UNIVERSITY OF WISCONSIN LA-CROSSE

Graduate Studies

THE EFFECTS OF THE CALM APP ON HEART RATE, BLOOD PRESSURE, AND MOOD STATES

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Clinical Exercise Physiology

College of Science and Health
Clinical Exercise Physiology

Alexa R. Christenson

December 2021

THE EFFECTS OF THE CALM APP ON HEART RATE, BLOOD PRESSURE AND MOOD STATES

By Alexa Christenson

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the Masters of Science in Clinical Exercise Physiology.

This candidate has completed the oral defense of this thesis paper.

Dr. John Porcari, Ph.D.
Thesis Committee Chairperson
On behalf of committee members named below:

4/29/21
Date

Scott Doberstein, MS
Susan Bramwell, MS

Thesis Accepted

Meredith Thomsen, Ph.D.
Dean, Graduate & Extended Learning

5/26/2021
Date

ABSTRACT

Christenson, A. R. The effects of the Calm app on heart rate, blood pressure and mood states. MS in Clinical Exercise Physiology, December 2021, 38pp. (J. Porcari)

Purpose: The purpose of this investigation was to determine if there is a reduction in resting HR, BP and an increase in positive mood states following a 4-week meditation intervention using The Calm App. This information is valuable as it can determine if meditation could be used as a supplemental intervention to medication and lifestyle changes to reduce resting HR, BP, and stress (by increasing positive mood states). **Methods:** Ten young, healthy, and recreationally active individuals served as subjects. Resting HR, SBP, DBP and mood states were assessed pretesting, after a 4-week-control period, and after using the Calm App for 4-weeks prior to going to bed. Moods states were assessed using the Profile of Mood States (POMS) questionnaire. **Results & Conclusion:** No significant differences in resting HR, systolic and diastolic BP, or mood states were found between pretesting values, control values, and post Calm App intervention values. There was tendency for total mood disturbance, tension, fatigue, and confusion scores to be lower following the Calm App intervention, but scores were also lower following the 4-week control period. This indicates that reductions could not be contributed to meditation through The Calm App.

ACKNOWLEDGEMENTS

I would like to thank my family for being my biggest support system throughout this year and all the years leading up to this. I would not be the person I am today without their guidance, support, and love. From my Dad, I have learned to be ambitious and relentless in going after what I want. From my mom, I have learned to be kind, compassionate, and strong. These qualities come from having them as role models and now that I am older, having them as friends.

My biggest thanks given to Dr. John Porcari for being my thesis chairman. I could not have completed this without your guidance, advice, snacks, and patience. It took a lot to turn this “DP” into a final thesis.

Thank you to my committee members, Scott Doberstein, MS, ATC and Sue Bramwell, MS, RCEP for their input, time, and guidance throughout this process.

Lastly, thank you to all my classmates. Although this was an unconventional year with Covid-19 I would not have changed a thing.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF APPENDICES

Page

INTRODUCTION

Heart Disease is the number one cause of death in the United States and is so prevalent that a death due to heart disease or cardiovascular disease (CVD), occurs every 37 seconds (*Heart Disease Facts*, 2020). There are many factors that contribute to the incidence of CVD, including stress, sleep quality, physical activity, nutrition, genetics, smoking, age, and gender. The most effective way to reduce the risk of CVD is by incorporating positive lifestyle changes, including changing one's diet and increasing physical activity level. The use of meditation has also been shown to be an effective intervention along with lifestyle changes to improve heart health through lowering blood pressure (BP), heart rate (HR), and to better control stress (Schneider et al., 2012). Although meditation has been around since 1500 BCE, it is still in its infancy regarding its effects on heart health (Stock, 2006).

Meditation, specifically transcendental meditation (TM), has been shown to reduce risks of CVD. Transcendental meditation is a specific form of mediation that focuses on detaching oneself from thoughts and anxiety in order to promote self-realization through repetition of a mantra or clearing one's mind of thoughts (Transcendental Meditation, 2008). The type of meditation and the medium in which it is practiced will produce different results regarding the effectiveness of the meditation.

The Calm App is a guided meditation app that offers literally thousands of classes, each led by doctors and other healthcare professionals (Experience Calm, 2019). The different types of classes and programs align with different practices of meditation, such as self-care, personal growth, stress, anxiety focus and emotions. The company

states that consistent use of the Calm App can lower stress, anxiety and improve sleep (Experience Calm, 2019).

One of the main risk factors of CVD is high BP. A high systolic and diastolic BP puts increased stress on the heart and arteries. This stress can lead to the formation of atherosclerosis plaques within the arteries which makes it more difficult for blood to flow through them (Wang et al., 2007) A high HR also has been linked to increased risks of cardiovascular events (Jenson et al., 2011). Additionally, stress has been shown to increase the risk of CVD through increases in HR and BP (Larkin, 2005). A stress response triggers hormones to be released in the body activating a “fight or flight” response. This response causes HR and BP to increase as the body prepares to handle the stressor (Firdaus, 2009).

To date, no studies have been conducted to evaluate the physiological effects of meditation through the Calm App. The purpose of this study is to evaluate the ability of the Calm App to increase positive mood states and decrease resting HR and BP. Understanding the effectiveness of meditation through The Calm App to decrease positive CVD risk factors could be valuable in heart disease prevention and rehabilitation.

METHODS

Subjects

Participants for this study included 10 apparently healthy adults between 22-25 years of age. Subjects were recruited by fliers posted and distributed around the University of Wisconsin-La Crosse campus and by word of mouth. Participants had access to a smartphone with Bluetooth that could download The Calm App. The study was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects. All subjects were provided written informed consent prior to participating in the study.

Procedures

Subjects were evaluated on three separate occasions in the Human Performance Laboratory in Mitchell Hall. They were evaluated prior to the start of the study, after a 4-week control period, and after using the Calm App for 4-weeks. Testing included having their HR and BP taken as well as completing an abbreviated Profile of Mood States (POMS) questionnaire (Curran, 1995). The initial data session consisted of obtaining the subjects height and weight. Height was measured with a stadiometer and weight was measured with a physician beam scale. Subjects laid on a treatment table with their arms relaxed and their legs uncrossed. The subjects laid quietly for 10 minutes without being spoken to and with minimal stimulus in the room to reduce variables that may have impacted resting HR, BP, or mood. The subjects wore noise cancelling headphones and the lights were turned off in the room to reduce outside stimulus. After the 10 minutes of rest, the investigator palpated the subject’s pulse on their left wrist and recorded the number of beats in one minute (BPM). Palpating the wrist for 60 seconds will give a

more accurate BPM compared to calculating BPM from beats per 15 seconds and multiplying by 4. Next, a resting BP was taken manually using a sphygmomanometer and a stethoscope. Subjects then filled out an abbreviated POMS Questionnaire which consists of 40 different adjectives. Subjects circled the number that best describes their feelings at that moment. The scale ranges from a 0 or “not at all” to a 4 or “extremely”. The subjects then returned to the laboratory after 4 weeks to be reevaluated using identical procedures as the pretesting. During the 4 weeks control period, the subjects were encouraged not to make any significant lifestyle changes.

Following the 4-week control period, all subjects meditated using the same 10-minute class called “7 Days of Calm.” They practiced meditation once a day, before they went to sleep, for 4 weeks. Following the 4-week intervention period, the subjects returned to the laboratory for a final testing session using the same procedures as were used during the first two testing sessions.

STATISTICAL ANALYSIS

Standard descriptive statistics were used to characterize the subject population and to summarize the changes observed in resting HR, BP, and mood states. A one-way ANOVA with repeated measures was used to determine differences in HR, BP, total mood disturbance, and the POMS subscales between pre-testing, control, and Calm App values. Values represent mean ± standard deviation. Alpha was set at $p<0.05$ to achieve statistical significance. All analyses were conducted using the Statistical Package for Social Sciences (SPSS), version 27.0 (Chicago, IL)

RESULTS

Ten men and women between the ages of 22-25 completed the study. Descriptive characteristics of the subjects are presented in Table 1. Data for HR, SBP, and DBP prior to the start of the study (Pre), after the 4-week control period, and after the Calm App intervention are presented in table 2. There were no significant differences in HR, SBP, and DBP between the three measurement periods. Data for the Total Mood Disturbance (TMD) and the six POMS subscales are presented in Table 3. The scores of the six subscales are also presented in Figure 1. There were not significant differences in TMD or any of the subscales between any of the measurement periods. However, there was a trend for TMD, tension, fatigue, and confusion to be lower after the Control Period and the Calm App intervention (N=10).

Table 1. Descriptive Characteristics (N=10)

	X±SD	Range
Age (yrs)	23.5±0.92	22-25
Weight (lbs)	163.6±28.75	119.1-204.5
Height (in)	67.4±3.50	62-73

Table 2. Heart Rate, Systolic and Diastolic Blood Pressure at Pre, Control and Calm App Sessions

Pre	Control	Calm App	
HR	61±10.8	64±7.6	62±7.7
SBP	104±10.2	97±11.0	102±14.8
DBP	63±5.6	62±5.9	65±6.9

Table 3. Total Mood Disturbance (TMD) and Factors at Pre, Control and Calm App Session

	Pre	Control	Calm App
TMD	103.0±9.8	97.7±8.3	96.7±7.3
Tension	3.3±2.78	2.6±2.0	2.0±2.2
Depression	0.7±1.3	0.4±0.7	0.5±0.9
Anger	0.8±1.2	0.5±0.9	1.1±1.7
Fatigue	4.3±2.8	2.4±2.8	2.1±2.0
Confusion	2.7±1.9	1.4±1.4	1.8±1.5
Vigor	9.6±4.3	9.6±4.4	10.8±4.1

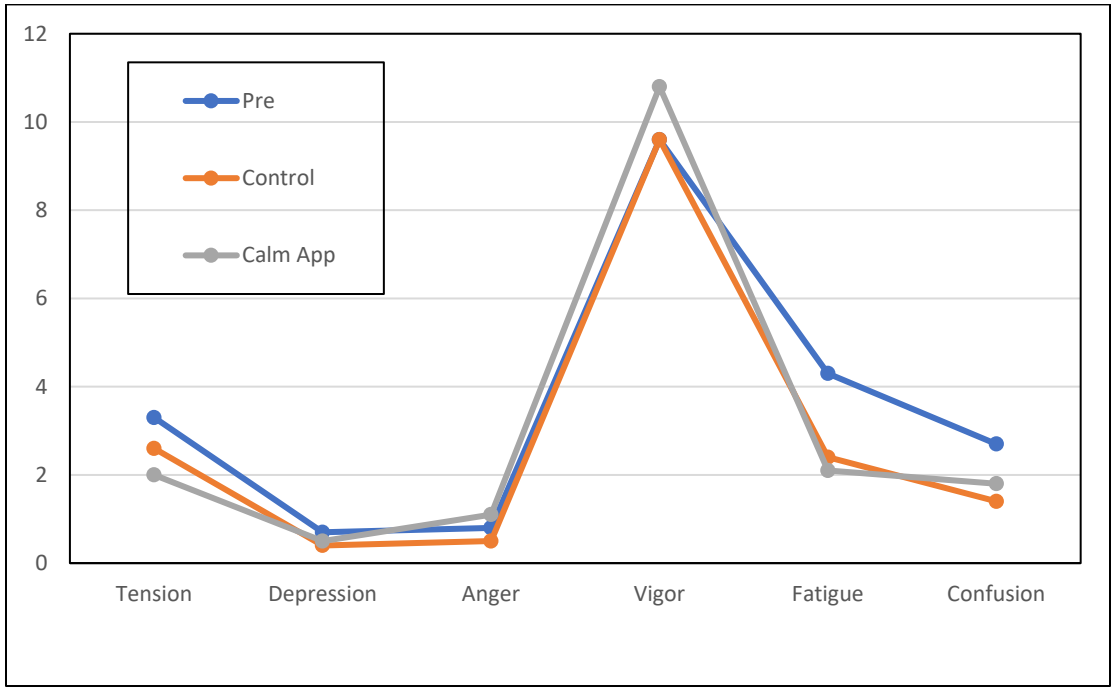

Figure 1. Total Mood Disturbance Subscale Scores

DISCUSSION

The results of this study did not find a significant reduction in resting HR, BP, or mood states following the Calm App intervention. There was a tendency for TMD, Tension, Fatigue and Confusion scores to be lower following the Calm App intervention, but they were also lower following the 4-week control period. Thus, these reductions could not be contributed to use of the Calm App.

In-person guided meditation has been shown to significantly reduce resting HR, BP and to increase positive mood states. A study conducted by Barnes et al. (1999) used 32 healthy adults divided into a TM group and control group. Heart rate and BP were assessed immediately before and during the three conditions: 20 minutes of rest with eyes open (all subjects) and either 20 minutes of TM (TM group) or eyes-closed relaxation (control). It was found that there was a greater decrease in systolic BP in the TM group than the control group. In comparison, Krygier et al. (2013) studied resting HR and HR variability following a 10-day intensive meditation retreat. The 36 individuals that completed the study had lower resting HR and lower HR variability after the 10 days of meditation intervention. The researchers noted that the findings represent differences between meditation styles and suggest that these changes in the meditation task may be attributed to ‘flow,’ or a state of positive, effortful immersion in an activity.

Another study conducted on 20 male undergraduate students found that meditation significantly lowered resting HRs compared to interventions which used biofeedback, cognitive load, incentive, and knowledge of results (Cuthbert, 1981). However, when the same procedure was used on 60 male undergraduate students as part of a continuation of the study, meditation lowered HR much less than previously

observed. It was also noted that the subjects were able to lower their HR to a greater degree when they were given performance feedback about what their HR was while they were meditating. The feedback was able to provide them with markers of performance and allow them to make changes to relax more and lower their HR.

A meta-analysis by Anderson et al. (2008) included nine randomized control trials which determined the effect of TM on both systolic and diastolic BP. The study concluded that regular practice of TM may have the potential to reduce systolic and diastolic BP by 4.7 mm Hg and 3.2 mm Hg, respectively, which are clinically significant changes. Steinhubl et al. (2015) studied the effects of meditation on neurological and cardiovascular responses. Twenty experienced and 20 novice meditators participated in a week-long wellness retreat where researchers monitored meditation sessions on the first and last full days of the retreat. Half of the participants wore a non-invasive continuous BP monitor during their meditation sessions. Participants in the study were predominately normotensive, but it was found that mean arterial pressure was reduced by 2-3 mm Hg during the 8-week meditation.

The effects of meditation on negative mental health were studied by Li-Chuan Chu (2010). Meditation and control groups participated in 8 separate 20-minute sessions over the duration of 8-weeks. The subjects were instructed to clear their mind during the meditation and to return their focus to their breath and attention on the meditation. The control group received no formal instruction and were told to sit and simply relax their mind and bodies. After the study, the meditation group was found to have statistically significant reductions in perceived stress, as measured by the Perceived Stress Scale. This

scale uses 10 questions to gauge things the subject may have felt or thought over the past month using a 0-4 likert scale from “Never” to “Very Often” (Siqueira et al., 2010).

A study conducted on surgeons, anesthesiologists, and nurses working in operating rooms used the POMS scale to determine mood changes before and after a 15-minute guided meditation session (Rangasamey et al., 2019). The Perceived Stress Scale was also used before the start of the study and found that operating room professionals tended to have higher stress levels than other professionals working in the hospital. The POMS questionnaire was administered to participants before and after the meditation session. It was found that TMDs were significantly reduced after just one time, 15-minute meditation yielding average pre and post scores of 99 and 87, respectively. A reduction was also seen in scores for the negative subscales of tension, anger, fatigue, confusion, and depression, but no significant changes were observed within the positive subscale of vigor.

To our knowledge, this is the first study conducted to examine the effects of the Calm App on physiological and psychological markers of stress. Chandler et al. (2020) found that meditation using the Tension Tamer app was able to significantly reduce resting systolic and diastolic BP, but no significant changes were found in perceived stress. Subjects completed a 12-month meditation period and found that there was an average reduction in systolic BP of 7.9 mm Hg after 3 months of meditation and further reductions of 10 and 11.6 mm Hg at 6 and 12 months, respectively. Heart rate data was not collected during this study.

It was hypothesized that the way in which measurements were made in the current study may have affected the results. In the current study, all HR and BP measurements

were made after the participants had been lying down for 10 minutes while wearing noise cancelling headphones. Research has shown that resting BP after 10 minutes of laying supine was lower than BP while in a sitting position (Krzesiński et al. 2016). The relaxed state of the participants during the rest period may have yielded lower HR and BP values, regardless of any meditation intervention. Secondly, a difference between the Tension Tamer study and the current study was the length of the intervention. The Tension Tamer study was conducted over a 12-month period, compared to a 4-week intervention of meditation using the Calm App. Meditation has been previously shown to have a dose response relationship where higher doses of meditation minutes yielding larger reductions in systolic BP (Adams et al., 2018). Another major factor why this study found no significant differences compared to both in-person guided TM and the Tension Tamer study was that the subjects in this study had low resting HR and BP values, and high mood states to begin with. Due to Covid-19 precautions, the subjects used for this study were young, healthy 22-25 year-old graduate students. The subjects already had average HRs during the pre-testing session of 61 bpm and resting systolic BP of 104 and diastolic BP of 63 mm Hg. The other studies that used TM to observe changes in HR, BP and mood states were conducted on participants that were roughly 10-20 years older and had BPs of 120-139/80-89 mm Hg. Due to the lower resting HR, BP, and TMD scores of the participants in the Calm App study, there was less room for improvement in their scores as they already had average to below average resting values.

CONCLUSION

No significant differences in HR, systolic and diastolic BP, or mood states were found between pretesting values, control values, and post Calm App intervention values.

There was tendency for a reduction in TMD, tension, fatigue, and confusion scores to be lower following the Calm App intervention, but scores were also lower following the 4-week control period. This indicates that reductions could not be contributed to meditation using the Calm App. Future studies may want to include subjects with a higher resting HR and BP values, and higher stress scores. Additionally, future studies may want to incorporate the Calm App over a longer study period (i.e., 3-4 months).

REFERENCES

Adams, Z. W, Sieverdes, J. C, Brunner-Jackson, B., Mueller, M., Chandler, J., Diaz, V., Patel, S., Sox, L. R, Wilder, S., & Treiber, F. A. (2018). Meditation Smartphone Application Effects on Prehypertensive Adults' Blood Pressure: Dose-Response Feasibility Trial. *Health Psychology*, *37*(9), 850–860.

Anderson, J. W, Liu, C., & Kryscio, R. J. (2008). Blood Pressure Response to Transcendental Meditation: A Meta-analysis. *American Journal of Hypertension*, *21*(3), 310–316.

Barnes, V A, Treiber, F A, Turner, J R, Davis, H, & Strong, W B. (1999). Acute effects of transcendental meditation on hemodynamic functioning in middle-aged adults. *Psychosomatic Medicine*, *61*(4), 525–531.

Chandler, J., Sox, L., Diaz, V., Kellam, K., Neely, A., Nemeth, L., & Treiber, F. (2020). Impact of 12-Month Smartphone Breathing Meditation Program upon Systolic Blood Pressure among Non-Medicated Stage 1 Hypertensive Adults. *International Journal of Environmental Research and Public Health*, *17*(6), 1955.

Chu, Li-Chuan. (2010). The benefits of meditation vis-à-vis emotional intelligence, perceived stress and negative mental health. *Stress and Health*, *26*(2), 169–180.

Curran, Shelly L, Andrykowski, Michael A, & Studts, Jamie L. (1995). Short Form of the Profile of Mood States (POMS-SF). Psychological Assessment, 7(1), 80–83.

Cuthbert, Bruc. (1981). Strategies of arousal control: Biofeedback, meditation, and motivation. Journal of Experimental Psychology. General, 110(4), 518–546.

"Experience Calm." *Calm*, 2019, www.calm.com/.

Firdaus S. D. (2009). A Hassle a Day May Keep the Pathogens Away: The Fight-or-Flight Stress Response and the Augmentation of Immune Function. *Integrative and Comparative Biology*, *49*(3), 215–236.

Heart disease facts. (2020, September 08). Retrieved February 04, 2021, from https://www.cdc.gov/heartdisease/facts.htm

Jensen, M. T., Marott, J. L., & Jensen, G. B. (2010). Elevated resting heart rate is associated with greater risk of cardiovascular and all-cause mortality in current and former smokers. *International Journal of Cardiology*, *151*(2), 148–154.

Krzesiński, P., Stańczyk, A., Gielerak, G., Piotrowicz, K., Banak, M., & Wójcik, A. (2016). The diagnostic value of supine blood pressure in hypertension. Archives of Medical Science, 12(2), 310–318.

Krygier, J. R., Heathers, J. A.J, Shahrestani, S., Abbott, M., Gross, J. J, & Kemp, Andrew H. (2013). Mindfulness meditation, well-being, and heart rate variability: A

preliminary investigation into the impact of intensive Vipassana meditation. *International Journal of Psychophysiology*, *89*(3), 305–313.

Larkin, K. T. (2005). *Stress and hypertension: Examining the relation between psychological stress and high blood pressure*. New Haven (Conn.): Yale University Press.

Rangasamy, V., Thampi Susheela, A., Mueller, A., F. H. Chang, T., Sadhasivam, S., & Subramaniam, B. (2019). The effect of a one-time 15-minute guided meditation (Isha Kriya) on stress and mood disturbances among operating room professionals: a prospective interventional pilot study [version 1; peer review: 2 approved]. *F1000 Research*, *8*, 335–335.

Schneider, R. H., Grim, C. E., Rainforth, M. V., Kotchen, T., Nidich, S. I., Gaylord-King, C., Salerno, J. W., Morley Kotchen, J., & Alexander, C. N. (2012). Stress Reduction in the Secondary Prevention of Cardiovascular Disease: Randomized, Controlled Trial of Transcendental Meditation and Health Education in Blacks. *Circulation Cardiovascular Quality and Outcomes*, *5*(6), 750–758.

Siqueira Reis, R., Hino, F., Akira, A., & Rodriguez Añez, R., Ciro. (2010). Perceived Stress Scale. *Journal of Health Psychology*, *15*(1), 107–114.

Steinhubl, S. R, Wineinger, N. E, Patel, S., Boeldt, D. L, Mackellar, G., Porter, V., Redmond, J. T, Muse, E. D, Nicholson, L., Chopra, D., & Topol, E. J. (2015). Cardiovascular and nervous system changes during meditation. Frontiers in Human Neuroscience, 9, 145.

Stock, B. (2006). Commentary: Reading and Healing: Reading, Healing, and the History of Western Meditation. *New Literary History*, *37*(3), 643–654.

"Transcendental Meditation: Definition of Transcendental Meditation by Oxford Dictionary on Lexico.com Also Meaning of Transcendental Meditation." *Lexico Dictionaries | English*, Lexico Dictionaries, www.lexico.com/definition/transcendental_meditation.

Wang, H.-X, Leineweber, C, Kirkeeide, R, Svane, B, Schenck-Gustafsson, K, Theorell, T, & Orth-Gomér, K. (2007). Psychosocial stress and atherosclerosis: family and work stress accelerate progression of coronary disease in women. The Stockholm Female Coronary Angiography Study. *Journal of Internal Medicine*, *261*(3), 245–254.

APPENDIX A

INFORMED CONSENT

Informed Consent

Protocol Title: Effects of The Calm App on HR, BP, and Mood States Effects of The Calm App on HR, BP, and Mood States

Principal Investigator: Alexa Christenson
925 Pine St
La Crosse, WI 54601
(507)304-2144

Emergency Contact: John Porcari
Mitchell Hall 141
La Crosse, WI 54601
(608)386-5416

- Purpose and Procedure
  - The purpose of this study is to test the validity and effectiveness of the guided meditations on The Calm App to improve resting blood pressure, heart rate and mood state scores after a period of 6 weeks.
  - Participation will involve an initial session where resting HR and BP are taken and completion of a Profile of Mood States (POMS) Questionnaire, 6 weeks of required asynchronous meditation and a follow up session repeating the initial session.
  - The total time requirement is around 30-60 minutes per data session and 10-30 minutes a day (5 out of 7 days a week) for meditation.
  - Testing will take place in the Human Performance Lab in Mitchell Hall (room 225).
- Potential Risks
  - Subjects may experience discomfort with tightness of blood pressure cuff.
  - Individuals trained in CPR, Advanced Cardiac Life Support and First Aid will be present during sessions and will end session if needed.
  - The risk of serious or life-threatening complications, for healthy individuals are very low.
- Rights & Confidentiality
  - Participation is voluntary. Participants can withdraw or refuse to answer any question without consequences at any time.
  - Subjects can withdraw from the study at any time for any reason without penalty.
  - The results of this study may be published in scientific literature or presented at professional meetings using grouped data only.
  - All information will be kept confidential and personal information will not be shared
- Possible benefits (for use if there are any direct benefits to the participant)
  - Possibility of decreased HR and BP and increased positive mood state.

- Free 1 year subscription to The Calm App ($60 value).

Questions regarding study procedures may be directed to Alexa Christenson (507-304-2144), the principal investigator, or the study advisor Dr. John Porcari, Department of Exercise and Sport Science, UW-L (608-386-5416). Questions regarding the protection of human subjects may be addressed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects, (608-785-8044 or irb@uwlax.edu).

Informed Consent

Participant_____ Date_____

Researcher_____ Date_____

APPENDIX B

ABBREVIATED PROFILE OF MOOD STATES QUESTIONNAIRE

Abbreviated POMS (Revised Version)

Name: _____ Date:

Below is a list of words that describe feelings people have. Please **CIRCLE THE NUMBER THAT BEST DESCRIBES HOW YOU FEEL RIGHT NOW**.

	Not At All	A Little	Moderately	Quite a lot	Extremely
Tense	0	1	2	3	4
Angry	0	1	2	3	4
Worn Out	0	1	2	3	4
Unhappy	0	1	2	3	4
Proud	0	1	2	3	4
Lively	0	1	2	3	4
Confused	0	1	2	3	4
Sad	0	1	2	3	4
Active	0	1	2	3	4
On-edge	0	1	2	3	4
Grouchy	0	1	2	3	4
Ashamed	0	1	2	3	4
Energetic	0	1	2	3	4
Hopeless	0	1	2	3	4
Uneasy	0	1	2	3	4
Restless	0	1	2	3	4
Unable to concentrate	0	1	2	3	4
Fatigued	0	1	2	3	4
Competent	0	1	2	3	4
Annoyed	0	1	2	3	4
Discouraged	0	1	2	3	4
Resentful	0	1	2	3	4
Nervous	0	1	2	3	4
Miserable	0	1	2	3	4

PLEASE CONTINUE WITH THE ITEMS ON THE NEXT PAGE

	Not At All	A Little	Moderately	Quite a lot	Extremely
Confident	0	1	2	3	4
Bitter	0	1	2	3	4
Exhausted	0	1	2	3	4
Anxious	0	1	2	3	4
Helpless	0	1	2	3	4
Weary	0	1	2	3	4
Satisfied	0	1	2	3	4
Bewildered	0	1	2	3	4
Furious	0	1	2	3	4
Full of Pep	0	1	2	3	4
Worthless	0	1	2	3	4
Forgetful	0	1	2	3	4
Vigorous	0	1	2	3	4
Uncertain about things	0	1	2	3	4
Bushed	0	1	2	3	4
Embarrassed	0	1	2	3	4

THANK YOU FOR YOUR COOPERATION

PLEASE BE SURE YOU HAVE ANSWERED EVERY ITEM

APPENDIX C

REVIEW OF THE LITERATURE

INTRODUCTION

Heart Disease is the leading cause of death in the United States, taking the lives of 647,000 American each year, which equates to 1 in 4 of total deaths. A death due to heart disease (CVD) occurs every 37 seconds (*Heart Disease Facts*, 2020). There are many risk factors contributing to CVD and they are distinguished by controllable risk factors and uncontrollable risk factors (*Know your Risk for Heart Disease*, 2020). Controllable risk factors are factors such as diet, exercise, sleep, blood pressure, smoking and obesity while uncontrollable factors are genetics, family history, age, and gender. The consensus for optimal health is underlined as being physically active, eating a healthy diet, managing stress, and sleeping well. These controllable risk factors are important for heart and overall health (Benjamin et al., 2019). Studies show that individuals who get the minimum recommended amount of 150 minutes of moderate activity per week have lower incidence rates for CVD, CAD, stroke, Type 2 diabetes, metabolic syndrome, osteoporotic fractures, cancers of the colon and breast and gallbladder disease (*ACSM Guidelines*, 2018). Exercise and diet are two main controllable factors that can help decrease the risk of developing CVD. There are other interventions that have recently been utilized for heart and overall health. Recent studies have shown that meditation has been an increasingly popular intervention, along with diet and exercise, to aid in lowering blood pressure (BP) and resting heart rate (HR) as well as increasing positive mood states (Schneider et al., 2012). Many factors are important to look at when determining overall health and many interventions can be used to alter health. The use of meditation intervention used through The Calm App as a prescription to lower BP, HR and increase

mood states is useful to determine that validity of this practice as a prescription for reducing positive CVD risk factors.

Health is defined as the interaction between physical, mental, and social wellbeing, and is not just the absence of illness and disease, (World Health Organization, 1997), which demonstrates the value that mental status contributes to overall health and are often overlooked. Meditation is a practice that has been around since 1500 BCE and is an umbrella term for the family of practices where one "trains their mind or self-induces a mode of consciousness in order to realize some benefit" (Stock, 2006). Meditation as a mental practice has been seen to provide many physiological benefits (Wallace, 1970).

The Calm App

The Calm App is an online application that features a wide variety of classes for the improvement of mental status, mental strength, and mental health. The classes can range from 5-60 minutes and cover topics targeting many different goals of meditation. Some of these goals include relaxation, sleep, stretching, stress relief, self-care, and personal growth. Meditation is used through the app to foster growth in these different areas. To our knowledge there have not been any studies on how meditation through the Calm App affects BP, HR and mood states (Experience Calm, 2019).

Blood Pressure

Blood pressure (BP) is a common measure of heart health. Blood pressure is expressed as two numbers, the first being systolic BP or the measure of the force against the arteries while the heart is pumping, and second number expressed as diastolic BP,

which measures the force during the hearts relaxation or filling phase. A higher resting BP indicates that the heart is having to work harder to pump and distribute blood throughout the body (Margolis, 1998). High BP or hypertension (HTN) has many different causes, including smoking, genetics, exercise, diet, stress, age, lack of physical activity and being overweight or obese. Essential HTN is where the underlying cause cannot be identified (Carey & Whelton, 2018). Approximately 45% or 108 million Americans have HTN, described as a BP higher than 130/80, or on medication for HTN. The treatments for HTN involve lifestyle changes such as quitting smoking, becoming physically active, eating well, and or taking diuretics, beta blockers, and ACE inhibitors. Meditation has also been shown to lower BP when practiced consistently (Goldstein et al., 2012). The most common type of meditation used is Transcendental Meditation (TM). Transcendental Meditation is the technique of detaching oneself from thoughts that cause harm and promoting harmony through self-realization by repeating mantras and other yogic practices (Transcendental Meditation, 2008). This is the type of meditation that is used in the Calm App.

In a randomized trial which compared TM vs. lifestyle changes for stress management, it was found that both groups had a similar reduction in BP. However, in the group which used meditation, half of the group was able to eliminate an antihypertensive medication while maintaining a safe blood pressure (Dusek et al., 2008). In a meta-analysis conducted by Anderson et al. (2008) it was concluded that regular and consistent practice of TM may have the potential to reduce systolic and diastolic BP by ~4.7 and 3.2 mm Hg, respectively, which are clinically meaningful changes. While these findings are promising and indicate a clinical benefit of meditation, the authors caution

that prior studies of the relationship between BP and TM have been criticized because of the quality of the studies and potential bias of investigators. While these results are promising, more research is needed to understand the chronic benefits of a decreased BP from meditation intervention.

Heart Rate

A normal heart at rest beats between 60-100 times per minute to distribute oxygen, nutrients, and blood throughout the body. The heart is one of the most important and complex organs in the body and because of this there can be many complications with its structure and function. An elevated resting heart rate (RHR) can be a sign of a problem in the body (Fryar et al., 2012). While an elevated HR can be caused by exercise, caffeine, or stress, it can also be a determinate of health. In a study by Jensen et al. (2010), it was found that subjects who were older were more likely to have a higher RHR, higher BMI, worse pulmonary function, greater tobacco consumption, have more sedentary lifestyles, and higher blood levels of cholesterol and triglycerides. While an elevated RHR is not shown to directly cause all those problems, it is important to note that an elevated RHR is a positive risk factor associated with health. It is also important to note that an elevated RHR may increase blood pressure at rest due to the heart contracting more times per minute to pump blood throughout the body, thus creating more force on the arteries (Palantini et al., 1999). Resting heart rate should be included as a risk factor in general risk assessments in primary prevention.

A study by Mitka (2010) explained how an elevated RHR may raise overall health risks. He found that a RHR of greater than 80 beats per minute increased the risk of cardiovascular complications. During routine checkups, an elevated RHR is frequently

documented and dismissed compared to HTN or elevated glucose levels. Palatini et al. (1999) agreed that that RHR over 80 bpm, after some rest in the doctor's office, can be associated with excessive risk of heart failure, sudden death, and myocardial infarction. They recommend exercise to bring RHR down 10-15 bpm by raising HR to 100 bpm three times a week for 30 minutes. While the effects of exercise and pharmacological intervention on lowering RHR are well studied and documented, the effects of meditation on lowering RHR are not as thoroughly documented.

A study by Zeidan et al. (2010) had 82 participants meet for a 20-minute, in person guided session meditation for 3 consecutive days. It was shown that there was a decrease in RHR of four beats per minute in young healthy adults. Even though these results are promising, more research is needed, especially in the clinical population.

Mood States

Mood states explain how individuals process the world around them and events that occur, specifically the individual's reactions to them (Joormann et al., 2007). The most common type of meditation used to influence mood states is transcendental. Transcendental Meditation is a way of thinking of a mantra or repeating a meaningless sound and going back to the mantra when the mind begins to wander or is forgotten (Travis & Parim, 2017). It has been shown that the mind has a powerful effect on the body. The brain has an immense intrinsic network that is influenced by external stimuli that can cause physiological changes to the body. Physiological changes occur from negative mood states occur when specific hormones are released as a response to external stressors or stimuli being processed by the brain. When stressed, the body releases

cortisol; when hungry the hormone ghrelin is released; and when happy the hormones dopamine and serotonin are produced (Tomiyama & Mann, 2011).

Stress, both eustress and distress, causes a surge of hormones throughout the body that cause the heart to beat faster and vessels to vasoconstrict (Larkin, 2005). As the heart beats faster and the blood vessels constrict, BP rises as the blood pumping through the body pushes harder against the vessel walls. In the clinical population, this can cause problems as it creates stress on the heart as it works harder to circulate blood throughout the body. While stress causes an increase in HR and BP acutely, the chronic effects of stress on the body can lead to unhealthy coping behaviors such as smoking, increased consumption of alcohol, and unhealthy eating habits (Firdaus, 2009), which are also risk factors for heart disease.

Mood states are often evaluated using The Profile of Mood States (POMS) questionnaire, which uses 65 items that are rated on a five-point response format (Andrade & Rodríguez, 2018). The user rates the moods based upon how they are feeling "right now" on a Likert scale from "not at all" to "extremely" for each item. The questions yield scores for six factors: tension, depression, anger, fatigue, confusion, and vigor. The abbreviated POMS scale only uses 40 items divided into the same six factors. To score the POMS, tension, depression, anger, fatigue and confusion scores are added together, and the vigor score is subtracted. The final score is added to 100 to ensure there are no negative numbers (Curran et al., 1995). Profile of Mood States scales have been used in prior studies to determine the effectiveness of TM on mood states and it was found that implementing TM had a positive affect and was effective at reducing psychological stress (Travis et al., 2018). A study conducted by Yuen and Shinpark

(2006) evaluated the ability of the POMS to be used in different settings and cultures. The results concluded that the POMS questionnaire was able to accurately capture total mood disturbance in various settings.

Conclusion

Guided meditation has been shown to decrease RHR, BP, and reduce total mood disturbance when used acutely or consistently over a period of weeks (Wallace, 1970). Although meditation has been around for thousands of years, the use of meditation as a supplemental intervention to improve heart health is a relatively new idea that could benefit apparently healthy individuals along with those suffering from chronic heart conditions (Dillbeck & Orme-Johnson, 1987). While meditation can be done with very little training, guided meditation is more effective in improving heart health and can have increased benefits when done properly (Phongsuphap et al., 2008). The effects of meditation have not been shown to be strong enough to be used as the only intervention for heart health in patients with CV disease, it has been shown to result in small improvements to risk factors for heart disease that aid in heart health (Anderson et al., 2008). Testing the validity and effectiveness of the Calm Apps to impact risk factors for heart disease will be helpful if proven effective as an accessible treatment intervention for heart health.

REFERENCES

ACSM's Guidelines for Exercise Testing and Prescription. Wolters Kluwer, 2018.

Anderson, J. W., Liu, C., & Kryscio, R. J. (2008). Blood Pressure Response to Transcendental Meditation: A Meta-analysis. *American Journal of Hypertension*, *21*(3), 310–316.

Andrade, E., & Rodríguez, D. (2018). Factor structure of mood over time frames and circumstances of measurement: Two studies on the Profile of Mood States questionnaire. PloS one, 13(10).

Benjamin, E. J., Muntner, P., Alonso, A., Bittencourt, M. S., Callaway, C. W., Carson, A. P., Chamberlain, A. M., Chang, A. R., Cheng, S., Das, S. R., Delling, F. N., Djousse, L., Elkind, M., Ferguson, J. F., Fornage, M., Jordan, L. C., Khan, S. S., Kissela, B. M., Knutson, K. L., Kwan, T. W., … American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee (2019). Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. Circulation, 139(10), e56–e528.

Carey, R. M., & Whelton, P. K. (2018). Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Synopsis of the 2017 American College of Cardiology/American Heart Association Hypertension Guideline. *Annals of Internal Medicine*, *168*(5), 351–358.

Curran, S. L., Andrykowski, M. A., & Studts, J. L. (1995). Short Form of the Profile of Mood States (POMS-SF). Psychological Assessment, 7(1), 80–83.

Dillbeck, M. C., & Orme-Johnson, D. W. (1987). Physiological Differences Between Transcendental Meditation and Rest. *The American Psychologist*, *42*(9), 879–881.

Dusek, J. A., Hibberd, P. L., Buczynski, B., Chang, B-H., Dusek, K. C., Johnston, J. M., Wohlhueter, A. L., Benson, H., & Zusman, R. M. (2008). Stress management versus lifestyle modification on systolic hypertension and medication elimination: a randomized trial. *The Journal of Alternative and Complementary Medicine (New York, N.Y.)*, *14*(2), 129–138.

"Experience Calm." *Calm*, 2019, www.calm.com/.

Firdaus S. D. (2009). A Hassle a Day May Keep the Pathogens Away: The Fight-or-Flight Stress Response and the Augmentation of Immune Function. *Integrative and Comparative Biology*, *49*(3), 215–236.

Fryar, C. D., Chen, T-C., & Li, X. (2012). Prevalence of uncontrolled risk factors for cardiovascular disease: United States, 1999-2010. *NCHS Data Brief*, *103*, 1–8.

Goldstein, C. M., Josephson, R., Xie, S., & Hughes. J. W. (2012). Current Perspectives on the Use of Meditation to Reduce Blood Pressure. *International Journal of Hypertension*, *2012*, 578397–11.

Heart disease facts. (2020, September 08). Retrieved February 04, 2021, from https://www.cdc.gov/heartdisease/facts.htm

Jensen, M. T., Marott, J. L., & Jensen, G. B. (2010). Elevated resting heart rate is associated with greater risk of cardiovascular and all-cause mortality in current and former smokers. *International Journal of Cardiology*, *151*(2), 148–154.

Joormann, J., Siemer, M., & Gotlib, I. H. (2007). Mood Regulation in Depression. Journal of Abnormal Psychology (1965), 116(3), 484–490.

Know your risk for heart disease. (2019, December 09). Retrieved February 04, 2021, from https://www.cdc.gov/heartdisease/risk_factors.htm

Larkin, K. T. (2005). *Stress and hypertension: Examining the relation between psychological stress and high blood pressure*. New Haven (Conn.): Yale University Press.

Margolis, S., Klag, M. J., & Johns Hopkins Medical Institutions. (n.d.). *Hypertension (Johns Hopkins Medical Institutions)*. Johns Hopkins Medical Institutions ; Medletter Associates.

Mitka, M. (2010). High Heart Rate May Raise Health Risks. *JAMA : the Journal of the American Medical Association*, *304*(9), 949–950.

Palatini, P., Casiglia, E., Julius, S., & Pessina, A. C. (1999). High Heart Rate: A Risk Factor for Cardiovascular Death in Elderly Men. *Archives of Internal Medicine (1960)*, *159*(6), 585–592.

Phongsuphap, S., Pongsupap, Y., Chandanamattha, P., & Lursinsap, C. (2007). Changes in heart rate variability during concentration meditation. *International Journal of Cardiology*, *130*(3), 481–484.

Schneider, R. H., Grim, C. E., Rainforth, M. V., Kotchen, T., Nidich, S. I., Gaylord-King, C., Salerno, J. W., Morley Kotchen, J., & Alexander, C. N. (2012). Stress Reduction in the Secondary Prevention of Cardiovascular Disease: Randomized, Controlled Trial of Transcendental Meditation and Health Education in Blacks. *Circulation Cardiovascular Quality and Outcomes*, *5*(6), 750–758.

Stock, B. (2006). Commentary: Reading and Healing: Reading, Healing, and the History of Western Meditation. *New Literary History*, *37*(3), 643–654.

Tomiyama, A. J., & Mann, T. (2011). Commentary on Crum, Corbin, Brownell, and Salovey (2011). *Health Psychology*, *30*(4), 430–431.

"Transcendental Meditation: Definition of Transcendental Meditation by Oxford Dictionary on Lexico.com Also Meaning of Transcendental Meditation." *Lexico Dictionaries | English*, Lexico Dictionaries, www.lexico.com/definition/transcendental_meditation.

Travis, F., Valosek, L., Konrad, A., Link, J., Salerno, J., Scheller, R., & Nidich, S. (2018). Effect of meditation on psychological distress and brain functioning: A randomized controlled study. Brain and Cognition, 125, 100–105.

Travis, F., & Parim, N. (2017). Default mode network activation and Transcendental Meditation practice: Focused Attention or Automatic Self-transcending? *Brain and Cognition*, *111*, 86–94.

Wallace, R. K. (1970). Physiological Effects of Transcendental Meditation. *Science (American Association for the Advancement of Science), 167*(3926), 1751–1754.

World Health Organization (1997). *Measuring Quality of Life: The World Health Organizations Quality of Life Instruments (The WHOQOL-100 and the WHOQOL-BRE).* Geneva: WHO (WHO/MSA/MNH/PSF/97.4).

Yeun, E. J., & Shinpark, K. K. (2006). Verification of the profile of mood states-brief: Cross-cultural analysis. Journal of Clinical Psychology, 62(9), 1173–1180.

Zeidan, F., Johnson, S. K., Gordon, N. S., & Goolkasian, P. (2010). Effects of brief and sham mindfulness meditation on mood and cardiovascular variables. *The Journal of Alternative and Complementary Medicine (New York, N.Y.), 16*(8), 867–873.