and in the evening. The researchers found that DBP decreased 4.5 mmHg with TM compared to no change in the control group. In contrast to other studies, the researchers did not find any change in the SBP in either group.

As defined previously, one major component in meditation is breathing control and awareness. To test the specific effect of breathing on HTN, 82 college students were divided into three groups: Vipassana meditation (traditional Buddhist meditation), sham meditation (only breathing without any instructions regarding how to clear the mind from thoughts) and a control group that served as a waiting list (Zeidan, Johnson, Gordon, & Goolkasian, 2010). The students practiced meditation for 20 min on three consecutive days. The researchers measured BP, HR and mood before and after sessions. They found

that, despite a decrease in the negative mood, HR increased for the meditation group. In addition, SBP and DBP decreased equally by 8 mmHg on average in all groups. This study isolated the breathing component and indicated that the effect of meditation on BP is mainly due to breathing and not thought control. Implications across these studies indicate that when teaching, and practicing meditation, the focus should be mainly on breathing and not on clearing the mind from thoughts.

Two meta-analyses have examined the effect of meditation on HTN. First, Anderson et al. (2008) examined nine randomized, controlled studies with a total of 711 participants with an average length of meditation practiced of 15 weeks. The researchers found that meditation significantly decreased SBP and DBP of subjects with normal BP by an average of 4.7 mmHg and 2.1 mmHg, respectively. The effect was similar (an average of 5.1 mmHg SBP and 2.1 mmHg DBP) for HTN subjects. However, when compared to exercise, no significant difference was seen. Anderson et al. (2008) concluded that this reduction in BP might significantly decrease the risk for CVD.

Another meta-analysis reviewed 10 studies and tested the connection between Zen meditation and physiological function (Chiesa, 2008). With a total of 559 subjects, it was found that Zen meditation increases the alpha and beta EEG function in many areas of the brain and can protect from aged-related decrease in cognitive function. In addition, Zen mediation was found to reduce HTN significantly. However, it is important to note that the biggest improvement was found in subjects with prior experience in Zen meditation. These meta-analyses suggest that experience in meditation is a main factor when measuring the effect on BP.

Together, these studies suggest that daily practice of meditation, for 15 min or more, might reduce SBP and DBP. Meditation was found to be effective, both in children and older adults, and individuals with normal BP and HTN. In most studies the BP reduction was significant when meditation was compared to a control group that did not received any treatment. In addition, meditation is a useful tool even when it is practiced independently and compared to other health education groups.

The Acute Effect of Meditation on BP

Most studies have examined the long-term effects of meditation. However, two studies have tested the acute effect of TM on HTN. Barnes et al. (1999) used 32 middle-aged experienced and non-experienced mediators with each group practicing two different situations (Barnes, Treiber, Turner, Davis, & Strong, 1999): resting with eyes open and relaxation with eyes closed. The results indicated the TM-experienced group reduced SBP with eyes closed by 2.5 mmHg, compared to an increase of 2.4 mmHg in the non-experienced TM group. However, when meditation was practiced with eyes open, neither groups reduced their BP. The researchers concluded that experience in TM could play an important role when testing the effect of meditation on HTN.

Another study tested the response of HR and BP during long meditation. Thirty-eight healthy, experienced mediators, and 21 non-experienced meditators, all normotensive, were selected for this study (Solberg et al., 2004). The meditation group practiced meditation for 3 hr whereas the control group was asked to sit for 1 hr without talking, sleeping or working. Solberg et al. (2004) found that the HR declined with meditation by 11 bpm compared to an average decrease of 2 bpm in the control group. In addition, HR continued to decline in the second hour after TM. However, BP remained unaffected by either meditation or rest condition. The researchers mentioned the factors

causing HR to decline was experience with practiced meditation with eyes close. The researchers explained that BP was unaffected due to the low BP in baseline in both groups.

A unique study tested the combined acute effect of exercise and relaxation on BP (Forghier et al., 2006). The researchers assigned 14 hypertensive and 16 normotensive subjects into four conditions, each participants practiced all four conditions in a random order: exercise (53 min at 50% of VO_{2peak}), relaxation (20 min of yoga in a supine position), exercise + relaxation (53 min of exercise and then 20 min of yoga) and a control condition. BP was measured before each trial and 10, 30, 50, 75, and 90 min after. The researchers found that BP decreased significantly in the exercise + relaxation condition compared to all other conditions. In addition, they found that BP decreased more in the hypertensive subjects compared with the normotensive. This was the first known study able to show that the combination of exercise and meditation is superior over either one of them. In addition it strengthened the theory that the BP reduction is greater in subjects with HTN.

To summarize, there is mixed evidence regarding the acute effect of meditation on BP. while studies showed small or no effect of practicing meditation on BP, others showed a significant effect. Those mixed results may be due to the different protocols and types of meditation chosen by the researchers.

Exercise and HTN

According to the Center for Disease Control and Prevention (2004), one of the main strategies to reduce BP is exercise. CV exercise has both an acute and chronic effect on HTN. Resistance exercise has also been studied for effects on HTN.

The Acute Effect of CV Exercise on HTN

Some studies testing the acute effect of CV exercise have focused on the differences between intensity and exercise duration. MacDonald et al. (2000) first tested the effect of three exercise durations on post-exercise hypotension among young males with normal BP. The subjects exercised for 15, 30 and 45 min at 70% of their VO2 max on three different occasions. BP was measured before exercise and 5, 10, 15, 30, 45 and 60 min after exercise. MacDonald et al. (2000) found that BP decreased significantly after exercise by 6 mmHg. However, they found no significant difference in BP between the three durations. Next, they tested eight pre-hypertensive subjects. Each subject exercised at two different durations: 10 and 30 min at 70% of their VO2 max. Findings indicated that the biggest decrease in BP was found with 30 min of exercise (14 mmHg), but no significant difference was found between the two durations. MacDonald et al. (2000) concluded that males with normal BP, and with pre-hypertension, are able to achieve a hypotension effect of CV exercise, after exercise for only 10-15 min.

To test the effect of intensity on HTN, MacDonald and colleagues required 10 healthy subjects to exercise at either 50% or 75% of VO2 max for 30 min (MacDonald, MacDonald, Macdougall & Hogben, 1999). BP was measured before and after exercise but no significant difference was found between the two intensities. The researchers concluded that intensity is not an influential factor in lowering BP.

To extend the knowledge of the acute effect of exercise on BP, two types of exercise were tested; 30 min of continuous CV exercise or three 10 min intervals at the same intensity with 10 min rest between each interval (Jones, Tylor, Lewis, George, & Atkinson, 2009). The intensity chosen for this study was 70% of VO2 max. The researchers found both types of exercise caused a significant decrease in BP in the hours

following exercise. In addition, they found that BP in the afternoon was significantly lower in the interval-training group compared to continuous CV.

To test the effect of exercise during working hours, university professors were divided into a cycling group (30 min at 80% of maximum heart rate reserve) and a control group (remained in a seated position for 30 min) (Ribeiro et al., 2011). Ambulatory BP was measured for 24 hours following both treatments. The researchers found that CV exercise reduced BP significantly for a few hours after exercise compared to the control group. These results indicated that physical activity might help healthy people in managing BP.

To understand more about both the acute and chronic effect of aerobic exercise on BP, researchers tested the effect of single bout of CV exercise (30 min at 65% of VO_{2peak}) and the long term (four sessions per week, 30 min per session, for eight weeks at 65% of VO_{2peak}) (Liu, Goodman, Nolan, Lacombe, & Thomas, 2012). In addition, the authors wanted to know whether the magnitude of the decrease in BP after a one-bout exercise might predict the extent of BP lowering after chronic CV training. The researcher found a significant correlation of 0.89 and 0.75, for ΔSBP and ΔDBP, respectively, after the acute bout and the 8-week exercise program. This study may help exercise professionals, with a relatively simple and fast means, to create realistic expectations regarding the effect of exercise on BP.

To summarize, acute CV exercise appears to reduce SBP by 8-10 mmHg and DBP by 2-4 mmHg for a few hours after exercise. These changes seem fairly independent of the intensity and duration of the exercise.

The Chronic Effect of CV Exercise on HTN

The chronic effect of CV exercise on HTN has also been examined. The length of the studies ranged from few weeks to few years, however most studies lasted 8-16 weeks. For example, Pitsavor et al. (2011) tested the effect of 16 weeks of CV training on BP in borderline and mildly hypertensive males. The subjects trained three times per week at 60%-80% of maximum HR for an average of 44 min per session. Pitsavor et al. (2011) found that exercise reduced SBP and DBP compared to a control group that did not train at all. Moreover, the exercise group reduced BP to normal levels (below 120 mm Hg), which allowed subjects to stop medications. Similarity, it was found that 15 months of 30 min daily CV exercise, with intensity that led to shortness of breath on most days, resulted in a 14 mmHg and a 5.1 mmHg decrease in SBP and DBP, respectively, among untrained subjects with mild to moderate HTN (Sjoling, Lundberg, Englund, Westman, & Jong, 2001).

Similar results were seen in a three-year study, 10 hypertensive subjects were trained twice a week for 60 min at 60%-70% of the max HR (Ketelhut, Franz & Scholze, 2003). The subjects were trained in-group sessions with an instructor, and BP taken at baseline and every six months. After six months, SBP during exercise was reduced significantly by 14 mmHg and during rest by 6 mmHg. BP continued to decline significantly after three years by 3 mmHg more during exercise and at rest. This study emphases the importance of maintaining an exercise routine for years.

Two other studies used slightly different methods to measured intensity; the first used heart rate reserve (HRR) and the second used anaerobic threshold. However, these studies showed similar results. In the first, 102 hypertensive males and females were divided into a CV exercise group and a control group (Tsai et al., 2004). The exercise

group practiced three times per week for 50 min at 60%-70% of their HRR. After 10 weeks, SBP and DBP decreased by13 mmHg and 6 mmHg, respectively in the exercise group, compared to an increase for the control group. It is interesting to note that after six weeks, a decrease of 6 mmHg and 3 mmHg was seen in SBP and DBP, respectively.

The second study, conducted in Japan, examined 16 males with mild HTN exercising twice a week for six months at their anaerobic threshold (Tsuda, Yoshikawa, Kimura & Nishio, 2003). After six months, SBP and DBP in the exercise group decreased significantly by 10 mmHg and 6 mmHg, respectively, compared to no change in the control group. Other variables (e.g., BMI, fasting serum glucose and HDL) did not change significantly. As seen, those two studies showed similar results to those reported by Ketelhut et al. (2003). Thus it could be concluded, that the method chosen to determine intensity is less important when testing the effect of exercise on BP.

In contrast to the magnitude of BP reduction seen in the pervious study, a meta-analysis examined 53 randomized, controlled studies and found that studies lasting more than six months showed only a small decrease in BP, probably because of the difficulty of the participants in sticking with the exercise program (Whelton, Chin, Xin, & He, 2002). The SBP decreased in 44 studies, but only in 20 was the decrease significant. DBP decreased in 42 studies, but only in 16 was the decrease significant. The average decrease in SBP and DBP in the CV exercise group was 4.13 mmHg and 2.68 mmHg, respectively. The researchers noted that the decrease in BP was seen for all intensities and durations and that exercise is an effective way to reduce BP independent of weight loss.

To summarize, most studies testing the chronic effect of CV exercise on HTN found that 30 min for four weeks or more could reduce both SBP and DBP. In addition, studies found that CV exercise can help pre-hypertensive patients to return to normal BP status.

The Effect of Resistance Exercise on HTN

Recent studies suggested that resistance training might also reduce HTN. A meta-analysis that examined the differences between CV exercise and resistance training on post-exercise hypotension (PEH) among hypertensive individuals, reviewed 32 studies (Anunciacao & Polito, 2011). Although the researchers found high variation in the numbers of repetitions, intensity, resting time and total training duration, they noted that there was little variation in the number of sessions per week, and in the type of muscle that were trained. They concluded that resistance training, regardless the protocol, significantly reduces SBP, especially in the first hour after the session. In addition, they mentioned that PEH effect could last up to 10 hours. However, the researchers found only three studies reported a significant reduction in DBP after resistance exercise. Most studies found that resistance exercise reduces SBP regardless of the duration or intensity. The researchers also noted that the hypotension effect after CV is longer in duration compared to resistance training.

Another study examining the differences between CV exercise and resistance exercise tested 30 pre and stage 1 HTN subjects (Collier et al., 2008). The CV group exercised three times a week, 30 min at 65% of their VO2 max and the resistance group exercised three times a week on nine different machines, doing three sets of 10 repetitions at 65% of 1 repetition maximum. The total exercise time for the resistance group was 40-50 min on average. After four weeks, SBP and DBP in the CV group

decreased significantly by an average of 3.6 mmHg and 3.1 mmHg, respectively, and by 2.4 and 4.1, respectively, in the resistance group. However, no significant differences were seen between groups. It is important to note that after only four weeks, change in resting SBP and DBP were seen in all groups.

To conclude, resistance training has both an acute and chronic effect on SBP and DBP. Studies with high variation in the number of sets, repetition and intensity seemed to all achieve such an effect.

Summary

To summarize, HTN may cause a variety of diseases, and affects over 50 million people in the U.S alone. The common treatment for HTN includes lifestyle modifications such as smoking cessation, lowering LDL levels, and engagement in physical activity. Most commonly, CV exercise is found effective in treating HTN. In addition, resistance exercise can also to reduce HTN. All types of exercise have both acute and chronic effect on HTN. The acute effect is achieved a few min after activity ceases and lasts potentially up to 72 hours. However, most studies reported that the peak decrease is observed after 30 min. The average decrease in SBP and DBP due to acute CV and resistance training was 6 mmHg, and 3 mmHg, respectively. The chronic effect in CV exercise is achieved after four weeks of 30 min at 65%-85% of the max HR. Mental stress may also play a role in BP elevation. Meditation, a common stress reduction technique, was found to reduce SBP. However, the acute effect of meditation on BP is not well documented and it may depend on the level of participant's experience with meditation. In addition, the effect on BP of combining two or more modalities (aerobic exercise following resistance training or meditation during exercise) is not documented.

Chapter 3

METHOD AND PROCEDURES

Introduction

This chapter outlines the methods and procedures used in this study. Specifically, this chapter deals with; (a) participants, (b) study design, (c) procedures and instrumentation and (d) data analysis.

Participants

Twenty-eight participants, ranging from 18-60 years of age (M_{age}= 27.43, *SD* = 13.39), volunteered and met the study requirements (n_{Female} = 16, n_{Male} = 12). The majority (87%) were Caucasian and the rest were Asian (13%). Some of the participants were considered as experience meditators (practiced meditation two or more times a week or relaxation technique for at least a year prior to the beginning of the study, *n* = 8), whereas some were not experience meditators (has not practiced any type of meditation or relaxation technique regularly, *n* = 20)

Procedures

The participants were recruited from a private college in upstate New York and from the city's community. Potential participants underwent BP measurements before they enrolled to the study (10 min of resting then two measurements with 1 min interval between each measurement). The rest (*n* = 28) were asked to maintain their regular diet and not practice any other new activity during the three and half week duration of the study. Clearance from the human subject research committee was obtained and all participants signed an informed consent form (Appendix A) before the start of the study.

Participants with no previous experience in meditation received a recruitment script (Appendix B) and then learned mindfulness meditation for two weeks prior to

beginning data collection whereas participants with experience in meditation, or any other relaxation technique, were only asked to attend the four testing conditions**.** The mindfulness meditation learning phase included six sessions, 20 min each, and was based on research that showed that five days of 20 min of meditation yielded significant improvement in attention and self-regulation compared to a control group that just got information about relaxation (Tang et al., 2007). The mindfulness meditation learning phase was held in the college sanctuary and included four min of verbal instructions followed by 15 min of deep breaths and clearing the mind of thoughts. The meditation was conducted while sitting on a chair with sessions guided by a certified meditation instructor.

After two weeks of learning meditation, and before the start of the study, participants completed a Personal Questionnaire form (Appendix C) that queried their weekly aerobic training hours, weekly resistance training hours, weekday sleeping hours, weekend sleeping hours, and stress level. Before each of the four testing conditions the participants filled out a 24-hour history form (Appendix D) that ask about their stress level, sleeping hours, diet, alcohol and caffeine consumption, and exercise in the past 24 hours.

All participants (including those with experience in meditation) completed four testing conditions in a partially randomized, balanced order (Appendix E) in the Exercise Physiology Lab on four different occasions: Exercise plus Meditation (E+M); exercise only (E); meditation only (M); control (C).

The participants were asked to come at the same time for all four testing conditions in order to keep consistency between conditions. No more than two

participants were tested together. On arriving at the Exercise Physiology Lab participants were asked to rest 10 min prior to the first BP measurement, then they practiced one of the four conditions for 20 min. After completing the first condition, participants completed the other three conditions with no more than 96 hours, and no less than 48 hours, separating each testing condition.

The four testing conditions were as follows:

1. Mindfulness meditation (M; Appendix F): During this condition participants practiced mindfulness meditation for 20 min.

2. Exercise plus mindfulness meditation (E+M; Appendix G): During this condition participants wore a Wahoo heart rate monitor (Wahoo Fitness Blue HR Heart Rate Strap for iPod /iPhone, Model Number: 0082HRS) and exercised on a cycle ergometer for 20 min at 65% of their HR max (maximum heart rate was determined by 220-age), while instructed to focus on their body's sensations and feelings. The height of the ergometer bicycle for each participant and the resistance was recorded in order to be consistent between E+M and E conditions.

3. Exercise (E; Appendix H): During this condition participants wore a Wahoo heart rate monitor and exercised on a cycle ergometer for 20 min at 65% of HR max.

4. Control: During this condition participants sat on a chair for 20 min without any instructions.

For each condition, BP was measured 10 min before and 5, 10, 15, 30, 45, and 60 min post-intervention. BP was measured using a mercury sphygmomanometer with Korotkoff's sound technique. These measurements were conducted in duplicate each time with a 1-min interval between each measurement. The measurements were conducted on

the left arm only. On one occasion, due to short cuff size, a calibrated jewel movement sphygmomanometer was used.

In the post-intervention time frame, the participants were asked to sit on a chair for 60 min. During this time the participants were asked to be inactive as much as possible. The participants were allowed to read and write as desired, however, no electronics devices were allowed. Participants were not aware of their BP values and received their data only after completing all testing conditions. The participants also received a debriefing statement (Appendix I) at the end of the study.

Study Design

This study was conducted in a switched-replication design. All participants were assigned to each of the four conditions in a balanced, partially random sequence. BP was measured pre- and post-intervention and was compared within subjects in all four conditions and between conditions at all time points. Comparisons were also made between experienced and non-experienced meditators.

Data Analysis

The primary independent variables were exercise and meditation conditions, while the primary dependent variables were SBP and DBP. Descriptive statistics are presented and data were analyzed using a two-way repeated measure ANOVA. Specifically, a 4 (condition) ×7 (time) ANOVA was run to determine if a difference exists in SBP and DBP between the four conditions. A 2 × 4 × 7 ANOVA was completed to examine differences between experienced and non-experienced meditators. An apriori decision was made to focus only on the differences in BP from baseline to post-intervention and not on inter time-points changes in BP post-intervention. One-way ANOVAs were used in order to test the differences between each of the four conditions

at each of the seven time-points. Bonferroni post-hoc tests (pairwise comparisons) were conducted in order to test the differences between conditions when needed.

Chapter 4

RESULTS

This chapter outlines the results of the study. Specifically, this chapter deals with description of the participants, changes in SBP and DBP, the differences between experience and non-experience meditators and a summary of the results. The average BP by Time and Condition for both SBP and DBP is presented in Appendix J. Appendix K contains the raw data collected and analyzed in this chapter.

Description of Participants

Seven of the 28 participants (25%) were pre-hypertensive at baseline (M = 127/80mmHg, SD_{SBP} = 6.33, SD_{DBP} = 7.41) and the rest (M = 114/72 mmHg, SD_{SBP} = 8.2, SD_{DBP} = 6.67) were normotensive. Nineteen of the participants (68%) started the study without any previous experience in meditation or any other relaxation technique; 32% had practiced meditation or other relaxation techniques for at least a year prior to the beginning of the study. Weekly aerobic training hours, weekly resistance training hours, weekday sleeping hours, weekend sleeping hours, stress level (as reported by the participants) and baseline BP are shown in Table 1.

Systolic Blood Pressure

Baseline measures of SBP (after 10 min of rest) and at six time-points (5, 10, 15, 30, 45, and 60 min post-intervention) following each of the four conditions are presented in Appendix J. A one-way ANOVA revealed no significant difference at baseline in SBP between the four conditions.

Table 1

Participant Characteristics

Characteristic	*M*	*SD*	Range
Age (years)	27.43	13.39	18-64
Weekly aerobic training (h)	5.0	4.12	0-15
Weekly resistance training (h)	2.16	2.36	0-10
Weekday sleeping hours	6.96	1.15	3-9
Weekend sleeping (h)	8.23	1.08	6-10
Stress level (10-point scale)	5.67	1.88	0-9
Average baseline SBP (mmHg)	117	8.64	96-142
Average baseline DBP (mmHg)	74	2.45	57-85

A 4 (condition) × 7 (time) repeated measures ANOVA was conducted in order to examine differences between the conditions over time. Results revealed a significant interaction effect ($F(18,486) = 3.83$, $p < .01$) (Figure 1). To tease out this effect, four one-way repeated measures ANOVAs were conducted for each condition on the time data.

First, for the control condition, SBP significantly decreased over time ($F(6,162) = 1.59$, $p < .05$). Bonferroni post-hoc analysis indicated that the significant decrease was from baseline to 5 min ($\Delta M = 1.25$, $p < .05$).

Second, analyzing the meditation condition, results revealed that there was a significant decrease in SBP over time, $F(3.85,104.03) = 6.59$, $p < .01$. Post-hoc analysis indicated that the significant decrease was from baseline to: 5 min ($\Delta M = 2.07$, $p < .01$), 10 min ($\Delta M = 1.36$, $p < .05$), 15 min ($\Delta M = 1.61$, $p < .01$), 30 min ($\Delta M = 1.39$, $p < .01$), 45 min ($\Delta M = 1.64$, $p < .01$), and 60 min ($\Delta M = 1.32$, $p < .01$) post-meditation.

Third, in the exercise condition, SBP decreased significantly over time, $F(6,162) = 20.12$, $p < .01$. Significant decreases were from baseline to: 5 min ($\Delta M = 3.39$, $p < .01$), 10 min ($\Delta M = 3.21$, $p < .01$), 15 min ($\Delta M = 3.04$, $p < .01$), 30 min ($\Delta M = 3.25$, $p < .01$), 45 min ($\Delta M = 2.5$, $p < .01$), and 60 min ($\Delta M = 2.29$, $p < .01$) post-exercise.

Fourth, in the exercise + meditation, SBP also decreased significantly over time, $F(3.94,106.36) = 22.17$, $p < .01$. The significant decreases were from baseline to: 5 min $\Delta M = 3.93$, $p < .01$), 10 min ($\Delta M = 3.79$, $p < .01$), 15 min ($\Delta M = 3.46$, $p < .01$), 30 min ($\Delta M = 3.17$, $p < .01$), 45 min ($\Delta M = 3.21$, $p < .01$), and 60 min ($\Delta M = 2.25$, $p < .01$) post-exercise + meditation.

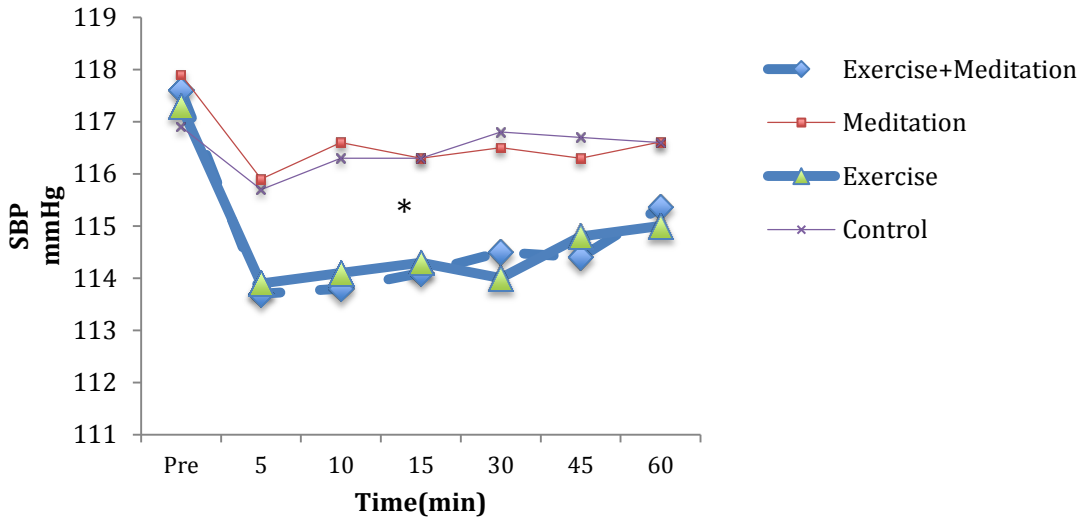

Figure 1. Systolic Blood Pressure (SBP) over time in four conditions. Pre= pre-intervention; Six time points (5-60 min) are post-intervention.

* Significant interaction of condition × time (*$p < 0.05$)

In order to reveal any difference between the conditions at each of the seven time-points, seven one-way ANOVAs were conducted. No significant differences between the conditions were found at any of the time-points [baseline ($F(3,108) = 0.07$, $p = .98$), 5 min ($F(3,108) = 4.87$, $p = .69$), 10 min ($F(3,108) = 0.77$, $p = .52$), 15 min ($F(3,108) = 0.53$, $p = .67$), 30 min ($F(3,108) = 0.69$, $p = .56$), 45 min ($F(3,108) = 0.43$, $p = .73$), and 60 min ($F(3,108) = 0.27$, $p = .85$)].

Upon examining the main effects, there was a significant main effect for time, $F(6,162) = 30.95$, $p < .01$, indicating that SBP was significantly greater at baseline compared to post-intervention, $F(3,81) = 3.6$, $p < .05$.

Diastolic Blood Pressure

Baseline measures of DBP (after 10 min of rest) and at six time-points (5, 10, 15, 30, 45, and 60 min post-intervention) for each of the four conditions are presented in Appendix J. A one-way ANOVA revealed no significant difference at baseline in DBP between any of the conditions.

A 4 (condition) × 7 (time) repeated measures ANOVA was conducted in order to examine differences between the conditions over time. Results revealed a significant interaction effect, $F(18,486) = 2.54$, $p < .01$ (Figure 2). To tease out this effect, four one-way repeated measures ANOVAs were conducted for each condition separately.

First, for the control condition, DBP did not significantly decrease from baseline at any time point post-intervention ($F(6,162) = 1.55$, $p = .17$).

Second, analyzing the meditation condition, results revealed a significant decrease in DBP over time, $F(6,162) = 3.62$, $p < .01$. Bonferroni post-hoc analysis indicated that the significant decreases were from baseline to 10 min ($\Delta M = 1.36$, $p < 0.01$), to 15 min

($\Delta M = 1.14$, $p < 0.05$) and to 45 min ($\Delta M = 1.25$, $p < 0.01$). No significant decrease was found in the meditation condition from baseline to 5, 30, and 60 min post- meditation.

Third, there was a significant decrease in DBP from baseline to post-exercise, for the exercise condition $F(6,162) = 6.43$, $p < .01$. Bonferroni post-hoc analysis indicated that the significant decreases were from baseline to: 5 min ($\Delta M = 1.89$, $p < .01$), 10 min ($\Delta M = 1.36$, $p < .01$), 15 min ($\Delta M = 1.14$, $p < .05$), and 30 min ($\Delta M = 1.36$, $p < 0.05$) post-meditation. No significant decrease was found in the exercise condition from baseline to 45 min post-exercise.

Fourth, examining the exercise + meditation condition, results revealed a significant decrease in DBP from baseline to post-intervention, $F(6,162) = 8.45$, $p < .01$. Significant decreases were from baseline to: 5 min ($\Delta M = 2.61$, $p < .01$), 10 min ($\Delta M = 1.79$, $p < .01$), 15 min ($\Delta M = 1.11$, $p < .05$), and 60 min ($\Delta M = 1.00$, $p < .05$) post-exercise + meditation. No significant decrease was found in exercise + meditation condition from baseline to 30 or 45 min post-exercise + meditation.

Upon examining the main effects, a significant main effect was found for time, $F(6,162) = 10.73$, $p < .01$, indicating that DBP was significantly higher at baseline compared to post-intervention**.** A post-hoc analysis using pairwise comparison revealed that DBP at 5, 10, 15, 30, 45, and 60 min was significantly lower than baseline (Appendix J).

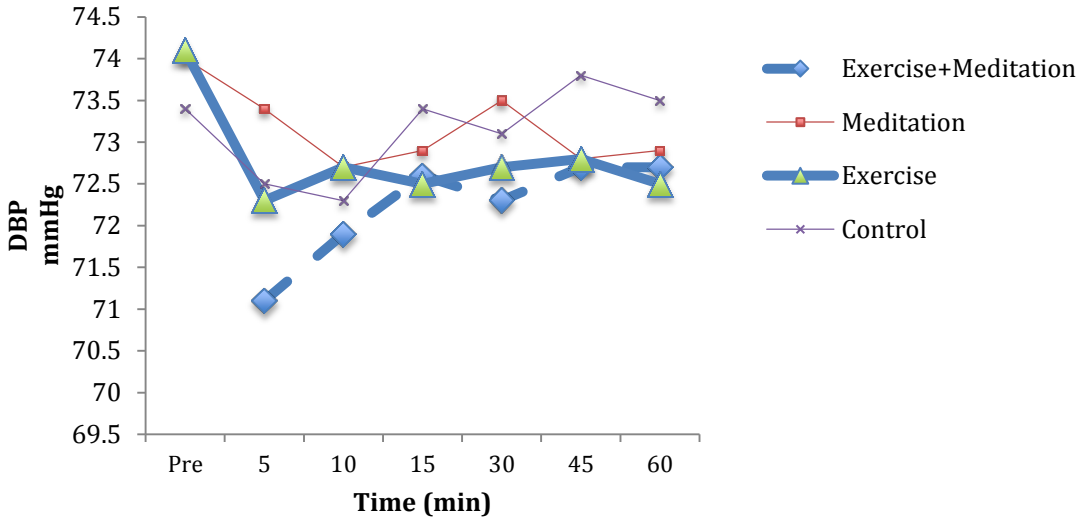

Figure 2. Diastolic Blood Pressure (DBP) over time in four conditions. Pre-= pre-intervention; Six time point (5-60 min) are post-intervention

Experienced and Non-Experienced Meditators

A 4 (condition) x 7 (time) x 2 (level of experience) repeated measures ANOVA was used in order to test the differences between experienced and non-experienced meditators at all conditions in all seven time-points. There were no significant differences for SBP or DBP as detailed in Appendix J: time x experience ($F(6,156) = 0.67$, $p = .60$, condition x experience ($F(3,78) = 1.06$, $p = .37$), time x condition x experience ($F(18,468) = 1.68$, $p = .09$). For DBP, the test revealed no significant interaction between: time x experience ($F(6,156) = 2.23$, $p = .36$), condition x experience ($F(3 ,78) = 1.10$, $p = .35$), nor between time x condition x experience ($F(18,468) = 1.31$, $p = .18$).

Summary

To summarize, SBP decreased significantly in all conditions from baseline to post-intervention with no significant difference between conditions. As for DBP, a significant decrease was seen from baseline to post-intervention in all conditions except the control. No significant difference was seen between experienced and non-experienced meditators.

Chapter 5

DISCUSSION

This study examined the acute effect of meditation and exercise, both alone and combined, on both SBP and DBP in the hour following treatment. This appears to be the first study testing the effect of exercise and meditation performed concurrently.

The main finding of this study is that both SBP and DBP were significantly lowered post-intervention. Surprisingly, the control condition also showed a significant reduction only in SBP, at 5 min post-intervention. However, the control condition failed to maintain a significant BP reduction beyond 5 min while the exercise and meditaion conditions had a prolonged BP effect. No significant difference between conditions, in SBP or DBP, could be determined at any time point. The following sections discuss the acute effect of exercise and meditation on BP.

The relatively small reduction in both SBP and DBP, between baseline and 5-min post-intervention, seen in all conditions, might in part relate to participants' low BP at baseline (M = 117/74 mmHg). It is logical to assume that a bigger reduction in BP would have been seen in participants with higher BP at baseline. The significant reduction in SBP, seen in the control condition, could be explained by the fact that both the control and the meditation conditions were performed similarly, while sitting on a chair for 20 min. Therefore, some of the participants may have, unintentionally, relaxed or meditated, in the control condition. However, it would be also fair to say that sitting and meditation caused this reduction in BP. More importantly, the BP reduction was maintained over the six time points only in three treatment conditions and dissipated after only 5 min in the control sitting condition.

The Effect of Exercise and Exercise Plus Meditation on BP

Both the exercise and the exercise plus meditation conditions showed a significant decrease from baseline to post-intervention. In addition, this effect lasted at least an hour following intervention. Thus, it can be concluded that only 20 min of moderate intensity (65% of HR maximum) exercise significantly reduced both SBP and DBP. It is also clear that 20 min of meditation alone can actually lower BP for most of the subsequent hour. However, this study failed to show that the combination of exercise plus meditation is superior over each modality alone.

These findings support the work of Forghieri et al. (2006). However, they did not test the simultaneous effect of exercise plus meditation but the effect of exercise followed by meditation on BP. They reported a significant decrease in both SBP and DBP from baseline to 75 min post-intervention in the exercise and meditation group as compared to the remaining groups. In addition, a greater reduction in both SBP and DBP was seen but the direction was similar to the results seen in this present study. An explanation may be that Forghieri et al. included pre-hypertensive participants whereas this current study included mainly participants with normal BP.

In addition, Forghieri et al. (2006) included a much longer session time for the exercise plus meditation group (54 min versus 20 min). This difference in BP effect may also be explained by the fact that Forghieri et al. (2006) used yoga as the relaxation technique.

The peak reduction in the current study, for SBP and DBP, in the exercise and the exercise + meditation condition, was seen 5 min post-intervention. In contrast,

MacDonald et al. (2000) reported that the peak reduction in BP was seen both at 15 and 30 min following exercise. Another difference between the studies was the duration of the hypotension effect. Where MacDonald et al. (2000) reported that the effect lasted only 30 min post--intervention, the findings in the current study demonstrated a longer hypotension effect.

To conclude, when comparing studies testing the acute effect of exercise on BP few differences are seen. Those differences can be explained by the difference in duration of the intervention, its intensity and the exercise modality chosen.

There is the lack of a known protocol for combining meditation into exercise as a simultaneous practice. This was the first study to attempt to simultaneously exercise while meditating and there was a need to create a protocol. The protocol used in this study was based on techniques that are closest in nature to the combination of exercise + meditation, such as Tai Chi. However, these techniques were not proven to have any beneficial effect on BP (Niranjan et al., 2009). In addition, those two practices, exercise and meditation, are opposites in nature; exercise works on increasing sympathetic activity, meditation increase parasympathetic activity. Moreover, the attempt to teach mindfulness meditation within two weeks and then integrate it into exercise was perhaps too challenging for participants. Perhaps given a more extended learning period, this integration would have greater BP lowering effect.

This study showed a significant decrease from baseline to post-intervention in all conditions (except the control in DBP). However, when conducting a post-hoc analysis in attempt to reveal any differences between conditions, no significance was found. This might be explained by the lack of statistical power in one-way ANOVA compared to

two-way repeated measures ANOVA that reduced chances for significance to be found on follow-up. Power decreases as the data point-size decreases (Newell, Aitchison & Grant, 2010). The two-way ANOVA used in this study included 784 data points (4 conditions × 7 time-points × 28 participants) whereas the one-way ANOVA included only 112 data points (4 conditions × 28 participants). The probability that a test would be significant (reject the null hypothesis if it is not true) decreases as the power decreases. Therefore, it is possible that a drop in statistical power made it less possible to detect a significant interaction in analysis of treatment at each time point. However, SBP was, on average, often lower in the exercise and the exercise + meditation conditions, compared with the meditation and control conditions. However, low statistical power, may account for the inability to detect a difference.

The Effect of Meditation on BP

This study was the first to show that only 20 min of practicing mindfulness meditation can acutely reduce both SBP and DBP. Moreover, only a two-week learning phase was necessary to achieve this effect. The average reduction in SBP (1.6 mmHg) and DBP (1.0 mmHg) from baseline was smaller in magnitude than that of experienced, meditators (3 mmHg in SBP) (Barnes et al.,1999). In addition, Barnes et al. (1999) reported such difference only in SBP and not DBP. Thus, it might be possible that the type of meditation chosen by Barnes et al. (Transcendental meditation) is more effective in reducing SBP whereas less effective in reducing DBP.

Another possible explanation for the small magnitude of reduction in BP is the short duration of the meditation-learning phase. In the present study, the participants learned mindfulness meditation for two weeks compared to eight weeks, three months

and a year reported by Dusek et al. (2008), Nidich et al. (2009), and Schneider et al. (2005) respectively. Nidich et al. (2009) reported a reduction of 2 mmHg and 1.2 mmHg in SBP and DBP respectively. Dusek et al. (2008) reported a reduction of 9 mmHg, and Schneider et al. (2005) reported a reduction of 3.1 mmHg and 5.7 mmHg in SBP and DBP, respectively. It is important to note that those studies tested the chronic effect of meditation on BP. Moreover, the study conducted by Solberg et al. (2004) found only a significant reduction in SBP and only among experienced meditators.

Contrasting what was hypothesized, no significant difference was found in effect on BP between experienced and non-experience meditators. This lack of difference could be explained by the fact that the inclusion criterion for the experienced meditators was only based on self-reported questionnaires. Participants were considered experienced if they had practiced any type of relaxation technique regularly in the past year. However, a variety of relaxation techniques exist. Some have not been proven to reduce BP and some have not even been proven to reduce stress. Moreover, some participants reported having a year of experience whereas others reported seven years. Therefore, extent of experience may not have been adequate to see stronger effects than in the two-week trained group.

Practical Implications

The clinical importance of the results seen in this study is interesting. The reduction in both SBP and DBP from baseline to post-intervention is small compared with other lifestyle changes including diet, smoking cessation and chronic exercise. However, this small reduction can sometimes be the difference between hypertension and pre-hypertension and possibly the need for medication.

The practice of meditation could help people who cannot exercise due to physical impairment and still want to use physical practice as a tool for lowering their BP.

Meditation may slightly decrease BP up to an hour or more following the session. The present study only measured one-hour post-intervention and the BP lowering effect might have been longer. This reduction in BP was seen after a relatively short duration of practice and learning phase (for the meditation). This fact is highly important for the general population due to the intense lifestyle in Western society.

Another practical implication is the lack of statistical difference between exercise and exercise and meditation conditions. As mentioned before, both revealed a significant reduction in BP from baseline that lasted 60 min. Thus, based on the results of this study, it may be concluded that there are no extra benefits in integrating meditation into exercise. It can also be said that similar acute BP-lowering effects can be gained from exercise or meditation. Thus, for those who wish to reduce their BP and cannot exercise, choosing meditation is a good option. Alternatively, individuals who enjoy exercise and feel uncomfortable with meditation, can chose to exercise and still achieve the same hypotension effect.

Further Studies

Due to the lack of studies testing the acute effect of meditation on BP, further research is needed in this field. In addition, more studies are needed to examine the health benefits of combining meditation + exercise and to determine if a more effective protocol exists. While no statistical effect was seen, the absolute reduction in SBP was about twice as great when exercise plus meditation were combined compared to the control condition. Moreover, research is needed to evaluate the differences between types of meditation and relaxation techniques, and to determine which type is best for lowering BP. Another interesting area of study should focus on the comparison between other meditation types

(Zen, Tai-Chi and Transcendental) and exercise. Lastly, more research is needed in order to test the duration of hypotension effect after meditation.

Summary

To summarize, this current study was aimed at measurement of the acute effect of meditation and exercise, both alone and combined on BP. It was found that both SBP and DBP decreased after all the exercise and the meditation conditions, with no differences between the conditions. This is the first known study to show that meditation has an acute effect on BP in non-experienced meditators. In addition, all conditions, except the control, demonstrated prolonged reduction in both SBP and DBP. No extra advantage was found in the integration of meditation into exercise nor in being an experience meditator. However, it was proved possible to integrate meditation and exercise into a single session concurrent protocol.

Chapter 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents an overview of the entire study, including the following sections: (a) summary, (b) conclusions, and (c) recommendations.

Summary

The purpose of this study was to test the acute effect of exercise and mindfulness meditation, both alone and combined, on BP in the hour following treatment. Specifically, this study focused on the differences in BP between baseline to post-intervention. In addition, this study aimed to test the difference between experienced and non-experienced meditators. The non-experienced meditators learned mindfulness meditation for two weeks, three times per week, for 20 min periods. All participants, normotensive and pre-hypertensive (no HTN medication or chronic disease) then completed, in a random order, all four conditions: exercise (20 min, 65% of HR max), meditation (20 min), exercise + meditation (20 min, 65% of HR max while meditating) and control (sit for 20 min). All conditions were completed within 7-10 days (48-96 hours between each condition). BP was measured after 10 min rest (pre-intervention) and 5, 10, 15, 30, 45, and 60 min post-intervention. The results indicated SBP decreased significantly from baseline in all of the conditions. For, all conditions, except the control, this effect persisted for 60 min post-intervention. DBP decreased significantly from baseline to post-intervention in all conditions, except the control condition. No significant difference was found at any time point between the conditions. Moreover, there were no differences in BP lowering between experienced and non-experienced meditators. Also,

no significant difference was found between the exercise and exercise + meditation condition. Meditation alone had statistical similar effect to the exercise condition.

Conclusions

The main finding of this study was the significant reduction in both SBP and DBP after meditation. Due to limited number of studies testing the acute effect of meditation on BP, this study fills a gap on this issue. Moreover, this study demonstrates that participants, who have never practiced meditation or any other relaxation technique, require only two weeks of learning meditation in order to achieve a small but significant reduction in both SBP and DBP. In addition, this study supports a long list of studies showing the acute effect of CV exercise on BP. However, this study failed to show that integrating meditation into exercise achieves a superior hypotension effect when compared to either exercise or meditation alone.

Recommendations

Based on the results of this study, the following recommendations for future study are suggested:

1. Future study is needed to test the acute effect of different types of meditation on BP.
2. Future study is needed to test the effect of meditation on BP with 24-hour ambulatory BP measurements.
3. Future study is needed to study the combined effects of exercise and meditation.

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APPENDIX A

Inform Consent Form

Purpose of the Study

The purpose of this study is to examine the acute effect of practiced mindfulness meditation combined with cardio-vascular exercise on both Systolic blood pressure and Diastolic blood pressure in the hours following treatment.

Benefits of the Study

You will learn to practice mindfulness meditation alone, and during cardio-vascular exercise. Both of those abilities might help to relax and reduce your blood pressure. In addition, you will get information regarding blood pressure management.

What You Will Be Asked to Do

Time- you will be ask to come for 20-30 min, three times per week for two weeks to the Wellness Clinic and practice mindfulness meditation. After those two weeks, we will begin measuring your response to meditation and exercise in four more visits to the Wellness Clinic. Those visits will be at 48-96 hour apart.

In total, you will be ask to spent 60-75 min per week for two weeks to study mindfulness mediation and then about 65 min per session for four sessions doing meditation and/ with exercise while we measure their effects. The four sessions are:

1. Exercise plus mindfulness meditation: During this session you will wear a heart rate monitor and exercise on a cycle ergometer for 20 min at 65% of your heart rate maximum while instructed to focus on your breathing. After completing the exercise session you will be asked to sit on a chair for 60 min while we make our measurements.

2. Exercise: During the session you will wear heart rate monitor and will exercise on a cycle ergometer for 20 min at 65% of your heart rate maximum. After completing the exercise session you will be asked to sit on a chair for 60 min while we make our measurements.

3. Mindfulness meditation: During the session participants you will practice mindfulness meditation for 20 min. A certified meditation instructor will instruct the mindfulness meditation. After completing the exercise session you will be asked to sit on a chair for 60 min while we make our measurements.

Initials_____

4. Control: During the session you will sit on a chair for 20 min without any instruction while we make our measurements.

Your blood pressure will be measured 10 min before each session and at 5, 10, 15, 30, 45 and 60 min after each session. In this time frame you will be asked not to use any electronic device and to be as inactive as much as possible.

Exclusion criteria

You will be excluded if you had a diagnosed chronic disease in the past year or use hypertension medications.

Risks

During exercise there is always a risk of musculoskeletal injury and cardiac events. There is no known risk for practicing mindfulness meditation or any of the procedure we will do.

We are asking you to do a general safe level of exercise and not expect any adverse events.

Withdrawal from the study

You will be able to withdrawal from the study at any time and from any reason. You will not need to explain why you decided to withdraw from the study.

Confidentiality

Your name, personal date and any other personal information will remain confidential and will not be shared by anyone except the researchers of this study.

Name_____ Date_____

Signature_____

APPENDIX B

Recruitment Script

I am conducting a study examining the combined effect of exercise and meditation on hypertension, and would like to ask for volunteers to participate. This study is part of my Masters Program in Exercise Science. I hope that your involvement in this study will provide you with more knowledge about blood pressure management.

You will be require to attend at three sessions per week for two weeks, each will last 20 min. Then you will be ask to take part in four study trials, each will last 65 min. At any time, during the course of the study, you will have right to withdraw from the study, for any reason.

If you volunteer to participate in the study you will be asked to study mindfulness mediation for two week and then to take part in four interventions trials that will take place in 24-72 hour frame:

1. Exercise plus mindfulness meditation: During the session you will wear a heart rate monitor and exercise on a cycle ergometer for 20 min at 65% of your heart rate maximum while instructed to focus on your breathing. After completing the exercise session you will be asked to sit on a chair for 60 min.

2. Exercise: During the session you will wear polar heart rate monitor and will exercise on a cycle ergometer for 20 min at 65% of your heart rate maximum. After completing the exercise session you will be asked to sit on a chair for 60 min.

3. Mindfulness meditation: During the session participants you will practice mindfulness meditation for 20 min. A certified meditation instructor will instruct the mindfulness meditation. After completing the exercise session you will be asked to sit on a chair for 60 min.

4. Control: During the session you will sit on a chair for 20 min without any instruction.

Your BP will be measured 10 min before each session and 5, 10, 15, 30, 45 and 60 min after each session. In this time frame you will be asked not to use any electronic device and to be as inactive as much as possible.

You should not participate in this study if you are under 30 years old or above 69, if you currently taking any form of hypertension medications, if you suffer from any chronic disease or practice any type of mediation.

If you are interested in participating, please write your name and phone number on form. Data collection times will be as flexible as possible. However, the four interventions condition should take place in 24-72 hour time frame. In addition, the four-intervention condition should take place no later than five days after the meditation course ends.

APPENDIX C

Personal Questionnaire

Age- Gender- M / F

1. Have you ever practiced meditation more than once a week in the last 6 months- Yes / No

2. How many hours of CV exercise do you get per week-

3. How many hours of resistance training do you get per week-

4. How would you define the level of mental stress you have in your life on a 1-10 scale, where 1 is the least and 10 is the most-

5. How many hours per night do you sleep during weekdays-

6. How many hours per night do you sleep during the weekend-

Name_____ Date_____

Signature_____

APPENDIX D

24-Hour History Form

1. Have you suffered in the past 72 hours from any event that might affect your mental status- No/ Yes (if yes, please describe briefly)
2. Has your diet changed in the past 72 hours- No/ Yes (if yes, please describe briefly)
3. Have you changed your exercise routine in the past 72 hours- No/ Yes (if yes, please describe briefly)
4. Have you consumed caffeine in the past 3 hours- No/ Yes (if yes, please describe briefly)
5. Have you consumed alcohol in the past 24 hours- No/ Yes (if yes, please describe briefly)
6. Have you taken any kind of medications in the past 24 hours- No/ Yes (if yes, please describe briefly)
7. Have you suffered from any mental stress in the past 72 hours- No/ Yes (if yes, please describe briefly)
8. Have you changed you sleep pattern in the past 72 hours- No/ Yes (if yes, please describe briefly)

Name_____ Date_____

Signature_____

APPENDIX E

Testing Order

Participants/ order of conditions	Meditation	Exercise + Meditation	Exercise	Control
A	1st	2nd	3rd	4th
B	4th	1st	2nd	3rd
C	3rd	4th	1st	2nd
D	2nd	3rd	4th	1st

Note- The fifth participant was tested in the same order as the first, the sixth participant was tested in the same order as the second, the seventh participant was tested in the same order as the third participant and so on.

APPENDIX F

Instructions for Mindfulness Meditation

The participants will arrive at the Wellness Clinic in comfortable clothes.

The meditation will last for 20 min; in the first 4 few min the participants will be instructed verbally. After 10 min, the participants will be reminded to breathe long breaths and to try to be present in the moment.

1. The participants will be asked to shut down any electronic device.

2. The participants will be asked to sit on a chair in a comfortable way.

3. The participants will be instructed to focus on a single point on the floor or on the wall. Alternatively, the participants may choose to close their eyes.

4. The participants will be instructed to take long breaths and to excel slowly. However, the breathing should be effortless and natural.

5. The participants will be asked to try watching their thoughts without any judgment. In case their mind is being filled with thoughts, they will advised to take few long breaths.

APPENDIX G

Instructions for Exercise Combined with Meditation

The participants will arrive at the Exercise Physiology Lab in comfortable cloths and will be asked to wear a pulse strip.

Heart rate maximum will be calculated as follow: 220-age.

1. The participants will sit on a cycle ergometer bicycle in a way fitted their height.

2. The participants will warm-up for 3 min at a light pace (40% of their heart rate maximum)

3. The participants will cycle at a moderate intensity (65% of their heart rate maximum) for 20 min.

4. During the activity the participants will be asked to look at a point on the wall and to focus on their breathing.

5. At the end the participants will cool-down for 3 min or until their heart rate decreases below 100 beat/min.

APPENDIX H

Instructions for Exercise

The participants will arrive to the Exercise Physiology Lab in comfortable cloths and will be asked to wear pulse monitor.

Heart rate maximum will be calculated as follow: 220-age.

1. The participants will sit on a cycle ergometer in a way that will fit their height.

2. The participants will warm-up for 3 min at a light pace (40% of their heart rate maximum)

3. The participants will cycle at a moderate intensity (65% of their heart rate maximum) for 20 min.

APPENDIX I

Debriefing Statement

Thank you for taking part in this study. My primary purpose was to test the effect of meditation combined with exercise on blood pressure. It is well known that exercise and meditation alone can reduce blood pressure. However, the combined effect of those two was not clear.

I hope that you enjoyed your participation in this study and have learned how to reduce your blood pressure through meditation and how to combine exercise and meditation. In addition, I hope you learned about the importance of maintaining your blood pressure inside the normal limits

Contact information:

If you have any concerns or questions, please don't hesitate to contact me:

Adi Amit

607-2802204

Aamit1@ithaca.edu

Provided below is the contact information for Ithaca College's Center for Counseling and Psychological Services if you experience any negative repercussions from participating in this study.

APPENDIX J

Systolic Blood Pressure by Time and Condition

	Exercise & Meditation	Meditation	Exercise	Control
Pre	117.61 ± 8.15	117.93 ±8.71	117.29 ±8.23	116.93 ± 8.66
5 min	113.68* ± 8.31	115.86* ±8.68	113.89* ± 8.24	115.68** ± 9.58
10 min	113.82* ± 8.60	116.57** ±8.12	114.07* ± 8.10	116.29 ± 8.94
15 min	114.14* ± 8.61	116.32* ±8.81	114.25* ± 8.60	116.29 ± 9.46
30 min	114.50* ± 8.71	116.54* ±9.32	114.04* ± 8.44	116.79 ± 9.16
45 min	114.39* ± 8.69	116.29* ±9.03	114.79* ± 8.44	116.68 ± 9.86
60 min	115.36* ± 8.31	116.61* ±9.06	115* ± 8.14	116.61 ± 9.47

Note. * = $p < .01$ (difference from baseline), ** = $p < .05$ from baseline.
Values are mean ± standard deviation.

APPENDIX J (continued)

Diastolic Blood Pressure by Time and Condition

	Exercise & Meditation	Meditation	Exercise	Control
0 min	73.68 ± 5.53	74 ± 6.61	74.14 ± 5.90	73.39 ± 6.02
5 min	71.07*± 5.58	73.36 ± 6.77	72.25* ± 5.92	72.46 ± 6.64
10 min	71.89* ± 5.93	72.64* ± 7.08	72.72* ± 6.23	72.25 ± 6.86
15 min	72.57** ± 6.17	72.86** ± 7.20	72.50* ± 5.95	73.39 ± 6.86
30 min	72.29 ± 6.77	73.46 ± 6.52	72.68** ± 5.91	73.14 ± 6.76
45 min	72.71 ± 6.11	72.75* ± 6.64	72.82 ± 6.32	73.75 ± 6.35
60 min	72.68** ± 6.31	72.89 ± 6.67	72.46* ± 5.62	73.50 ± 6.56

Note. * = $p < .01$ (difference from baseline), ** = $p < .05$ from baseline.
Values are mean ± standard deviation

APPENDIX K

Raw Data

Pre-intervention (time 0)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	117/73	121/72	120/75	112/70
2	F	NO	109/69	114/67	110/68	112/72
3	F	YES	123/73	120/74	126/78	120/75
4	F	YES	117/75	120/72	122/72	116/72
5	F	NO	122/72	120/73	113/75	122/76
6	F	NO	106/74	114/74	110/72	107/72
7	F	NO	120/72	116/74	119/79	118/72
8	F	YES	116/76	116/78	115/75	117/70
9	F	YES	98/61	96/57	95/64	98/60
10	M	NO	120/71	121/73	118/72	121/79
11	M	NO	111/71	116/68	112/69	114/65
12	F	NO	123/72	114/72	114/72	112/68
13	M	NO	118/78	117/65	114/72	114/72
14	F	NO	120/69	115/74	123/72	112/73
15	F	NO	114/66	107/67	112/72	115/65
16	F	NO	111/67	108/68	116/68	115/72
17	F	YES	118/78	121/76	117/72	115/72
18	M	YES	117/69	114/78	114/72	112/72
19	M	YES	127/82	125/75	125/78	126/82
20	F	NO	122/80	123/79	124/82	127/79
21	M	NO	135/85	128/78	129/89	128/84

APPENDIX K (continued)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
22	M	NO	124/84	123/79	124/76	119/77
23	M	NO	118/78	124/79	121/79	125/82
24	F	NO	113/69	110/70	111/69	107/70
25	F	NO	139/88	138/75	136/88	142/85
26	M	NO	125/80	124/78	124/76	124/76
27	M	NO	118/78	124/80	118/68	121/78
28	F	NO	101/62	104/68	102/64	103/65

5 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	115/71	116/70	114/72	112/67
2	F	NO	109/68	108/65	107/65	110/71
3	F	YES	121/74	117/73	118/75	118/73
4	F	YES	115/74	117/70	118/70	115/70
5	F	NO	120/72	115/69	110/72	123/78
6	F	NO	104/75	109/73	108/69	104/70
7	F	NO	117/71	114/73	115/75	116/72
8	F	YES	115/75	114/73	112/72	118/71
9	F	YES	97/59	94/55	93/63	95/60

APPENDIX K (contiuned)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
10	M	NO	119/70	118/69	116/71	119/77
11	M	NO	109/69	112/67	107/67	113/65
12	F	NO	121/75	108/65	110/69	109/65
13	M	NO	117/78	114/73	108/69	112/72
14	F	NO	117/68	112/72	120/71	110/72
15	F	NO	112/66	104/66	108/71	112/63
16	F	NO	110/67	102/63	112/67	113/69
17	F	YES	118/77	118/74	115/70	114/70
18	M	YES	114/67	111/73	111/69	109/71
19	M	YES	125/82	120/72	121/77	125/82
20	F	NO	119/81	121/78	119/79	129/78
21	M	NO	133/84	124/76	127/87	132/80
22	M	NO	121/81	119/76	122/74	121/80
23	M	NO	115/75	117/77	118/77	123/85
24	F	NO	109/71	107/69	110/70	105/69
25	F	NO	137/88	134/84	134/87	140/86
26	M	NO	122/79	123/73	122/78	123/76
27	M	NO	116/77	118/76	116/75	119/75
28	F	NO	97/60	97/66	98/62	100/62

APPENDIX K (continued)

10 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	114/72	116/70	115/73	115/73
2	F	NO	111/70	113/66	106/66	112/74
3	F	YES	121/74	116/73	116/78	119/72
4	F	YES	114/73	115/72	118/71	121/72
5	F	NO	122/70	115/70	114/70	122/80
6	F	NO	104/76	109/72	106/70	105/72
7	F	NO	118/70	114/74	114/76	114/70
8	F	YES	114/73	113/75	114/73	120/74
9	F	YES	101/58	95/56	94/62	97/59
10	M	NO	117/70	119/71	114/70	119/78
11	M	NO	109/67	111/69	110/70	110/67
12	F	NO	122/69	104/69	112/70	108/66
13	M	NO	116/75	116/74	109/71	113/71
14	F	NO	11866	110/68	119/71	109/71
15	F	NO	113/65	103/65	110/71	112/63
16	F	NO	112/66	100/64	114/68	112/66
17	F	YES	122/76	116/73	114/72	114/72
18	M	YES	116/67	112/75	111/70	108/72
19	M	YES	124/83	122/73	120/79	129/84
20	F	NO	123/80	124/76	121/79	128/77
21	M	NO	133/84	124/76	127/87	132/80

APPENDIX K (continued)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
22	M	NO	121/82	121/80	124/78	121/79
23	M	NO	116/76	123/75	118/79	127/83
24	F	NO	111/68	108/68	108/69	104/70
25	F	NO	13687	135/88	135/86	142/87
26	M	NO	121/81	119/77	119/76	122/78
27	M	NO	116/76	115/78	114/74	120/80
28	F	NO	99/60	99/66	98/58	101/61

15 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	114/69	114/72	115/74	107/71
2	F	NO	110/67	112/67	107/67	111/73
3	F	YES	122/75	116/75	121/76	122/74
4	F	YES	116/74	114/72	117/69	118/70
5	F	NO	121/74	116/72	111/73	121/76
6	F	NO	104/74	111/73	108/69	105/75
7	F	NO	118/69	115/74	116/74	115/72

APPENDIX K (contiuned)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
8	F	YES	115/75	115/76	113/73	121/70
9	F	YES	97/61	94/54	92/65	98/59
10	M	NO	116/69	118/69	117/71	119/77
11	M	NO	106/67	113/67	110/67	113/67
12	F	NO	121/71	107/70	110/69	110/65
13	M	NO	116/76	112/71	112/70	114/70
14	F	NO	118/68	113/73	120/69	111/69
15	F	NO	112/64	105/66	111/70	112/66
16	F	NO	114/65	98/67	115/70	113/72
17	F	YES	120/76	117/75	116/70	113/70
18	M	YES	115/68	112/76	108/70	110/70
19	M	YES	124/80	123/76	122/80	127/83
20	F	NO	118/78	122/77	118/80	125/82
21	M	NO	136/86	123/79	128/85	129/83
22	M	NO	122/83	124/79	122/77	123/79
23	M	NO	118/79	123/77	117/77	126/86
24	F	NO	111/69	108/66	107/67	103/71
25	F	NO	138/88	134/85	137/86	143/87
26	M	NO	120/77	120/80	116/78	122/79
27	M	NO	116/80	119/79	116/75	121/76
28	F	NO	99/58	98/65	97/59	104/63

APPENIX K (continued)

30 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	115/72	115/69	114/69	108/69
2	F	NO	107/70	113/69	106/68	108/74
3	F	YES	124/73	115/73	118/78	120/73
4	F	YES	114/77	115/73	118/72	121/76
5	F	NO	121/71	117/69	112/72	119/80
6	F	NO	106/75	112/72	105/69	104/72
7	F	NO	116/71	113/72	114/76	119/75
8	F	YES	117/74	114/76	109/70	118/71
9	F	YES	96/63	95/55	93/64	97/59
10	M	NO	119/69	119/73	116/70	118/78
11	M	NO	109/70	114/66	111/68	111/63
12	F	NO	122/70	110/70	109/70	114/70
13	M	NO	118/77	114/72	107/70	116/70
14	F	NO	117/67	112/72	121/70	114/71
15	F	NO	109/65	102/66	110/71	112/65
16	F	NO	114/69	103/65	114/67	112/70
17	F	YES	118/74	116/75	118/73	116/72
18	M	YES	116/68	113/75	110/71	112/70
19	M	YES	125/81	122/77	121/79	128/80
20	F	NO	120/80	122/80	120/80	126/79
21	M	NO	137/87	126/80	126/86	128/79
22	M	NO	122/82	121/80	124/76	124/82

APPENDIX K (continued)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
23	M	NO	117/80	119/78	114/75	124/85
24	F	NO	111/68	109/67	110/70	110/69
25	F	NO	138/85	138/87	136/86	141/88
26	M	NO	122/79	122/77	122/79	126/76
27	M	NO	117/79	119/78	115/76	122/70
28	F	NO	96/61	96/58	100/60	102/62

45 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	115/70	116/71	116/73	110/69
2	F	NO	108/67	113/68	107/67	110/73
3	F	YES	123/74	118/73	118/76	122/72
4	F	YES	117/72	117/70	120/70	120/74
5	F	NO	119/69	117/74	114/72	122/75
6	F	NO	105/72	113/73	104/65	105/74
7	F	NO	115/72	112/72	116/77	121/70
8	F	YES	118/75	114/75	113/72	123/74
9	F	YES	95/60	94/56	93/63	96/61
10	M	NO	121/70	115/71	116/70	119/76
11	M	NO	108/69	113/69	109/69	109/65

APPENDIX K (continued)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
12	F	NO	118/70	108/67	108/67	116/71
13	M	NO	115/77	114/73	109/72	114/72
14	F	NO	118/68	110/74	119/68	110/70
15	F	NO	112/67	104/65	111/70	110/67
16	F	NO	108/67	104/67	114/70	110/70
17	F	YES	118/75	115/73	117/75	115/75
18	M	YES	116/69	110/74	112/70	112/72
19	M	YES	124/79	125/75	122/78	129/82
20	F	NO	121/79	124/79	121/81	128/82
21	M	NO	134/83	124/79	128/87	130/80
22	M	NO	123/84	121/79	124/76	121/81
23	M	NO	116/79	120/79	119/79	126/84
24	F	NO	110/67	106/66	109/68	103/70
25	F	NO	139/87	135/88	135/87	140/89
26	M	NO	123/80	123/79	123/80	124/80
27	M	NO	117/76	121/79	116/75	121/73
28	F	NO	100/60	97/68	101/62	101/64

APPENDIX K (continued)

60 min post-intervention

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
1	M	YES	116/71	115/70	115/70	111/71
2	F	NO	110/68	113/67	108/67	112/71
3	F	YES	120/72	117/73	122/77	120/74
4	F	YES	113/73	117/71	119/71	118/73
5	F	NO	121/72	118/72	112/70	120/74
6	F	NO	104/72	114/74	106/67	106/75
7	F	NO	118/70	112/71	117/77	120/75
8	F	YES	118/73	115/77	114/73	120/70
9	F	YES	100/60	93/53	92/64	97/62
10	M	NO	118/70	118/70	117/70	124/75
11	M	NO	109/67	114/68	111/70	112/64
12	F	NO	121/71	112/71	112/69	115/70
13	M	NO	116/76	114/73	110/72	113/71
14	F	NO	119/68	113/73	121/71	111/70
15	F	NO	112/70	103/66	112/71	112/65
16	F	NO	112/67	107/65	115/67	110/68
17	F	YES	120/72	119/75	116/70	113/72
18	M	YES	117/68	113/76	113/71	110/71
19	M	YES	123/80	123/73	123/79	127/82
20	F	NO	12182	122/80	119/80	126/80
21	M	NO	133/83	126/78	125/86	131/83

APPENDIX K (continued)

Participants	Gender	Experience in meditation	Meditation SBP/DBP	Exercise + Meditation SBP/DBP	Exercise SBP/DBP	Control SBP/DBP
22	M	NO	121/81	119/79	123/77	123/82
23	M	NO	116/77	122/79	116/75	127/86
24	F	NO	110/69	107/68	106/67	102/70
25	F	NO	136/90	136/87	135/85	140/87
26	M	NO	123/81	124/79	122/75	123/78
27	M	NO	118/77	122/78	117/75	120/76
28	F	NO	100/61	102/69	102/63	102/63

BP in mm/Hg