UNIVERSITY OF CALIFORNIA

Los Angeles

Mindfulness and Lifestyle Education for Blood Pressure Reduction in Hypertension

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Nursing

by

Eunjoo An

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ABSTRACT OF THE DISSERTATION

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by

Eunjoo An

Doctor of Philosophy in Nursing

University of California, Los Angeles, 2019

Professor Paul Michael. Macey, Chair

This dissertation contains two related studies as shown in the two abstracts below. Chapter 1 thru Chapter 4 are the original dissertation chapters. Chapter 5 thru 7 describes the main study where we evaluated mindfulness as an intervention to improve lifestyle behaviors in people with HTN, and these chapters are in manuscript form. Chapter 8, also in manuscript form, provides study results on obstructive sleep apnea (OSA) and hypertension (HTN) as OSA is a risk factor for HTN. The purpose of the OSA/HTN was to evaluate the time of diagnosis between OSA and HTN.

Abstract 1 Mindfulness on Lifestyle Behaviors

Introduction: HTN is the leading modifiable cardiovascular risk factor affecting 103 million adults in the US. A healthy diet and engaging in regular physical activity are key components in lifestyle medicine for maintaining normal BP. Yet, most Americans struggle making these changes. We evaluated the effects of mindfulness practice on lifestyle behaviors and BP. **Hypothesis:** We hypothesize that the mindfulness practice will improve lifestyle behaviors and BP in patients with HTN, relative to health education only. **Methods:** We recruited 36 adults (75% female) with elevated BP (> 120/80), aged 60.8 ± 11.5 years and

block randomized them to Mindful Awareness Program (MAP) or Health Promotion Program (HPP). Both groups MAP (n = 20) and HPP (n=16) received training for 6 weeks in their respective programs. Weekly BP, diet, exercise and medication adherence data were collected for a total of 12 weeks. Relationships with outcome measurements were compared between the two groups by linear mixed model with repeated measures. **Results:** Interaction between time and groups was significant. Mediational analysis of MAP group data showed that the total effect of mindfulness practice minutes on SBP with indirect effect (ab) of (-.057) was significant, resulting in a 40% lower SBP for total effect (c) compared to direct effect (c`) alone. **Trial Registration Number:** NCT03924531.

Abstract 1 OSA and HTN

Introduction: Obstructive sleep apnea (OSA), a breathing disorder that effects around 30 million people nationally, is considered a primary risk factor for hypertension (HTN). A common model is that OSA pathophysiology leads to HTN, implying that treating OSA would help prevent or resolve HTN. However, randomized trials of treating OSA with continuous positive airway pressure (CPAP) show inconclusive effects on HTN, raising questions about the links between the two conditions. Since the CPAP findings are inconsistent with the OSA-causes-HTN model, we sought to assess clinical evidence that OSA precedes HTN. **Objective:** To determine if diagnosis of OSA precedes diagnosis of HTN. **Design, Setting, and Participants:** A retrospective evaluation of electronic health record with OSA and HTN diagnosis within UCLA health system. Data analysis was performed from January 1, 2006, to December 31, 2016. **Main Outcomes and Measures:** Days of diagnosis between OSA and HTN by age and sex differences – the first OSA diagnosis was set as 0 (relative starting point), and the time difference represented as days to first HTN diagnosis. **Results:** Of the 1.6 million patient records evaluated (n = 1,654,067) with at least one diagnosis, approximately 2% (29,764) contained OSA diagnoses and 14% (192,771) contained HTN diagnoses. There were 16,974 (1%) patient records with both diagnoses of

OSA and HTN, of which 36% (6124) had a sleep study within the UCLA Health System (A sleep study is required to diagnose OSA). We defined long-term care as patients with encounters at least a year before and after OSA diagnosis, who comprise 29% (4848) of records the OSA/HTN patients.

The dissertation of Eunjoo An is approved.

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Michael Ray Irwin

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University of California, Los Angeles

2019

DEDICATION

To my patients.

To my participants.

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Acknowledgements

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PUBLICATIONS/WORK IN PROGRESS

An, E. (2013). *Factors Associated with LBW Babies in Non-Hispanic Black Women*. [Master's thesis]. California State University, Los Angeles

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An, E., Irwin MR., Doering, LV., Brecht, M., Watson, KE., Aysola, R., Macey, PM. Which came first, obstructive sleep apnea or hypertension? *The Journal of the American Medical Association* [In review; sub# JAMA19-3791]

An, E., Irwin MR., Doering, LV., Brecht, M., Watson, KE., Macey, PM (2019). Meditation as a Clinical Intervention to Facilitate Eating and Exercise Behaviors for CV Risk Reduction: A Focused Review. [Manuscript in preparation]

An, E., Irwin MR., Doering, LV., Brecht, M., Watson, KE., Macey, PM (2019) Mindfulness Practice and Reduction in Blood Pressure: Mediation by Health Behaviors. [Manuscript in preparation]

ABSTRACTS/PRESENTATIONS

Booth, P., & **An E.** (2011). Decreasing cannulation IV time for difficult access via ultrasound. Poster presentation at: Emergency Nursing Leadership 2011 Conference, Portland, OR.
An, E. (2013). Factors Associated with LBW Babies in Non-Hispanic Black Women. Unpublished master's thesis, California State University, Los Angeles
An, E., Aguila, A., Watson, K., Irwin, M. R., Aysola, R., Doering, L., Harper, R. M., Macey, P. M. (2016). Female and Male Obstructive Sleep Apnea Patients Show Prior Diagnosis of Co-morbid Hypertension and Mental Health Conditions [abstract]. In: Society of Neuroscience Annual Meeting; 2016 Nov 12 – 16; San Diego, CA.
An, E., Aguila, A., Watson, K., Aysola, R., Doering, L., Harper, R. M., Macey, P. M. (2017). A Re-evaluation of Sleep Apnea as a Causal Factor for Hypertension [abstract]. In: Western Institute of Nursing's 50th Annual Communicating Nursing Research Conference; Apr 12 – 22; Denver, CO.
An, E., Irwin MR., Doering, LV., Brecht, M., Watson, KE., Macey, PM (2018). Hypertension Lifestyle Behavior Changes with Mindfulness Practice [abstract]. In: 23rd Joint Southern California Chapters STTI Nursing Odyssey Conference; Nov 8,9, San Diego, CA.
An, E., Irwin MR., Doering, LV., Brecht, M., Watson, KE., Macey, PM (2019). Cardiovascular Disease Risk Reduction through Meditation: A Focused Review [abstract]. In: Western Institute of Nursing's 52th Annual Communicating Nursing Research Conference; Apr 10 – 13; San Diego, CA.

INVITED PRESENTATION/LECTURE

4/2017	Promoting Adherence to Hypertension Self-management Behaviors through Mindfulness Practice. Sigma Theta Tau International 40th Chapter Anniversary and Induction Ceremony.
5/2018	*Hypertension and Cardiovascular Diseases.* UCLA Nursing 160: Secondary Prevention.
7/2018	Mindfulness Practice and Health Behavior Change among Adults with High Blood Pressure. UCLA Summer Health Professionals Education Program.
7/2018	Promoting Healthy Lifestyle Adoption and Maintenance through Mindfulness Practice by way of Improving Self-Regulation. UCLA Psychiatry 175: Mindfulness Practice and Theory.
1/2019	*Autonomic Nervous System* UCLA Nursing 115: Pharmacology and Therapeutics.
2/2019	*Antihypertensives Hematologic pharmacology* UCLA Nursing 115: Pharmacology and Therapeutics.

EXPERIENCE: COMPUTER SCIENCE, CLINICAL, TEACHING

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Chapter 1: Introduction to Dissertation, Study Background, Purpose, Aims

Hypertension is a chronic medical condition characterized by elevated blood pressure that affects a third of adults in the United States.[1,2] It is a primary risk factor for cardiovascular diseases and accounts for nearly 10 million deaths every year worldwide.[3] In the majority of cases, hypertension is preventable and manageable through lifestyle modifications, specifically a healthy diet and physical activity.[4] However, many with hypertension do not follow with these recommended lifestyle behavior changes. Recent estimates indicate that over half of individuals with hypertension report poor blood pressure control, suggesting that many either ignore the information or do not have the adequate resources or ability to follow through with the therapeutic guidelines.[5]

The traditional method of offering general information or technical skills for the care of hypertension may be inadequate to prompt most individuals to adopt healthy behaviors, so other approaches are needed. A possible approach to influence health behavior change is mindfulness practice, which have been used in diverse populations for various mental and physiological disorders.[6] In addition, mindfulness-based therapies have been shown to be beneficial for eliciting healthier food choices, better control of impulse eating, weight control, and smoking cessation.[7-9] But no study has evaluated mindfulness practice and its effect on behavior change among adults with hypertension. Therefore, the primary goal of this study is to evaluate the UCLA's Mindful Awareness Program on health behavior change among adults with hypertension.

Definition and Consequence of Hypertension

Hypertension is a physiobiological condition characterized by a persistent elevation in the systemic blood pressure. Medically, two broad categorizations of hypertension exist: one is referred to as primary (essential) hypertension, while the other is referred to as secondary hypertension because of its associated known cause. About 80% to 90% of all hypertension diagnoses are considered primary hypertension.[10,59] The cause of primary hypertension tends to be multifactorial involving a combination of genetics, lifestyle behaviors, and environmental factors.[4,10] Secondary hypertension, however, is normally

associated with one main causal factor. Some of the identifying causes of secondary hypertension include renal disease or structural abnormalities, endocrine dysfunction, neurological conditions, obstructive sleep apnea, disease of the aorta, exogenous hormones, and pregnancy.[11-13] Unlike primary hypertension, secondary hypertension is potentially curable when the secondary cause is eliminated or resolved.[11,13] This dissertation focuses on adults with primary hypertension because this accounts for most of the hypertension diagnosis today.[10,13,59]

Effective self-management of hypertension involves adherence to lifestyle behaviors, specifically a healthy diet with low sodium and regular physical activity.[4,14,15] Medication adherence is also an essential self-management behavior for optimal blood pressure control. However, adherence to medication and lifestyle behaviors among those with hypertension are inadequate.[16] For example, studies report 20% to 50% of adults with hypertension comply with their prescribed medication regimen, and only about 30% adhere to a healthy diet.[17-21] Studies have found that a well-controlled blood pressure reduces the risk of stroke and heart disease while improving overall overall cardiovasculor health.[4,14,15]

Conversely, poor managed blood pressure can lead to catastrophic health outcomes. For instance, poor hypertension control has been linked to 54% of all stroke incidences and 47% of ischemic heart diseases in the United States.[22] In addition, about 40% of all cardiovascular-related deaths were attributable to hypertension.[23] Studies have shown that even small increments in blood pressure can adversely affect health outcomes, including increase in mortality. For instance, according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7) report, mortality rates double with each 20mmHg increment of systolic blood pressure or 10mmH increment of diastolic blood pressure.[4]

Poor adherence levels to hypertension treatment regimens reflects the difficulty in modifying heath behaviors. An integral part of behavior change involves a process known as the self-regulatory process.

Self-regulation is an important aspect in most behavior modifications and will be discussed in more detail in the next section.[24]

Self-Regulation

Self-regulation is a key internal mechanism for the engagement of proper self-care behaviors.[25,26] Bandura's Social Cognitive Theory of Self-regulation suggests that the self-regulation system functions through three psychological sub-operations, which consist of 1) self-monitoring, 2) judgmental sub-function, and 3) reactive influences.[24,27] Controlling one's behavior and choosing the proper behaviors are important features of self-care for optimal chronic disease management.[25,26] Having a chronic condition necessitates that individuals constantly monitor and engage in health promoting behaviors in order to reduce the negative effects of the disease process. Those individuals that do not follow through and properly manage their chronic condition usually exacerbate the disease condition, leading to a health crisis.

According to Bandura's Theory of Self-regulation, self-regulation is an internal process and a mechanism that consistently adjusts and redirects thoughts and behavior. The self-regulatory process itself is guided by self-reflection, evaluation of past experience, and cues from the environment.[27] The process of self-regulation is a key concept in behavior change.[28,29] When the self-regulatory process is functioning appropriately the behavior is tends to be purposeful and with concrete intentions.[27] Moreover, purposeful action is associated with greater control in adoption and maintenance of positive health behaviors.[29,30] However, at times, the self-regulatory process may be deficient. The self-regulatory process is likened to an energy source, therefore depletable.[31,32] The depletion of the self-regulatory process is usually associated with one's lack of the motivation or self-drive to a particular behavior.[31,32] When the self-regulatory process performs sub-optimally, the 'self' is in the state of ego depletion, resulting in the 'self' engaging in less than ideal choices and actions.[31,32]

An important aspect of the self-regulatory depletion is that the process can be strengthened or restored to baseline. [31] Colloquially, the act of self-regulation is known as willpower or self-control.[31] A possible mechanism to restore the self-regulatory process is the practice of mindfulness.[33]

Mindfulness Practice for Health

Over the years, researchers have used mindfulness-based therapies to treat various psychological and behavior issues, including eating disorders, obsessive compulsive disorders, chronic pain management, smoking cessation, and system management associated with post-traumatic stress disorder.[9,34-37] However, few studies, if any have evaluated mindfulness as an intervention to modify a set of self-care behaviors related to effective hypertension self-management.

Understanding the mechanisms of how mindfulness affects psychological and cognitive function is still very much in its infancy. Behavior psychologists are discovering that mindfulness affects the psyche by way of "uncluttering" the mind of unnecessary thoughts, thereby promoting a sense of awareness to the present.[33] The result of 'being in the present' appears to increase the aspect of self-monitoring, leading to improved self-awareness.[33] Theorists have hypothesized that the increase in self-awareness reestablishes the self-regulatory process.[33]

Mindfulness practice is a mind training method for the consciousness to become more aware of the present moment experience. The acute sense of 'now' is associated with heightened awareness of 'self,' an important internal shift within the mind.[38,39] This shift results in the self-regulatory process to resume, a vital process that is essential for generating positive behavior.

Guidelines for Hypertension Self-Management

The current guidelines reported by the Eighth Joint National Committee (JNC8) emphasize the importance of lifestyle modification as the first-line treatment for the prevention and management of hypertension.[15] Allied healthcare providers are encouraged to reinforce lifestyle behavior modifications through the course of treatment for patients with hypertension, regardless of whether anti-hypertensive

medications are part of the initial treatment plan.[15] Of these lifestyle modifications, diet, physical activity, and weight control appear to be essential for optimal management of hypertension. Other key health behavior modifications for optimal blood pressure control include smoking cessation and limited alcohol consumption.[15,40] This study will focus on behavior change related to diet, physical activity, and medication adherence; because, these three behaviors empirically have been shown to have the most positive impact on blood pressure.[4]

Chronic Disease and Management of Chronic Disease

According to the U.S National Center for Health Statistics, a chronic disease is a medical condition that lasts longer than three months.[41] Examples of chronic diseases include hypertension, diabetes, heart disease, chronic obstructive pulmonary disease, and asthma. It is a progressive condition that requires medical treatment. In literature and healthcare settings "chronic disease," "chronic illness," and "chronic condition" are all used interchangeably. This study will use the term chronic disease consistent with the U.S National Center for Health Statistics definition.

Chronic Disease Self-management is a set of behaviors that individuals are prescribed for the treatment of their chronic disease.[42,43] Self-management related activities in the context of chronic disease were first used and described by the work of Thomas Creer and colleagues published in the mid-1970s.[44,45] Their initial study described and evaluated discharge instructions on children with chronic asthma. They created a comprehensive discharge plan, including instructions for self-care of asthma at home.[44] Since that time, other terms such as "self-care," "patient counseling," and "self-regulation" have been used interchangeably to describe the active participation in the day-to-day activities by individuals with chronic disease.

The term "chronic disease self-management" for this study is based on Dr. R. Lorig meaning of self-management. Dr. Lorig emphasizes that the self-management of a chronic disease is not an option to

partake but a necessity when one has a chronic disease.[46,47] The self-management process involves engaging in a pre-determined set of behaviors usually on a daily basis, requiring long-term commitment and engagement by the individuals.[46] These activities can range from medication intake to daily blood pressure monitoring. Also, many may experience emotions such as fear, anger, anxiety frustration, and depression related to the self-management of their chronic disease.[42,48-51] Therefore, not only does effective chronic disease self-management require follow-through of recommended health behavior changes, but also the development and acquisition of resources and skills to manage emotional distress associated with chronic disease diagnosis and treatment regime.[46]

Hypertension Self-Management

Hypertension self-management fits within the broad framework of chronic disease self-management.[46] Unlike diabetes self-management, to date, there is no validated instrument or questionnaire that measures level of hypertension self-management. Diabetes self-management health behaviors and skills have been aggregated into one instrument called Self-care Inventory (SCI).[52] The SCI measures diabetes self-management activities, which include glucose monitoring, food portions, food types, and medication adherence.[53] However, because there is not a self-reported measurement for hypertension self-management, this study will measure the self-management activities separately using these three instruments:

1) 8-item Morisky Medication Adherence Scale for medication adherence;
2) Rapid Eating and Activity Assessment for Patients for diet; and
3) 3-item Brief Physical Assessment tool for exercise.

In addition, *hypertension self-management* is operationalized as these following four self-management activities:

1) Diet adjustments (increase in fruit and vegetable intake, decrease in sodium consumption; Adoption and maintenance of physical activity;

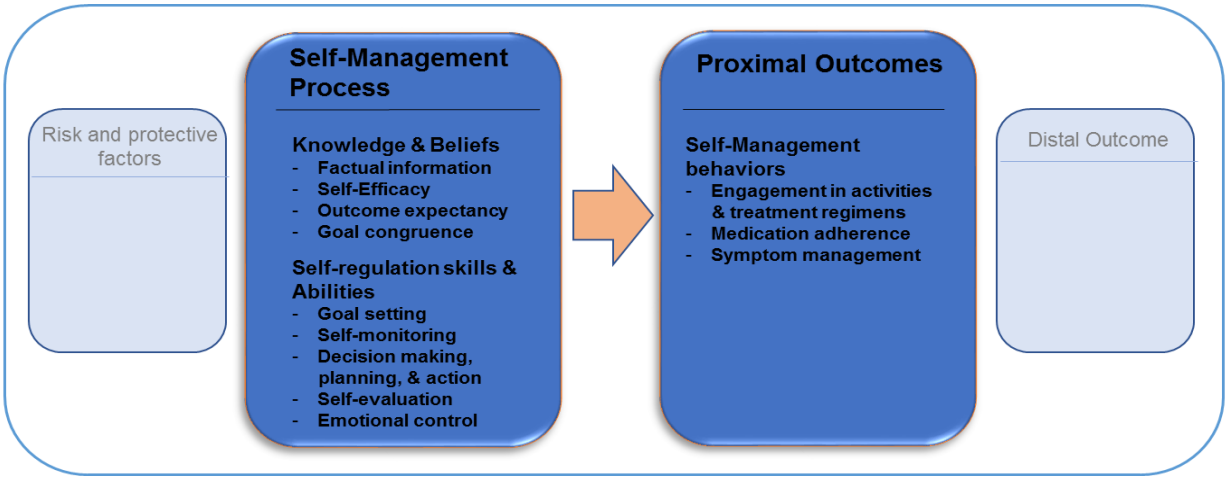
2) Medication adherence; and

3) Self-monitoring of blood pressure.

The Self-Management Process

This study will utilize the Individual and Family Self-Management Theory (IFSMT). The authors of IFSMT posit that addressing one or more of the three concepts within the Process domain (The Self-Management Process) will promote self-management behaviors, which are listed in the Proximal Outcomes domain (Figure 1).

Of the four domains within the IFSMT, this study will focus on the Process (The Self-Management Process) domain to affect the Proximal Outcomes domain as depicted in Figure 1.[54] The concepts within the Self-Management Process domain will be addressed in two ways. One, for the Knowledge and Beliefs concept, participants in both the intervention group and the attention-control group will receive education about the proper skills and information needed for effective hypertension self-management. Two, this study will offer the UCLA's Mindful Awareness Program to the participants in the intervention group as mindfulness practice appears to restore the self-regulatory process to baseline.[33]



Chapter1-Figure 1: The four domains of IFSMT with focus on the Self-Management Process and Proximal Outcomes domains.

Low Adherence to Hypertension Self-management

Only 50% of those with hypertension report adequate blood pressure control, an indication that many are not adhering to the recommended therapeutic guidelines.[4] Studies report that fewer than 10% of individuals with hypertension adhere to a Dietary Approaches to Stop Hypertension (DASH) diet, and close to a third report a sedentary lifestyle.[55-57] These low adherence levels to recommended lifestyle behaviors would indicate that for many, changing behavior is difficult, especially in cases where diet and exercise modifications are involved.

Adopting these lifestyle behaviors may be difficult because most health behaviors require long-term commitment and focus. In addition, lifestyle behavior such as diet and exercise usually require sufficient time during the day to perform these behaviors. Another possible reason for poor adherence to therapeutic recommendations is that hypertensive individuals typically do not experience overt symptoms related to high blood pressure, unlike those with diabetes mellitus. A diabetic patient will usually experience serious and at times life threatening symptoms within 24-hours of poor blood glucose control, whereas hypertensive individuals may not feel any discomfort until a sudden, significant adverse cardiovascular event occurs like stroke or heart attack. Hence, hypertension is commonly referred to as the "silent invisible killer."[10]

Additionally, many may encounter psychological barriers when it comes to translating knowledge about these health behavior modifications to actions. For example, the National Canadian Health Survey found 35% of their population indicated a "lack of willpower" as a hindrance to adopting and maintaining a healthier lifestyle, particularly with diet and exercise modifications.[58] In addition, others reported feelings of powerlessness, questions of self-identity and self-worth in the context of their illness, and lack of self-control over their illness.[59]

Clearly, health behavior modification is complex and challenging for most individuals regardless of whether behavior changes are related to the management of a chronic medical

condition. However, having a chronic condition such as hypertension adds another level of complexity and difficulty for those individuals that are now required to make lifestyle behavior changes. It appears that knowledge alone will not initiate individuals with hypertension to act on the recommended therapeutic guidelines. The ability to successfully self-manage a chronic condition, such as hypertension, requires a high level of self-control and an inner belief in the ability to complete immediate tasks and accomplish long-term goals.

Statement of the Problem

Approaches to health behavior interventions are still largely focused on providing information and education to the patients. However, studies suggest that providing information alone does not motivate people to alter their current behavior.[60,61] For example, a comprehensive self-management program (behavioral skills training, nutritional education, social support focused on physical activity) was administered to African-American adults with co-morbid diabetes type II and hypertension.[62] A 6-month follow-up of these adults found no significant changes on HbA1c (indicator for diabetes control) and weight, suggesting that adequate levels of physical activity and proper diet changes were not followed by the subjects.[62]

The change in how patients receive healthcare information does not necessarily improve better behavior adoptions either. Today, patients can receive and respond to healthcare information in real time through their home computer or personal computer devices including smartphones and tablets.[63,64] Researchers use personal smartphones to send text messages to remind individuals to comply with their medication prescription, to follow a proper diet, and to engage in physical activity.[65-68] Although text messaging-based interventions have shown some level of efficacy (d =.329) in various health behavior modifications, there is more to be done given that half of those with hypertension report poor blood pressure control.[69]

Perhaps, education alone, regardless how patients receive the information may not be enough for some individuals. The current approaches today may not adequately address the psychological barriers that are associated with managing a chronic medical condition. A novel approach appears to work through these internal barriers is mindfulness practice. But, to date, no study has evaluated mindfulness training on the effects of health behaviors among individuals with hypertension. Hence, this study will evaluate mindfulness practice as a possible method to improve health behavior adoption and maintenance at population level. A detailed description of the purpose of this study is described below.

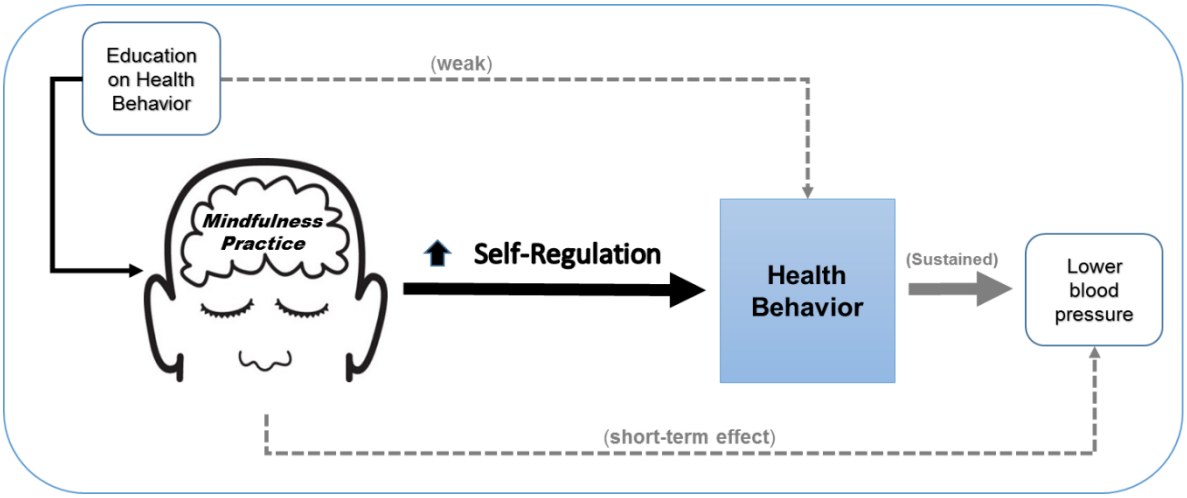
Purpose of the Study

The purpose of this study is three-fold:

1) Investigate the effect size, feasibility, and acceptability of UCLA's Mindful Awareness Program, as an intervention to improve self-management behaviors for individuals with hypertension who are not following recommended guidelines.
2) Evaluate the effects of total mindfulness practice minutes on these three hypertension self-management behaviors: medication adherence, diet, and physical activity.
3) Evaluate the relationship between hypertension self-management health behaviors and blood pressure.

The Mindful Awareness Program through the UCLA's Mindful Awareness Research Center will be utilized as the mindfulness intervention for this study. The UCLA's Mindful Awareness Program is a six-week program that meets once a week for two hours. The classes lay the foundation for students to understand basic principles of mindfulness, develop a personal meditation practice, and to apply the principles in their daily activities.

This study will evaluate the UCLA's Mindful Awareness Program on the effects of health behaviors as outlined in Figure 2 below.



Chapter1-Figure 2: Mindfulness practice with education on health behavior influences the self-regulatory process and thereby, changing health behavior.

As depicted in Figure 2, this study will utilize the UCLA's Mindful Awareness Program along with an educational component to influence hypertension self-management related health behaviors. As mentioned in previous sections, self-regulation is an essential component and mechanism in positive health behavior adoption and maintenance.[33] Additionally, education about proper hypertension self-management will be included for all participants, as other studies have shown the importance of proper education as a prerequisite to making informed decisions.[70]

The recommended guidelines for effective management of hypertension (better blood pressure control) is through consistent engagement of these three health behaviors: medication adherence, diet, and exercise.[4,15] Evidence suggests that regular engagement in these three health behaviors will result in better blood pressure control.[4,15]

Of note, some studies have shown that mindfulness practice has beneficial effects on blood pressure.[71] However, these blood pressure changes are not enduring.[72,73] There is some evidence the mindfulness training may affect blood pressure short-term by way of decreasing sympathetic activity.[72] This study will collect daily blood pressure measurements from participants, as a way to control for the possible direct effect mindfulness practice may have on blood pressure readings.

This study will offer evidence about the efficacy of UCLA's Mindful Awareness Program on health behavior, providing insight on whether a mindfulness-based program is an effective tool to restore the self-regulatory process to encourage more positive health behavior choices.

Specific Aims, Research Questions, and Hypotheses

Aim 1: Describe the effect size of UCLA's Mindful Awareness Program (MAP) on health behaviors (medication, diet and exercise adherence) as compared to the attention-control (AC) group at 6 and 12 weeks.

What will be effect size of MAP for these three health behaviors: medication adherence, and diet and exercise?

H_{oA}: There will be a difference between the groups in their change over time (interaction effect) for medication adherence.

H_{oB}: There will be a difference between the groups in their change over time (interaction effect) for diet adherence.

H_{oC}: There will be a difference between the groups in their change over time (interaction effect) for exercise adherence.

Aim 2: Evaluate the relationship between average daily mindfulness practice minutes (DMPM) from 6 to 12 weeks, i.e., dose, on health behaviors (medication, diet, and exercise).

Will higher levels of mindfulness practice minutes have a positive relationship with the level of medication adherence, and diet and exercise changes?

H_{oA}: Average DMPM (between baseline and at week 6) will be positively associated with medication adherence level.

H_{oB}: Average DMPM (between baseline and at week 12) will be positively associated with medication adherence level.

H_{oC}: Average DMPM (between baseline and at week 6) will be positively associated with diet adherence level.

H_{oD}: Average DMPM (between baseline and at week 12) will be positively associated with diet adherence level.

H_{oE}: Average DMPM (between baseline and at week 6) will be positively associated with exercise adherence level.

H_{oF}: Average DMPM (between baseline and at week 12) will be positively associated with exercise adherence level.

Aim 3: To evaluate the feasibility and acceptability of UCLA's Mindful Awareness Program through program evaluation.

Will the intervention group attend the mindful awareness program class at least five out of the 6 sessions?

H_{oA}: At least 80% of the participants in the intervention group will attend at least five out of the 6 mindful awareness class sessions?

Will the intervention group fill out the weekly questionnaire at least 80% of the time?

H_{oA}: At least 80% of the participants in the intervention group will fill the weekly questionnaires at least 80% of the time?

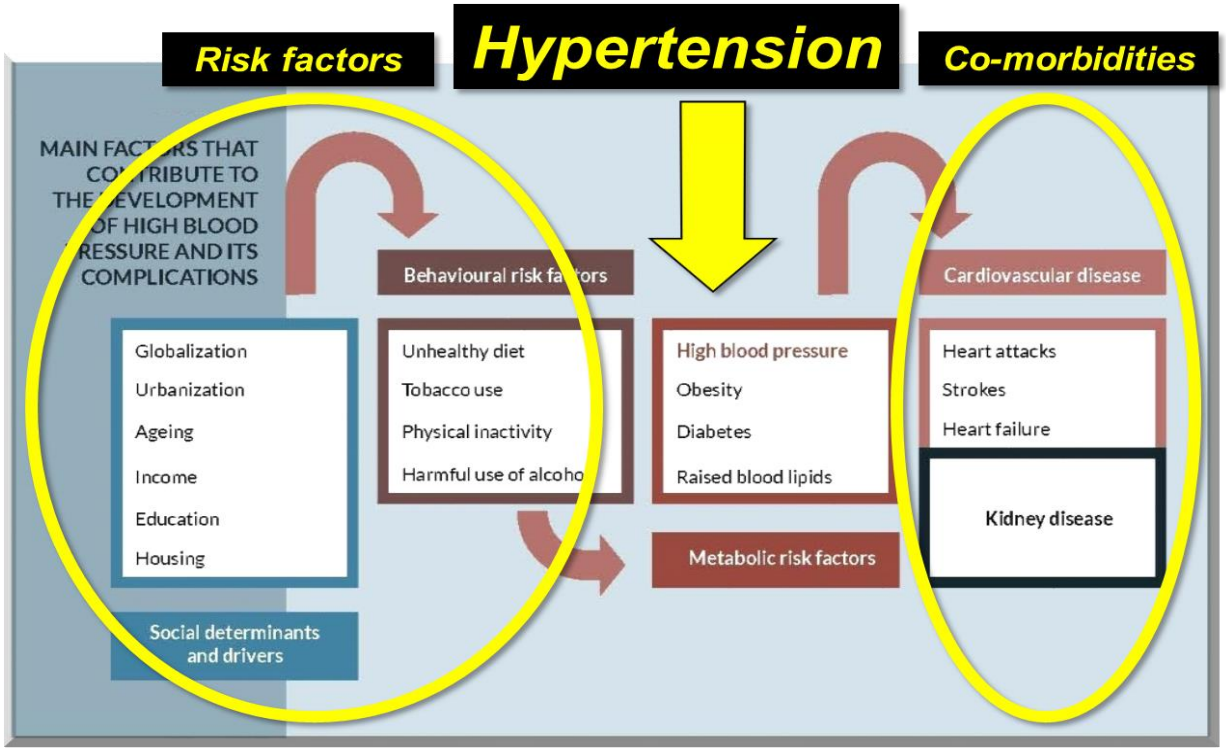
Significance of Study

Hypertension is a national health concern, affecting nearly 80 million of U.S. adults.[74] An intervention that can effectively improve individuals to better self-manage their hypertension has the potential to save many lives while reducing healthcare costs. An advantage of a mindfulness intervention that is effective in promoting improved health would be its portability and low cost. Mindfulness-based programs can be taught in a classroom or delivered via the internet, making them accessible on personal devices. Furthermore, the program can be customized to fit the needs of the population. For example, UCLA Mindful Awareness Programs are delivered online, and there is also a Spanish version of the mindfulness class. This study will show whether mindfulness has promise as an effective intervention to improve self-management of hypertension.

Chapter 2: Hypertension

The World Health Organization (WHO) identifies hypertension as a global health crisis, in part, due to its strong causal link to multiple cardiovascular diseases (Figure 3). A large population-based found that hypertensive men with systolic blood pressure (SBP) of greater than 160 mmHg or diastolic blood

pressure (DBP) greater than 95 had a 3-fold greater risk for cardiovascular disease related event compared to normotensive men; whereas, women had a 6-fold greater risk for cardiovascular disease (CVD) compared to normotensive women.[75,76]



Chapter2-Figure 3: Adopted from World Health Organization's report on hypertension and its negative impact on cardiovascular health and co-morbidities.

There is evidence however, that proper blood pressure control can effectively lower the risk of CVDs. For example, Rapsomaniki and colleagues reviewed 1.25 million electronic patient health records from 1997 to 2010 and found that a 20 mm Hg lower SBP was associated with hazard ratio of 0.78 (CI, 0.75–0.80) for myocardial infarction, 0.74 (CI, 0.70–0.78) for ischemic stroke, 0.69 (CI, 0.63–0.76) for intracerebral hemorrhage.[77] Therefore, improving hypertension control through diet and exercise can have lasting positive health effects for millions of individuals.

Factors Associated with Primary (Essential) Hypertension

The mechanisms leading up to primary hypertension are complex and multifactorial involving a wide range of biological factors such as neurohormonal, renal, metabolic, and vascular as well as the

environment.[78,79] Additionally, obesity, insulin resistance, high alcohol intake, high salt intake, age, stress, low potassium intake, and low calcium intake are all considered contributing factors for primary hypertension.[80,81] Of these initiating factors, some are genetically determined while others are associated with the environment and behavioral influences (Figure 3). In most individuals with primary hypertension, there is no one relatable cause. To a certain degree, unmodifiable risk factors such as age, sex, ethnicity, and genetics add to the complexity of hypertension self-management.

The Effects Obesity, Diet, and Sodium on Hypertension.

Obesity, quality of diet, and high sodium intake are important determinants in the management of hypertension. Obesity, specifically adipose tissue around the abdomen has been shown to increase the risk of developing hypertension and type 2 diabetes mellitus.[82-84] White adipose tissues secrete bioactive peptides and proteins. In the case of obese individuals, an excess amount of bio-actives are produced.[85] The roles of these bio-actives, also collectively known as adipokines play a key role in body homeostasis, including insulin regulation, lipid, and glucose metabolism, coagulation, and angiogenesis and vascular remodeling, which all affect blood pressure regulation.[85] Adipokine alternation is a key risk factor for hypertension and obesity.[85] Both conditions are part of the cardio-metabolic risk factors, which are collectively named Metabolic Syndrome.[86]

The World Health Organization and the International Diabetes Federation defined Metabolic Syndrome as having three or more of the following five health-related conditions:

1) Abdominal obesity (waist circumference ≥ 42 inches in men, ≥ 32 inches in women);
2) Bypertriglyceridemia (≥ 150 mg/dL);
3) Low high-density lipoprotein (≤ 40 mg/DL in men, ≤ 50, mg/DL in women);
4) High blood pressure (Systolic ≥ 130 mmHg, Diastolic ≥ 85 mmHg); and
5) High fasting glucose (≥ 110 mg/dL).[87]

In addition, having three or more of these health-related risk factors increases the risk for hypertension.[87]

The effects of high-calorie consumption and physical inactivity are two primary contributing factors for the rise in obesity.[88] Obesity is also a primary risk factor for hypertension.[89,90] The high-caloric intake can be attributable to poor nutritional values of foods available today. For better cardiovascular health, the America Heart Association recommends a balanced diet of nutritionally rich foods such as vegetables, fruits, whole grains, fish, and poultry while avoiding foods high in saturated fats and sugar.[91,92] Individuals with hypertension are also encouraged to adopt a healthy cardiovascular diet and a diet consisting of no more than 2,400 mg of sodium per day.[93]

The negative effects of high sodium on blood pressure have been well established. One of the first studies that demonstrated the effects of sodium on blood pressure found that some individuals' blood pressure increased significantly with increased intake of sodium while others did not.[94] Dr. Kawasaki and Associates classified these two groups as "salt-sensitive" or "non- salt sensitive." [94] More recent studies have shown that there are individuals with hypertension that are more "salt sensitive," than others with hypertension.[95]

Conversely, not all individuals exert vascular changes with high sodium intake. In fact, in one study, subjects that were given a high sodium diet for a week did not result in high blood pressure readings, and thus, were referred to as the "non-salt sensitive group." Therefore, the prevailing thought to restrict sodium consumption in all individuals with hypertension has been revised by the American Heart Association to recommendation sodium of less than 2400 mg daily compared to the previous recommendation of 1500 mg daily.[93] However, American Heart Association still considers sodium of less than 1500 mg daily an ideal goal.

Seven Health Metrics of Cardiovascular Health

The association between obesity, healthy diet, exercise, and hypertension are encapsulated in the American Heart Association (AHA) 2020 Impact Goal, where seven determinants of cardiovascular health are identified. These seven determinants are defined as metrics of health outcomes for optimal cardiovascular health. The seven metrics (also known as Life's Simple 7™) includes ***four health behaviors*** (adequate physical activity level, non-smoking, a healthy diet pattern, and normal body weight) and ***three health factors*** (optimal cholesterol level, blood pressure, and fasting glucose levels, in the absence of treatment).[96] The four health behaviors from the AHA 2020 Impact goal are also aligned with heath behaviors associated with prevention and self-management of hypertension.[15]

The results of these seven metrics identified by the AHA helped formulate the national cardiovascular health goals. The AHA has set national goals to improve "cardiovascular health of all Americans by 20% while reducing deaths from cardiovascular diseases by 20%" by year 2020.[96]

Cardiovascular health is categorized as either "poor," "intermediate," or "ideal," based on the total scores associated with each risk factors identified by AHA. Each risk factor correlates to a response value of 0, 1, or 2. An ideal cardiovascular health status is a score between 11 to 14, an intermediate cardiovascular status is a score between 8 to 10, a poor cardiovascular health status is a score ≤ 7 based on the 7 metrics identified by the AHA as outlined in Table 1.[96] Of adults between the ages of 20 to 79 years, only 14% of adults were identified as having ideal cardiovascular health, 46% as intermediate, and 41% as poor according to the National Health and Nutrition Examination Survey, 2001 to 2010.[97]

The Life's Simple seven™ metric has identified blood pressure as one of the three health factors of overall cardiovascular health. Also, the four health behaviors that Life's Simple 7™ has identified as determinants of cardiovascular health are also health behaviors for optimal blood pressure management.[15] Therefore, improvements made on hypertension self-management behaviors will also have a positive impact on the cardiovascular health indicators as defined by the AHA. This study will evaluate the Life's Simple 7™ metric in future studies as this current study does not have plans to collect cholesterol and fasting glucose levels.

Chapter 2-Table 1: Cardiovascular Health Metrics developed by American Heart Association

Component	Score	Definition
Physical Activity	0	No Exercise
	1	1-149 min. of moderate exercise or 1- 74 min vigorous exercise/week
	2	150+ minutes of moderate exercise or 75+ minutes of vigorous exercise/week
Diet*	0	0–1 components of healthy diet
	1	2–3 components of healthy diet
	2	4–5 components of healthy diet
Blood pressure	0	Systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg
	1	Systolic blood pressure 120–139 mmHg or diastolic blood pressure 80–89 mmHg or treated to <120/80 mmHg
	2	<120/80 mmHg, un-medicated
BMI	0	≥30 kg/m2
	1	25.0–29.99 kg/m2
	2	<25.0 kg/m2
Cholesterol	0	≥240 mg/dL
	1	200–239 mg/dL or treated to <200 mg/dL
	2	<200 mg/dL, un-medicated
Smoking	0	Current smoker
	1	Former smoker, quit ≤12 months ago
	2	Never smoker or quit >12 months ago

*Dietary components include: consuming (1) ≥4.5 cups per day of fruits and vegetables, (2) ≥ two 3.5-oz servings of fish per week, (3) ≥ three 1-oz-equivalent servings per day of fiber-rich whole grains, (4) <1500 mg per day of sodium, and (5) ≤450 kcal (36 oz) per week of sugar-sweetened beverages

Definition of Adherence and Compliance

Terms ‘adherence’ and ‘compliance’ are used interchangeably in the medical community to describe behaviors associated with patients’ follow-through of prescribed treatment plan. However, over the past decade, the medical community expressed interest in moving towards a consensus to use the term ‘adherence’ rather than ‘compliance.’ Historically, the term ‘patient compliance’ was more widely accepted in the medical community.

This broad acceptance of the term ‘patient compliance’ was likely due to the seminal works by Haynes and Sackett in the mid-1970s in which the term ‘compliance’ was defined as “*the extent to which the patient yields to health instructions and advice”*

(Sackett & Haynes, 1976, p. 2).[98] Their work was published based on proceedings of a workshop on *Compliance with Therapeutic Regime*, held at McMaster University Medical Center, Ontario, Canada in 1974. There, the experts who attended the workshop agreed that the term 'compliance' should be used. In 1975, the National Library of Medicine added the term 'patient compliance' to their Medical Subject Headings nomenclature, which solidified the use of this term for decades.[99]

Over the years, the medical community has been critical of Sackett & Haynes's original definition of 'patient compliance,' primarily due to the negative connotation associated with the term compliance.[100,101] Sackett & Haynes's described 'compliance' as "*the extent to which the patient yields to health instructions and advice, whether declared by an autocratic, authoritarian clinician or developed as a consensual regimen through negotiation between a health professional and a citizen*" (Sackett & Haynes, 1976, p. 2). Most in the medical community found that the definition provided by Sackett and Hayes implied clinicians as tyrannical or dictatorial.[101] As such, the healthcare community is now promoting the usage of the term 'patient adherence' rather than 'patient compliance.' In fact, the World Health Organization provided a definition of 'patient adherence' with language denoting the importance of patient and heath care provider collaboration and patients as active participants in their health care.[102]

The World Health Organization defines patient adherence as "to the extent to which a person's behavior – taking medications, following a diet, and executing lifestyle changes, corresponds with agreed recommendations from a healthcare provider." Evidence suggests that effective communication and partnership between the patient and the healthcare provider appears to be a key determinant of adherence to healthcare recommendations.[103-105] Accordingly, the WHO encourages healthcare professionals to communicate, engage, and negotiate a therapeutic plan with their patients that both parties can agree.[102] Therefore, this study will use 'patient adherence' as defined by the World Health Organization.

Low Adherence Medication and Health Behaviors

Low adherence to therapeutic recommendations persists despite extensive patient education and numerous interventions targeting health behaviors.[67,68,106] For example, 50% of individuals with

hypertension do not adhere to antihypertensive medication regimens, 75% do not exercise regularly, and 70% are non-adherent to a low sodium diet.[55,57,107,108] The next three sections provide an overview of medication adherence and lifestyle modifications related to hypertension self-management.

Anti-hypertensive Medication

Adherence to antihypertensive medication is an integral part of optimal hypertension control. Pharmacy led interventions typically include patient education, medication reconciliation, medication refill reminders as well as collaborative care between the pharmacist and patient's primary care.[109] While some pharmacy-led interventions show a significant increase in antihypertensive medication adherence; there is usually no direct correlation with lowered blood pressure readings.[109]

Furthermore, a recent Cochran review of interventions to improve medication adherence concluded that many studies did not include clinical outcomes that correlated with the increase in medications adherence.[110] When studies did include physiological measurements to validate the increase in medication adherence, the results were mixed. For example, 127 patients with newly diagnosed ocular hypertension, where patients were provided with face-to-face needs assessment by an intervention nurse. Based on the assessment, the nurse then educated the participants about their medication and proper ocular hypotensive medication drop instillation techniques. A one-year follow-up of these patients found that there was significant difference in the ocular hypotensive medication adherence, but no significant changes to the intraocular pressure.[111]

Diet Adoption and Maintenance

Diet modification and physical activity are essential components in the prevention and management of hypertension.[112-114] The Dietary Approaches to Stop Hypertension (DASH) diet is a well-validated diet program that is found to be effective in reducing overall blood pressure and to some extent weight loss.[112,115,116] The DASH diet plan consists of fruits and vegetables, lean meats, and foods low in sodium and saturated fats. A recent meta-analysis on the influence of DASH diet on blood pressure showed that

there was a significant reduction in systolic blood pressure (6.74 mmHg) and diastolic blood pressure (3.54 mmHg). However, adherence rate for the DASH diet is between 20% to 60%, a relatively low percentage considering the amount of empirical evidence available on benefits of the DASH diet.[57, 115,117-120] This study will utilize the concepts of the DASH diet, particularly fruits and vegetable intake and sodium reduction for participants enrolled in this study.

Sodium and Blood Pressure

Large amount of empirical evidence exists today on the benefits of a low sodium diet on hypertension.[94,121-124] The health benefits of a low sodium diet extend beyond optimization of blood pressure control. A diet that is low in sodium has a positive impact in decreasing cardiovascular risk and healthcare costs. For instance, when daily sodium intake is reduced from 2300 mg/dl to 1500 mg/dl, there is an estimated decrease of 17% to 32% in cardiovascular risk.[121] Additionally, a lower sodium diet in patients with hypertension can result in healthcare cost savings of $10 to $24 billion dollars annually.[95]

Exercise Adoption and Maintenance

As for physical activity, the American Heart Association and American College of Cardiology 2013 Lifestyle Work Group recommend 40 minutes of moderate to vigorous aerobic exercise 3 to 4 times a week for overall cardiovascular health.[125] The Lifestyle Work Group is also is the preferred guideline that JNC8 recommends in their 2014 Evidenced Based Guideline for the Management of High Blood Pressure in Adults report.[15] The American College of Sports Medicine recommends 30 minutes of moderate aerobic exercise most of the day.[126] Additionally, growing evidence suggests that high-intensity interval training is more effective in cardiovascular health than moderate-intensity exercise training.[127] This study will follow the recommendations provided by the American Heart Association and Lifestyle Work Group of 40 minutes of moderate to vigorous aerobic exercise 3 to 4 times a week.

Gaps in Literature

Most models and theories that explain the mechanism of behavior change are based on a single behavior outcome. However, in the last decade, there is an increased awareness and interest in developing interventions to effect more than one behavior.[128] Studies have shown that some behaviors are more interrelated than others. For instance, studies of health behavior dyad such as exercise and diet are common.[129-131] A strong correlation existed between diet and physical activity ($r = 0.16 – 0.26$, $p < .01$) compared with non-smoking and diet ($r = 0.08 – 0.16$, $p < .03$), or non-smoking and physical activity ($r = 0.01 – 0.21$).[132] Furthermore, when interventions are designed to effect more than one behavior at a time, the odds ratio was greater for behavior change of the second behavior when the first behavior change was maintained (OR 1.71, 1.28, $p < .001$).[133]

Although there is considerable amount of research on hypertension self-management, few studies have evaluated mindfulness-based therapy as a method to improve hypertension self-management health behaviors. In fact, a Cochran review of 34 studies related to lifestyle interventions on hypertension management revealed that almost 50% of these studies contained non-specific descriptions of the intervention.[40] In addition, most studies that evaluate behavior intervention target one health behavior.

Consequently, a study that did investigate mindfulness on a set of self-management related health behaviors was completed as a dissertation study.[134] Brown's dissertation found that mindfulness was a statistically significant predictor of self-management behaviors (blood glucose monitoring, food portioning, food logs, medication dosing and adherence, and exercise) in adults with type 2 diabetes.[134] To date, there are no studies that evaluated a mindfulness program as an intervention to influence a set of health behaviors in adults with hypertension. The next section provides a review of the literature on current mindfulness-based programs and its effect on health behavior.

Mindfulness-based Therapies

The National Center for Complementary and Alternative Medicine (NCCAM) describes mindfulness practice and meditation as "focusing on the interactions among the brain, mind, body, and behavior, and on the powerful ways in which emotional, mental, social, spiritual and behavioral factors can directly affect health" (www.NCCAM.NIH.gov). According to the NCCAM, complementary and alternative therapies include but not limited to meditation, guided imagery, yoga poses, deep breathing exercises, and Tai Chi.[135]

The origin of mindfulness is embedded in Buddhism with the primary focus to ease suffering and to develop compassion for self and others.[136] Additionally, mindfulness practice involves contemplation without judgment and receptiveness to the present experience.[136] Most mindfulness-based approaches will apply one or more of the following techniques to gain more awareness to the present: awareness to the breath, use of a mantra, or visual focus on a single object.[137]

Over the last several decades, the use of complementary and alternative therapies has gained popularity as an adjunct to current medical treatment. For example, approximately 35% of patients with cardiovascular disease report having used at least one form of mind-body therapy, which is a testament to the growing popularity of complementary and alternative therapies.[138-140] The two most popular mindfulness-based approaches today are Mindfulness-based Stress Reduction and Yoga.[135]

Mindfulness-based Stress Reduction (MBSR), developed by Jon Kabat-Zinn, was first introduced as an adjunct therapy to help individuals to better self-manage their chronic pain in the mid-1980s.[34,36] The first cohort that utilized the MBSR program consisted of 21 individuals recruited from several neighboring pain management clinics in Massachusetts. The subjects were required to practice mindfulness for 45 minutes daily as well as perform Hatha yoga in their homes. The control group participated in the usual care (nerve blocks, physical therapy, analgesic, antidepressants) of chronic pain management. The MBSR group showed a significant reduction in self-reported pain levels and mood disturbance, including anxiety and depression when compared to the control group. At 15-month post-

MBSR, approximately 70% of the subjects reported that they maintained their mindfulness practice, and also reported reduction in all relevant outcome measurements, except for present-moment pain.[34,141]

The next three sections will provide an overview of the current mindfulness-based studies on outcomes associated with blood pressure, diet, and exercise changes.

Mindfulness and Blood Pressure

There is some evidence that mindfulness practice lowers blood pressure, however, the effects are short-term. The primary mechanism in which mindfulness affects blood pressure is unclear. Researcher hypothesize the lowering of the blood pressure post mindfulness practice is related to the overall reduction in stress that one feels after a mindfulness session.[142] Feelings of anxiety and stress are known to induce physiological changes, especially the activation of the sympathetic system.[72] This activation naturally results in an in increase in heart rate and elevated blood pressure. Mindfulness appears to have a calming effect, which results in lowered heart rate and blood pressure.[72,143]

Understandably, researchers have used the mindfulness training as a non-pharmacological treatment for lowering blood pressure through a reduction in stress levels.[71,144,145] For example, a randomized control study of 52 subjects with un-medicated prehypertension received the MBSR training (intervention group) or the progressive muscle relaxation training (control group). Both groups attended an 8-week mindfulness training session lasting about 2.5 hours each week. Subjects in the MBSR group showed a significant reduction in clinical systolic blood pressure (4.8 mmHg), whereas the control group had a small reduction of 1.9 mmHg.[146] However, there were no significant findings between the MBSR group and the control group for the 24-hour ambulatory blood pressure.[146] In a similar study of subjects with un-medicated stage-1 hypertension, the results of 24-hour ambulatory blood pressure readings found no significance between the intervention group ($-0.4 \pm 6.7/0.0 \pm 4.8$ mm Hg) compared with the group randomized to the wait-list control group ($-0.4 \pm 7.8/-0.4 \pm 4.6$ mm Hg).[73] Evidence suggests that the mindfulness training does affect blood pressure short term, but long term effect of lowered blood pressure is not evident.[146,73]

Mindfulness and Diet

Mindfulness-based therapies are also utilized to promote healthier eating behaviors. For many, poor eating habits are associated with high levels of stress. For example, there was significant association between higher stress levels and non-nutritious food consumption ($r = .154$, $p = .001$) and a significant negative association with nutritious food consumption ($r = -096$, $p = .040$), while controlling for age, BMI, income, and education among women between the ages of 20 to 56 years old. (n=457) .[147] Also, the same study revealed that the perceived stress was related to binge eating ($r = .321$, $p < .001$) and greater reports of hunger ($r = .327$, $p < .001$). [147]

Furthermore, studies have found that mindfulness-based training positively affects the over-eating behavior that is usually prompted by emotional distress. A study of 26 women between the ages 18 and 65 years of age was recruited for their self-identified problematic eating habits (emotional eating, stress-related eating, binge eating). These 26 women were provided with an 8-week mindfulness training program that met once a week. The mindfulness training was focused on body awareness and mindful eating (awareness of taste, texture, sensation of food).[7] Post intervention, those who received the mindfulness training had a significantly lower self-report of emotional eating ($t (11) = 1.08$, $p = .03$, $d = .53$), compared to the wait-listed control group ($t(13) = 1.08$, $p = .30$).[7] Preliminary findings of another study, suggests that those who are more mindful tend to consume fewer calories, resulting in greater weight loss.[148]

Attitude about certain foods is another area that mindfulness training appears to have a positive impact. For example, 36 men with recurring prostate cancer were randomized to receive an 11 weekly mindfulness training with dietary and cooking lessons or to the waitlisted group. Those in the intervention group were associated with a negative attitude towards sweets ($p = .017$) and positive attitude towards fruits ($p < .001$), resulting in participants choosing a healthier snack over an unhealthy snack.[149] In addition, the same study indicated that there were significant changes

in the consumption of vegetable proteins (considered healthier protein alternative to animal protein) over animal proteins ($p = .01$).[149] However, because mindfulness training was integrated with the dietary and cooking classes, it is unclear how effective mindfulness training was to the outcome of the food choices made. Nevertheless, mindfulness training appears to impact the emotions and attitudes when it comes to food choices.

Mindfulness and Exercise

Typically, mindfulness-based interventions geared towards exercise behavior modification will incorporate some form of physical body movements with mindfulness practice. Some of these mind-body approaches are yoga, Gi Gong, Tai Chi, and dance therapy. A study that evaluated the effectiveness of yoga practice on exercise found a significant increase in the 7-day physical activity recall ($p < .012$) in the yoga practice group compared to the control group.[150]

Moreover, studies have found that people who have a higher propensity towards being mindful during their normal activities are more likely to adopt and maintain physical activity.[151,152] Kangasniemi and associates (2013) implemented the Kentucky Inventory of Mindfulness, an instrument that measures the ability to practice mindfulness to 50 physically active adults and 58 physically inactive adults.[153] Kangasniemi's research found that adults, who engaged in some form of physical activity tended to report more mindfulness associated skills than those who were less active.[153] The Kentucky Inventory of Mindfulness contain these following attributes observing, describing, acting with awareness, and accepting without judgment as dimensions to measure the propensity for mindfulness. Evidence show that higher levels of mindfulness have been associated with higher levels of physical activity.[152]

Regardless of whether we are born to have a higher deposition to mindfulness, the skills to be more mindful can be learned. In one particular study that was conducted in Germany, the subjects who were randomized to the exercise group reported an increase in dispositional mindfulness compared to those subjects that were randomized to the relaxation group or the waitlist control group.[154] Therefore,

mindfulness practice is a possible method to improve adoption and maintenance of physical activity level among individuals with hypertension.

Chapter 3 – Conceptual Framework

The National Prevention Council views self-management as a key strategy to empower individuals to achieve greater health and wellness through the whole life cycle.[155] This study will utilize two theories that explain the self-regulatory process for the engagement of self-management behaviors to effectively self-manage one's chronic disease. Mindfulness practice will be utilized as in intervention to restore the self-regulatory process. The concept of mindfulness practice is aligned with the philosophical view of Idealism, which is described in more detail in the following section.

Philosophical Underpinning

Idealism is a philosophy embedded in the belief that "knowing" or knowledge about the external (physical) world is framed within the constructs of the mind in the form of ideas.[156] The philosophical view of Idealism stems from Plato's earlier works.[156,157] Plato considered the consciousness (mental world) is where thoughts or ideas were formed, and he considered these ideas to be absolute, universal, permanent, and orderly.[158] A well-known French philosopher, René Descartes, extended Plato's philosophical view of reality and claimed that knowledge is solely formed in the mind, and the physical world is simply our mind's perception of what is external to our senses; therefore unreliable.[158] René Descartes's famous quote, "I think. Therefore I am" illustrates the importance of the "self" as the sole creator of one's reality.[159] Thus, concepts such as self-regulation and self-management are thought processes that the "self" connects with the physical world.[159]

Idealism

A main tenant of Idealism is that knowledge about the physical world originates in the mind.[159] Other main tenants of Idealism are that humans are essentially spiritual beings and that ideas are formed in the mind as a means of the "Spirit" to interpret and relate to what is perceived as the physical world.[159]

Hence, Idealists view anything outside of ideas as inherently flawed; therefore, all mental images formed through our senses are unreliable because these images cannot be validated.[160]

There are four sub-categorizations (Subjective, Transcendental, Objective, and Absolute) within Idealism.[159] The distinguishing factor between these variations of Idealism is how the 'self' is defined as it relates to the physical world.[159] A German philosopher, George Wilhelm Hegel asserts that the physical world does exist outside of 'self' and is not merely an illusion. Based on Hegel's views, accuracy of the physical world is verifiable through the self.[159] Absolute Idealism supports the philosophical basis for this study in that sentient beings do, in fact, interact with the physical world. Furthermore, according to Absolute Idealism, the 'self" has the innate ability to generate ideas and thoughts to gain knowledge about the physical world.[159]

Philosophical views of Idealism are the basis for choosing mindfulness practice as the intervention to influence thoughts and ideas of the mind. When the mind is practicing mindfulness, there is greater tendency to be self-aware of the present moment experience. The self-awareness is an important concept in that the state of being more aware of 'self' promotes the self-regulatory process to resume.[33]

Mindfulness as a Philosophy

Mindfulness is a practice that is embedded in the teachings of Buddhism.[161] In Buddhist principles, mindfulness is a practice to anchor the mind to the present moment experience.[161] The Buddhist teachings emphasize that with mindfulness practice, one can achieve purification of the mind of unwanted and unnecessary thoughts.[161] By ridding the mind of superfluous thoughts, the 'self' is more primed to perceive the physical world in an unbiased and unaltered way.[161] Therefore, mindfulness practice is a form of training the mind to foster deliberate and controlled thoughts and ideas, which leaves virtually no room for impulsive and imprudent behavior.

In the last several decades, mindfulness practice has gained remarkable ground as a viable practice for treatment of various health conditions and disorders. The secular mindfulness practice has moved beyond

the traditional religious affiliation. This growth in popularity of mindfulness practice as a valid method to influence health behaviors has lead theorists to develop models to describe and explain the concept of mindfulness. One such model is called Self-Awareness, Self-Regulation, and Self-Transcendence (S-ART).

Vago and Silbersweig, developers of S-ART, explain that the term mindfulness denotes a "state, trait, process, and type of meditation." The S-ART is a theory that explains the mechanism of mindfulness practice. Simply, the process of mindfulness is a way for the mind to become more aware of the present experience.[33] When one's mind is focused on the present moment experience, there is heightened awareness of the senses and the 'self' relation to the present moment.[33]

According to Vago and Silbersweig, mindfulness practice is a form of mind training, whereby development of self-awareness transpires.[33] The heightened self-awareness restores one's capacity to control self-driving behaviors.[33] The ability to effectively modulate one's behavior is termed Self-Regulation. One other construct described in the S-ART is the Self-Transcendence, which is how one applies the needs of the others over their needs.[33] This study will focus on the Self-awareness and Self-regulation aspect of the S-ART model.

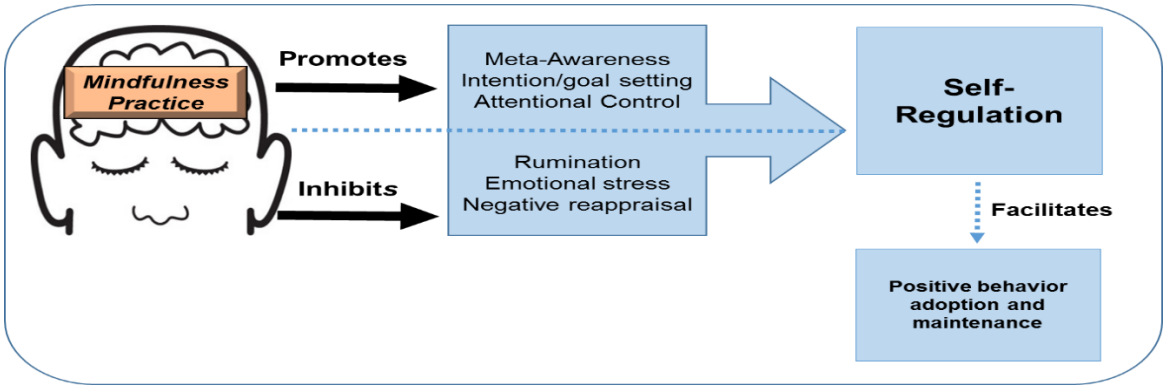
Self-Awareness and Self-Regulation

Mindfulness practice has shown to facilitate and regulate the self-processes, specifically the self-regulatory process.[30,36] The mind is usually in constant flux with either thoughts that come by way of senses or thoughts about past experiences.[61] The variability and quantity of our thoughts hinder the process to better self-regulate our emotions and our attention, which can lead to impulsive and irrational behaviors.[33,162] Mindfulness is a state of consciousness that is inherent in all of us, and therefore, it is possible to relearn the technique to bring the mind into the state of mindfulness. Once the consciousness is in a state of mindfulness, the self-regulatory process can be restored to its baseline.

Most secular mindfulness trainings involve individuals to focus on one thought or a non-moving object. The focus can be on the awareness of each breath, the repetitive wording of a mantra either quietly

or vocally, or a visual focus on an object, usually while sitting in a comfortable position.[161] As the mind focuses on one activity or thought, the mind will naturally subdue the random thoughts and thus subduing the distractions that usually fill the consciousness.[161] The heighted self-awareness is the result of the mind focusing on one single idea or thought.[30,36]

The acute awareness of the present moment parallels the heightened self-awareness. Within this state of self-awareness is the restoration of the self-regulatory process. When the self-regulatory process is resumed, purposeful action can occur, a critical factor in sustained health behavior change as summarized in Figure 4.[28,29]



Chapter-3: Figure 4: Mindfulness effects on the self-regulatory process.

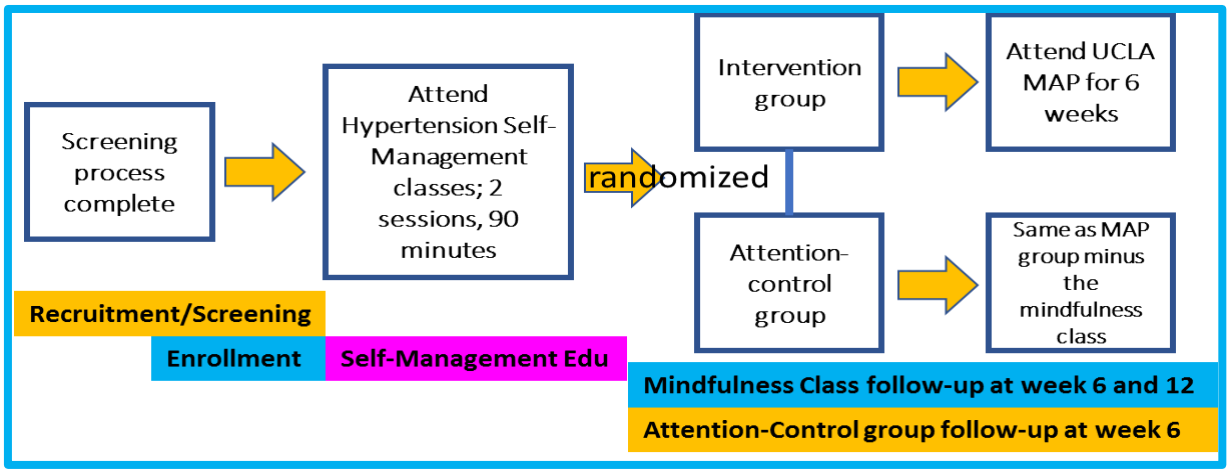
The Self-Management Process through Self-Regulation

Self-regulation is an essential component of the self-management process, especially important in adoption and maintenance of positive health behaviors.[28,29,163-165] For example, a study on improving diabetes self-management behaviors found that those who received the mindfulness training resulted in significant changes in HbA_{1c} compared to those who just received the educational component.[166] The increase in self-management health behaviors related to diabetes care was the basis for the change in $HbA_{1c.}$[166] Therefore, it is possible that mindfulness practice could lead to improved blood pressure control by way of restoring the self-regulatory process, which then results in better self-management behaviors.

Chapter 4 – Methods and Procedures

Research Design Overview

This is a two-group experimental study design. Participants will be randomized to the intervention group or to the attention-control group. Before randomization, both groups will receive education on the proper self-management skills for optimal hypertension control. Comparisons between the two groups will be made at baseline, at week 6, and at week 12. Figure 5 below illustrates the proposed study flow.



Chapter 4-Figure 5: Study flow from screening process to enrollment.

Power Analysis

The proposed sample size was calculated using G*Power Version 3.[167] For Aim 2; the power analysis indicated that a sample size of 52 would allow a detection of a moderate (f = .30) effect size at alpha of 0.05 and power of 0.80. Effect sizes for this calculation were based on the differences in adherence to medication, diet, and exercise between baseline, 6-week, and 12-week follow-up as well as covariates age and hypertension knowledge level. Intention-to-treat analysis will be used; hence we were conservative in determining power based on the number of participants after attrition. A moderate effect size was used based on the results of a meta-analysis on the effectiveness of mindfulness-based practice on various disorders.[168]

Instruments and Measurements

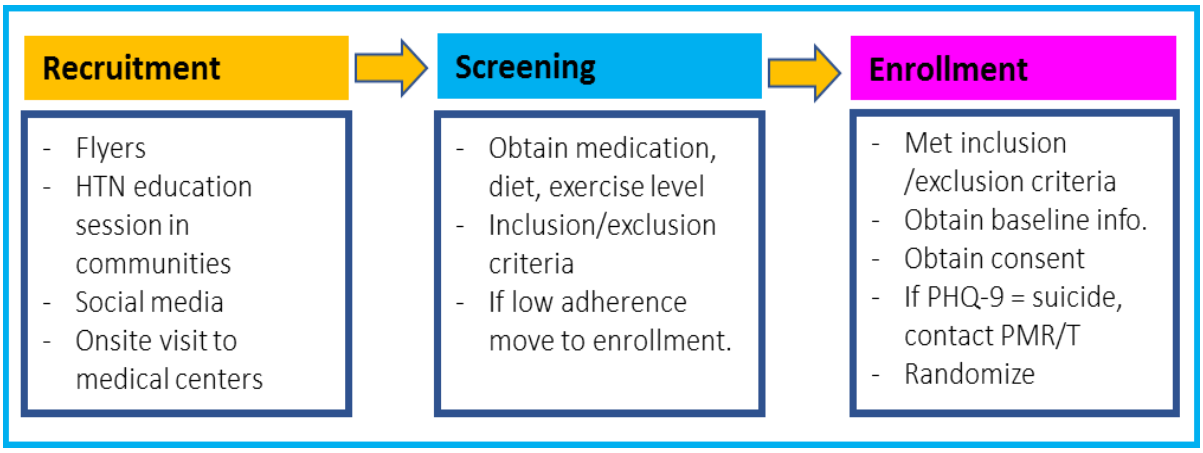
The specific instuments used in this study is outlined in Table 1. Patient demographic information will be collected at baseline. Measurements of weight and hit-to-waist ratio will be measured at baseline at week 6 and week 12. See Appendix A for specific demographic questions.

Chapter 4-Table 1: Study Instruments, questionnaires, and surveys

Self-Report Instruments, Questionnaires, and Surveys		
Name	**Description**	**Time points**
Hypertension Evaluation and Lifestyle Management (HELM)	14 items across three domains: general hypertension knowledge, lifestyle and medication management, measurement and treatment goals. HELM provides a valid measure of the knowledge required for patients to take an active role in the chronic disease management of hypertension with good internal reliability with a Cronbach's alpha of .89.[169]	baseline week 6
Self-Efficacy of Hypertension Management[170]	Higher self-efficacy scores were significantly associated with higher levels of medication adherence, decreased amount of sodium intake, and increase physical activity.[170]	baseline week 6 week 12
Patient Health Questionnaire-9 (PHQ-9)	The PHQ-9 is a validated brief screening tool for anxiety and depression with a Cronbach's alpha score of = 0.88.[171]	baseline weekly week 12
Short-Form 20 Health Survey (SF- 20)	Developed by Rand Health. SF-20 is the abbreviated version of the Rand Medical Outcome Study Short-Form 36 Health Survey. Cronbach alpha of.85.[172,173]	baseline week 6 week 12
Mindful Attention Awareness Scale (MAAS).[30]	The MAAS is a commonly used 15-item measurement validated in several languages and utilized within diverse populations.[174-180] The measurement is a 5-point score Likert scale.	Baseline week 6 week 12
8-item Morisky Medication Adherence Scale (MMAS-8)	The 8-item Morisky Medication Adherence Scale (MMAS-8) has a high internal consistency rating (α =.83).[108] The MMAS-8 has been used in various clinical settings for over two decades and has been translated and validated to multiple languages.[108] A score of < 6 is considered low adherence.	baseline weekly week 12
Rapid Eating and Activity Assessment for Patients (REAP)	The REAP is a 30-item questionnaire designed to quickly for assess nutritional intake and requires only 10 minutes to complete.[181,182] REAP has been used in various settings across a diverse population.[181-184] The food groups include fruits, vegetables, dairy, meat, fried foods, snacks, sweets, and fats/oils. The REAP also includes sodium and alcohol intake questions.	Baseline weekly week 12
3-item Brief Physical Assessment tool (BPA)	The BPA has a moderate test-rest reliability rating.[185] This principle investigator used the decision matrix table provided by the American Heart Association. The BPA has been utilized in multiple studies in a diverse population.[186,187] Higher scores indicate adequate to high physical activity.	baseline weekly week 12
Mindfulness practice time log	Total minutes of mindful practice at week 6 and week 12.	daily
Blood pressure measurements	Self-monitored blood pressure measurements logged at home.	daily

Recruitment Strategies

The next three sections provide an overview of the recruitment process, screening, and enrollment (Figure 6).



Chapter 4-Figure 6: Recruitment, Screening, and Enrollment flow

Recruitment flyers will be posted at various Los Angeles locations that are easily accessible to the UCLA Mindful Awareness Research Center. Recruitment flyer distribution locations include outpatient medical clinics in and near the UCLA Medical Center and at the UCLA Cardiovascular Center. The principle investigator will work closely with Dr. Watson in the recruitment process as Dr. Watson is the Co-Director of both the Cholesterol and Lipid Management Center and the UCLA Cholesterol, Hypertension, and Atherosclerosis Management Program (CHAMP). The principle investigator will be available in person at least once a week at the UCLA Medical Center and the UCLA Cardiovascular Center for the purposes of recruitment. Additional recruitment strategies include:

1) The principle investigator will reach out to physicians at the UCLA Medical Center and at the Cardiovascular Center to promote this study.

2) The principle investigator will visit other venues near the campus (churches, synagogues) for the purposes of providing health education on hypertension management, which include an introduction to this study.

3) Recruitment information will be posted on UCLA affiliated social media (SON weekly email, SON Facebook).

4) As a part-time faculty at California State University, Northridge School of Nursing, I will reach out to faculty and students to promote this study through email and posting of flyers.

Retention strategies include $10 to $25 gift card, bus tokens to UCLA Mindful Awareness Research Center, parking validations, and weekly follow-ups.

Recruitment flyer will include the following information:

1) Brief description of the study
2) Eligibility
3) Time commitment
4) Compensation
5) Name and address of the investigator and center doing the research
6) Location of the research and name of the person to contact for further information
7) IRB protocol number and approval details

Our goal is to recruit at least 65 participants. This will allow for 20% attrition rate, which was determined by several studies with a similar patient population where the attrition rate was between 0% to 22%.[71,144]

The City of Los Angeles is home to a diverse population. We estimate the ethnicity/race make up will be 48% Hispanic, 28% White, 10% African-American, and 10% Asian based on the current City of Los Angeles census. The random sample will be drawn from those residing in Los Angeles County. We aim to recruit more men than women because research shows that women tend to be more compliant to self-management regimens.[188]

Sample and Screening Process

The sample will consist of adults with hypertension over the age of 18 and who self-report low adherence to antihypertensive medication and lifestyle modifications (measured during screening). The initial screening process includes a diagnosis of hypertension for more than six months as well as self-

reported low adherence levels to medication, to diet, and to exercise. Table 2 provides the detail list of inclusion and exclusion criteria proposed for this study. In addition, practical exclusion criteria include physical limitations that prohibit certain body movements, including not able to sit for more than 10 minutes. The principle investigator will also be able to access for limitations during the initial screening process. The eligibility of participants will be determined by the inclusion and exclusion criteria.

If inquiries about the study are received through email or by phone, the principle investigator will provide the potential participant with the description of the study and eligibility information. If potential participant expresses interest in the email or during the phone call, the principle investigator will invite the potential participant to fill out a screening packet (Appendix A) to see whether the participant meets eligibility for the study. If a potential participant meets with the principle investigator during in-person visits to the clinic or other neighboring venues, the principle investigator will offer the participant the screening packet at that time. The screening packet will be reviewed by the principle investigator as to determine participant's study eligibility. The participant can opt to leave or wait to see if they are eligible. If the participant chooses to leave, they will get notification by the principle investigator within 24 to 48 hours as to their eligibly to be in the study. Partipants will receive a $10 gift card upon completion of the screening packet regardless of their eligibility.

Chapter 4-Table 2 Study inclusion and exclusion list

Inclusion Criteria
• Greater than 18 years of age • Diagnosis of Primary/essential hypertension > 6 months • On at least one blood pressure-lowering prescription medication • Able to understand English • Agree not to enroll in other mindfulness-based programs • Agree not to enroll in other structured exercise and diet programs
Exclusion Criteria
• Previous experience with mindfulness-based practice within six months of enrollment date. • Poor mental health status or dementia (Mini-Mental State Examination Score < 23) • Cognitively impaired or major psychiatric disorder that may hinder participants to fully engage in the study. • Currently pregnant or breastfeeding • Any medical diagnosis and condition resulting in kidney damage or decrease in kidney function within six months of enrollment date. • Cachexia/malnutrition, conditions leading to muscle wasting, muscle weakness, and loss of appetite; morbidly obese

Enrollment

Once eligible participants have been identified through the initial screening process and the eligibility requirement have been met, participants will be guided through the study enrollment procedure by the principle investigator. The enrollment process includes collecting consent forms from participants, obtaining anthropometric measurements (height, weight, waist-to-hip ratio), baseline blood pressure measurement and filling out the baseline questionnaires (Appendix C).

Upon completion of the screening process, all enrollees will receive a kit that includes a Sphygmomanometer (blood pressure measuring device), study questionnaires, instructions on the use of the kit, and contact information for the principal investigator. Once all pertinent information is provided by the principle investigator to the enrollees, they will be enrolled in a two, 90-minute hypertension self-management information sessions.

Approximately, 5 to 10 participants will be enrolled at a time. During the information sessions, the proper use of the Sphygmomanometer will be discussed. The participants will return demonstrate the proper use of the Sphygmomanometer to ensure that the partipants can properly measure the blood pressure at home. This study will use the guidelines provided by the American Heart Association on the proper use of a Sphygmomanometer.

Hypertension Self-Management Information Sessions Overview

The principle investigator will provide the Hypertension Self-Management Information sessions for the eligible partipants in two, 90-minute sessions. These 90-minute sessions will provide information for proper hypertension self-management and participants will receive a binder with all materials that will be covered in class (Table 3). Outline of topics covered in class are in Table 3. The content of the HTN educational sessions is evidenced-based, reported by the Lifestyle Work Group (LWG) on guidelines on lifestyle management to reduce cardiovascular risks.[189] For hypertension management, LWG found strong evidence that DASH diet and aerobic exercise training lowered blood pressure.[189] The enrollees will

receive materials and brochures for proper hypertension self-management available through the American Health Association and Centers for Disease Control and Prevention websites, which are also available to the general public at no cost.

Chapter 4-Table 3: HTN self-management information session topics

WEEK1: Hypertension Self-Management Information Session ONE Topics:	WEEK2: Hypertension Self-Management Information Session TWO Topics:
- What is blood pressure? - How to read blood pressure measurements - The importance of monitoring blood pressure - Risks of uncontrolled blood pressure - Benefits of effective blood pressure control - Importance of medication adherence	- Facts about DASH diet - Overview of sodium and blood pressure - Portions, reading food labels - Healthy recipes and healthy cooking - Importance of physical activity - Proper blood pressure measurements

The information sessions will also emphasize the importance of health behavior maintenance. Once the participants complete their group classes, Hypertension Evaluation and Lifestyle Management (HELM) questionnaire will be readministered. Those participants who receive a score of 11 or better will be randomized to the intervention group or to the attention control group.

Intervention Group

The intervention group will receive the UCLA's Mindful Awareness Program, a 6-week signature mindfulness class series provided by the UCLA Mindful Awareness Research Center. The weekly classes are two hours long, and weekly attendance is expected. Each class is a combination of lecture, practice, group feedback, and class discussion. Classes include mindful sitting meditation, mindful walking, and mindful movement. The weekly topics include 1) Introduction to mindfulness; 2) Listening, embodiment and Obstacles; 3) Working with pain; 4) Difficult emotions and positive emotions; 5) Thoughtful and mindful interactions; and 6) Loving-kindness. These classes lay the foundation for students to understand the basic principles of mindfulness, develop a personal meditation practice, and apply the principles in their daily life on an ongoing basis. Although full participation is encouraged for both groups, we

anticipate absences for various reasons. Therefore, if participants attend greater than five of the six classes, they will be considered fully compliant to the mindfulness-based intervention.

Up to 15 participants will be enrolled in the 6-week UCLA Mindful Awareness Program classes. Enrollees will receive a textbook on mindfulness practice authored by the founder of the UCLA Mindful Awareness Research Center and a compact disc that has guided mindfulness practice, ranging from five minutes to 20 minutes that the enrollees can use at home. Enrollees will be instructed to practice mindfulness as homework beginning with five minutes and increasing to 20 minutes at Week 5.

Along with the mindfulness related materials, the intervention group will receive a 6-week questionnaire packet and an automated blood pressure monitor. The 6-week questionnaire packet will contain daily log book to write down mindfulness practice minutes, daily blood pressure log book to write down daily blood pressure measurements, and weekly questionnaires (refer to Table 1).

Participants will be instructed to take their blood pressure readings at the same time each day to minimize temporal variations. Blood pressure readings will also be measured by the principle investigator after each UCLA Mindful Awareness Program classes. Participants will be instructed to record their daily blood pressure readings and daily mindfulness practice sessions on their log sheets, which will be provided upon enrollment

Attention-Control Group

The attention-control group will have completed the Hypertension Self-Management Information sessions before randomization. After completion of the Hypertension Self-Management Information sessions, the attention-control group will be observed for six weeks. This group will receive a packet containing an automated blood pressure monitor and a 6-week questionnaire packet equal to what the intervention group will receive. The 6-week questionnaire packet will contain the same materials provided to the intervention group except for the mindfulness practice minute logbook. They will also be instructed to take their blood pressure daily and fill out the weekly questionnaires. The principle

investigator will follow-up with the attention-control group on a weekly basis to answer questions or concerns that the attention-control group may have as well as encourage the participants to take their blood pressure daily and to fill out their weekly questionnaires. These weekly follow-ups will be conducted over a phone call or by email, based on the preference of the participants.

Data Analysis Plan

Initial analyses will include descriptive statistics on age, ethnicity, weight, height, annual income, educational level, health insurance coverage status, gender, hip-to-waist ratio and health status. Assessment of distributional characteristics including outliers, evaluation of missing data, examination of baseline differences among groups in sociodemographic and clinical variables (using a t-test, ANOVA, and chi-square as appropriate to distributional characteristics), and assessment of reliability for computed scores using Cronbach's alpha will be performed. Multilevel analyses will be performed to analyze the outcome measures over time.

The outcome measures (mindfulness practice time in minutes, medication adherence, diet, and exercise behavior) are all interval or ratio level measurement; and therefore, linear mixed models with a random intercept will be used. Also, the models will be assessed as to whether random slopes than those without random slopes have a better fit. The difference between these models follows a chi-square distribution with degrees of freedom as the difference in a number of estimated parameters. Improved fit will be examined using a likelihood ratio test. Predictors include a condition (intervention vs. attention-control) and a time factor (6-week and 12-week follow-up). This time factor will be modeled on ordinal measurement level. The baseline measurement is used as a predictor. The interaction between condition and time will be included in the models. Missing values will be imputed using multiple imputations, and intention-to-treat strategy will be used.

Aim 1: Describe the effect size of UCLA's Mindful Awareness Program (MAP) on health behaviors (medication, diet and exercise adherence) as compared to the attention-control (AC) group at 6 and 12 weeks.

What will be effect size of MAP for these three health behaviors: medication adherence, and diet and exercise?

H_{oA}: There will be a difference between the groups in their change over time (interaction effect) for medication adherence.

H_{oB}: There will be a difference between the groups in their change over time (interaction effect) for diet adherence.

H_{oC}: There will be a difference between the groups in their change over time (interaction effect) for exercise adherence.

Effect sizes of UCLA's Mindful Awareness Program on the outcome variables (medication adherence: MMAS-8, diet changes: REAP, and exercise frequency: BPA) will be determined by using Cohen's *d* formula.

Aim 2: Evaluate the relationship between average daily mindfulness practice minutes (DMPM) from 6 to 12 weeks, i.e., dose, on health behaviors (medication, diet, and exercise).

Will higher levels of mindfulness practice minutes have a positive relationship with the level of medication adherence, and diet and exercise changes?

H_{oA}: Average DMPM (between baseline and at week 6) will be positively associated with medication adherence level.

H_{oB}: Average DMPM (between baseline and at week 12) will be positively associated with medication adherence level.

H_{oC}: Average DMPM (between baseline and at week 6) will be positively associated with diet adherence level.

H_{oD}: Average DMPM (between baseline and at week 12) will be positively associated with diet adherence level.

H_{oE}: Average DMPM (between baseline and at week 6) will be positively associated with exercise adherence level.

H_{oF}: Average DMPM (between baseline and at week 12) will be positively associated with exercise adherence level.

We will construct linear regression repeated models to evaluate the relationship of DMPM on each of the outcome variables (medication adherence, diet, and exercise) between baseline and two follow-up

time points of week 6 and week 12. A posthoc test will be used to compare the change scores between the two groups.

Aim 3: To evaluate the feasibility and acceptability of UCLA's Mindful Awareness Program through program evaluation.

Will the intervention group attend the mindful awareness program class at least five out of the 6 sessions?

H_{oA}: At least 80% of the participants in the intervention group will attend at least five out of the 6 mindful awareness class sessions?

Will the intervention group fill out the weekly questionnaire at least 80% of the time?

H_{oA}: At least 80% of the participants in the intervention group will fill the weekly questionnaires at least 80% of the time?

Aim 3 will assess quantitative and qualitative measures of adherence to UCLA's Mindful Awareness Program practice, UCLA's Mindful Awareness Program training satisfaction scores, and frequency of daily mindfulness practice as outlined in UCLA's Mindful Awareness Program training. Participants' feedback will be collected through open-ended questions about the study experience. A satisfaction survey of the UCLA's Mindful Awareness Program will be administered upon completion of the UCLA's Mindful Awareness Program class at week 6. If 80% or more of the participants respond with values of ≥ 4 to the three questions listed in Table 4, then we can conclude with some certainty that the UCLA's Mindful Awareness Program is feasible and acceptable for individuals with hypertension. The results of the open-ended questions will provide additional information about the feasibility and acceptability of the UCLA's Mindful Awareness Program.

Chapter 4-Table 4: MAP program satisfaction questions

Satisfaction questions to access feasibility and acceptability questions
1. Overall, how satisfied are you with the UCLA's Mindful Awareness Program training? (5) Very satisfied (4) Satisfied (3) Don't know (2) Dissatisfied (1) Very Dissatisfied 2. How likely is it that you will continue to practice mindfulness in the future? (5) Definitely will (4) Probably will (3) Don't know (2) Probably will not (1) Definitely, will not 3. How likely will you recommend the UCLA's Mindful Awareness Program training? (5) Definitely will (4) Probably will (3) Don't know (2) Probably will not (1) Definitely, will not
Possible open-ended questions about the study experience.
1. What aspect of the study did you find it most/least challenging? 2. Describe your mindfulness class experience. 3. What was your mindfulness practice experience like at home? 4. What are your thoughts about continuing this practice after the study?

Participant Retention Strategies

Our retention plan is to collect contact information (i.e., email, number, address) from participants to track adherence to the study intervention and to contact them with follow-ups. Additional tracking measures will be implemented for any participants who for whatever reason can't be reached by phone, email, or postcard. The principal investigator's contact information will be provided to all participants.

Participants will be encouraged to contact the research staff or the principal investigator with any concerns or questions. Additionally, the principal investigator will contact each participant on a weekly basis to keep the line of communication open throughout the study. We will minimize any inconvenience that participants may experience by providing free parking to attend class as well as bus passes for those participants who do not want to drive. The classroom will be easily accessible to all participants. Participants will receive one $10 gift card upon 1) confirmed weekly attendance to the classes, and 2) filling out the weekly questionnaires. They will also receive one $20 gift card upon completion of 12-week follow-up.

Informed Consent Protocol

Participants will be informed of data collection methodology and of the measures taken to safeguard such information from disclosure. During the recruitment process, potential participants will be made aware that they can refuse to participate and withdraw from the study at any time. Participants will receive consent forms approved by the UCLA IRB. Participants will be provided a copy of their signed consent form. All signed copies collected will be kept in the data cabinet located inside a secured data room.

Throughout the recruitment and study process, participants will be provided with information about the study and involvement. Once a prospective participant agrees to take part in the study, the principle investigator or trained research assistant will explain the study in detail and the criteria for participation. Prospective participants will be invited to come in for a baseline screening. Baseline screening, obtaining consent, and other one-to-one interaction with the participants will occur in a private office to ensure participants' privacy. The office in the Factor building is walking distance from the UCLA Mindful Awareness Program Center. During the baseline screening process, the principal investigator will review the study involvement and requirements with the prospective participant. If a prospective participant meets the selection criteria and agrees to participate in this study, this principle investigator or a trained research staff will review with them the consent process. Ample time will be provided for the prospective participant to review the consent forms. This principle investigator or a trained research staff will ask the prospective participant questions such as "in your words, what is your understanding as to what is required of you during this study" to confirm their proper understanding of the study.

Participants will sign the consent form(s) indicating that they are being asked to participate in a research study, that they understand the risks involved in participating, that they can refuse to answer any question that they are not comfortable with, and that information they will provide will be kept strictly confidential. The consent process will be ongoing, and participants will be periodically reminded of their right to "withdraw" or "opt-out" of the study or procedure at any time.

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Chapter 5: Mindfulness to Facilitate Lifestyle Behaviors for CV Risk Reduction: A Focused Review

Introduction

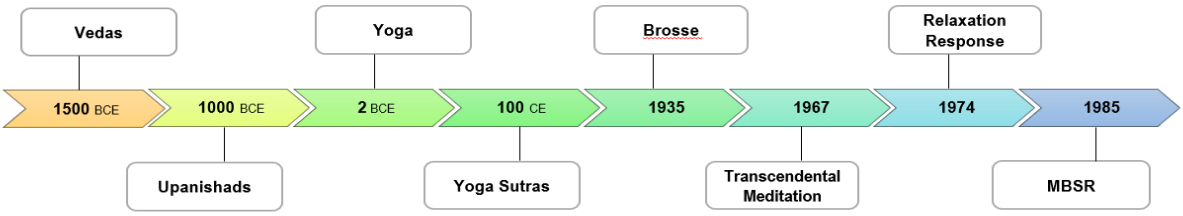
This focused review evaluates evidence of how meditation may impact cardiovascular disease (CVD) risk factors, specifically diet and exercise. The motivation for this review is to provide clinical application on how patients may apply meditation to improve their health through lifestyle behavior modification. While the American Heart Association (AHA)[1] and others have provided consensus on the general positive benefits of meditation on health, further understanding would be helpful in respect to 1) origins of meditation practices in the United States, 2) lifestyle behavior modifications related to cardiovascular risk reduction, specifically diet and exercise, and 3) relevance to clinical setting.

Cardiovascular disease affects over 84 million people in the United States,[2] and development and progression are contributed to unhealthy diet and sedentary lifestyle. Despite widespread knowledge about basic healthy behaviors, over 75% of adults report inadequate levels of aerobic activity, and have poor dietary habits consisting of eating foods high in sodium, fat, and refined sugar.[3] These two unhealthy lifestyle behaviors are estimated to contribute to the 40% of US adults who are obese (BMI $\geq$ 30).[4] Getting adequate exercise and having a healthy diet is a challenge for most adults. A solution for this challenge may lie in the ancient practice of meditation. Approximately 33% of adults in the US use some form of complementary approaches such as meditation, yoga, and biofeedback for a wide range of health benefits.[5] Meditation approaches, in particular have expanded to reducing cardiovascular risk such as stress reduction in patients with hypertension (HTN), blood pressure reduction in patients with HTN, better abstinence rates in tobacco use, slowing atherosclerosis progression, and improving endothelial function.[1] However, it is unclear to what extent meditation has an effect on modifying lifestyle behaviors, particularly diet and exercise. Therefore, the purpose of this review is to evaluate the current evidence of meditation on diet and exercise behavior modification. In addition to the review, we provide a historical perspective of yoga as most meditation programs used in a clinical setting are founded on the principles of yoga practice.

Cardiovascular (CV) risk reduction has both a physiological and psychological component. The physiological benefits associated with meditation is immediate influence on lower heart and respiration rate, and blood pressure. The psychological component in this focused review is on diet and exercise behavior modification. In this review, we will highlight the most widely used meditation-based programs: Transcendental Meditation, Relaxation Response, and Mindfulness-based Stress Reduction. Although all three meditation-based programs have shown positive physiological and psychological outcomes associated with CV risk reduction, studies reviewed here for diet and exercised modification utilized Mindfulness-based Stress Reduction or similar mindfulness-based practice. Whereas, Transcendental Meditation and Relaxation Response are associated positive physiological outcomes for CV risk reduction. We start with a historical perspective of how mediation programs came to be used clinically for cardiovascular risk reduction.

The Effects of Meditation on Cardiovascular Risk Reduction in US: A Historical Perspective

The initial practice of meditation in the US was not driven by CV risk prevention, nevertheless health benefits were observed in people who first used these techniques in the Western setting. The earliest written words that describe the principles of yoga practice as we know it today are found in scriptures called Vedas, which date back to the Iron Age of India (Figure 1).[6] The Vedas spoke of sacrificial rituals carried out by priests for the purpose of unifying the self with the "One consciousness."[6] Over a half century later, in another scripture, Upanishads, described techniques of controlling one's breath to focus the mind.[6] The controlling of breath and focusing the mind replaced the ceremonial rituals as a way to gain enlightenment.[6] While these early scriptures did not refer to any particular health benefits, the techniques found in these scriptures are associated with relaxation, which is considered clinically a healthy state mentally and physically.



Chapter 5-Figure 1: History of meditation from India's Iron Age to the present - meditative based approaches in US.

The word "yoga" does not appear in India's texts until 2 B.C.E. (Figure 1). The earliest written words about the practice of yoga are short aphoristic stories, collectively called The Yoga Sutras. Within these stories, esthetic techniques are described as a way to train the mind (which is referred to as an internal organ) for the purpose of understanding the self through contemplative practice (i.e. meditation).[7] The Yoga Sutras describe training of the mind by repeating a mantra or focusing on an object. The focusing of the mind fosters a greater self-awareness, which then promotes a strong connection to the external environment, creating an anchor by which the mind is focused on the present moment. Furthermore, the focusing of the mind is a way to rid the constant thoughts that appear randomly. Most thoughts are not representative of the present moment and tend to invoke negative emotions.[8] The focused self-awareness and the calming of the mind promote a sense of balance between the self and the external environment. Until the 20th century, the practice of yoga was not known to the rest of the world until scientists from neighboring countries heard about yogis who were able to stop their heartbeat at will. The intersection between the practice of yoga and science emerged when a French cardiologist, Dr. Therese Brosse, traveled to India in 1935 with an electroencephalograph (ECG) to obtain a recording of yogis meditating.[9] The four yogis who were observed while in meditation did not show heart rates of zero in the ECG reading, although some of the yogis did show a heart rate less than 40 beats per minute. Two decades later, other scientists repeated the study, and found similar findings in that yogis meditating were able to lower their heart rate but did not stop their heart.[9,10] These were the first immediate effects of meditation on CV health, specific to physiological changes associated with a relaxed state. However, long effects of meditation on CV health and health behaviors were not evaluated until decades later.

Wenger and Bagchi published one of the first studies evaluating yoga practice and its effect on the autonomic nervous system, particularly with the body's regulation of the sympathetic and parasympathetic systems.[10] Wenger and Bagchi's evaluation of three yogis during meditation was similar to Brosse's earlier findings. There was no direct evidence that the yogis were able to stop their heart. These earlier studies were conducted in India because the practice of yoga was not common in the US. This would change however, when yoga masters such as Paramhansa Yoganda and Maharishi Mahesh Yogi traveled to the US to spread the ancient practice of yoga. People generally were not drawn to the practice of yoga for health benefits, but instead an alternative approach for spiritual growth without the affiliation of traditional religious beliefs.

One such method of yoga practice is Transcendental Meditation (TM), which was brought by Maharishi Mahesh Yogi who arrived in the US in 1967. The TM is a meditation-specific technique that is part of yoga practice known as concentrative focus of the mind. The focusing of the mind is typically taught through focused concentration on a mantra or visually focusing on an inanimate object. This meditation technique was easy to understand to many people that were unfamiliar with meditation practice. The application of TM on health goes beyond the original intent as being a spiritual practice as demonstrated by a study published by a graduate student, Robert Keith Wallace. His thesis "Physiological Effects of Transcendental Meditation Technique: A Proposed Fourth Major State of Consciousness" was one of the first studies conducted in the US that demonstrated TM's beneficial outcome on oxygen consumption, heart rate, and respiration rate.[11] Wallace's initial research was the impetus for future studies to evaluate meditation effects on not only physiological changes, but psychological benefits that is associated with the mind and the body in a relaxed state.

A consequence of TM's beneficial effect on physiological changes prompted other scientists to develop TM like practice but devoid of any spiritual context. One such practice, the Relaxation Response was developed by Herbert Benson from Harvard Medical School. The development of Relaxation Response was based on the initial collaboration of Benson and Wallace where they further investigated

the effects of TM on physiological changes. Their study enrolled 36 healthy adults with at least 6 months of TM experience and outcome measurements included respiration rate, oxygen consumption, and heart rate. Results showed significantly lowered rates for all three outcomes as well as an increased elimination of carbon dioxide.[12] Additional bioactivity was measured using an Electroencephalogram (EEG) during meditation of the same 36 subjects. The EEG pattern during TM showed an increase in slow alpha-waves intensity, which is characteristic of a person who is asleep. The physiological changes and the EEG pattern were collectively referred to as "a wakeful hypometabolic physiologic state."[12] Based on these findings, TM appears to invoke a sympatholytic state, a downregulation of the sympathetic activity and upregulation of the parasympathetic activity. It appears likely this immediate physiological improvement, including the increase in slow-alpha waves intensity reflects psychological variations associated with feeling of calm, which could facilitate health self-care behaviors, particularity with diet and exercise. The advantage with observing immediate results is that people feel benefits instantly, which could be a motivation for continuing the practice. This phenomenon of observing immediate benefits may underlie the popularity of activity trackers such as FITBIT®.

Benson went on to expand on these previous findings and focused primarily on the sympatholytic effect of the TM practice on lowering BP in patients with hypertension (HTN). Subjects with HTN were enrolled, and baseline BP measurements were taken for two weeks prior to the TM training. Subjects agreed to return every two to three weeks for BP measurements for 12 months after the training period. During the subjects' onsite visits, TM practice times and their antihypertensive medication compliance were logged by the researchers. The results showed no significant changes in BP measurements pre TM training (146/92 mmHg) compared to post TM training period (135/87 mmHg).[13] Although, the results did not show that TM practice could lower BP in subjects with HTN, Benson continued to apply the principles of TM practice, whereby developing his own version of TM which he referred to as "eliciting the relaxation response."[14] Benson continued to develop his relaxation response (RR) technique and in

1974 published *The Relaxation Response*. A more detailed review of TM and RR effect on cardiovascular risk reduction are described in later sections.

Other seminal work in meditative practices was developed by Jon Kabat-Zinn. Where Benson focused on the wakeful hypometabolic physiologic state induced by meditation, Kabat-Zinn focused on the psychological effect of meditation on destressing the mind. Hence, Kabat-Zinn referred to his program as Mindfulness Based Stress Reduction (MBSR). Meditation practices are broadly classified as either mindfulness meditation (open monitoring meditation) or concentrative meditation (focused attention).[15,16] Whereas TM is considered a concentrative meditation, Kabat-Zinn's MBSR is based on mindfulness meditation, an open monitoring of thoughts without judgement. The MBSR program was widely accepted, and popularized the term "mindfulness practice".[17] Jon Kabat-Zinn's pioneer work on MBSR laid the groundwork and development of other forms of mindfulness-based therapies, particularly in mental health and behavior modification associated with cardiovascular disease prevention. The term mindfulness practice was popularized by his original work in the late 1980s, which is described in more detail in a later section.

Another important aspect of yoga history is the philosophy of the mind-body connection. Yoga philosophy does not differentiate the mind from the body but considers them as one unit, mind-body. Whereas in western philosophy, many of the theoretical models explaining the concept of self typically view the mind separate from the body. This difference in the mind and body relationship is magnified when it comes to treating illnesses. In India, a more holistic approach is applied when caring for the sick because their belief in that the mind and body are not separate; whereas in the US, we differentiate between the mind and the body, and typically have medical treatment that only affect the body or only affect the mind. For example, in the care of CVD such as HTN, medication is given to address the high blood pressure, but there are no clear guidelines as to how people should adopt and maintain healthy lifestyles. Although non-pharmacological approaches are applied in the US for various health conditions,

most of these approaches are applied to the body only, and do not directly modify health behavior. Meditation could be an intervention to bridge the psychology of behavior change into intention to action.

Meditation in Cardiovascular Health in US, 2019

The three popular meditation-based programs: TM, RR, and MBSR are part of a larger group of complementary approaches recognized by the National Center for Complementary and Integrative Health (NCCIH). The NCCIH classifies complementary and alternative medicine (CAM) approaches into five broad domains: Biologically-based therapies, Mind-Body Therapies, Manipulative and Body-based Therapies, Energy Medicine, and Whole Medical Systems. The CAM therapies are defined as having:

"a broad range of therapeutic interventions developed and practiced by trained healthcare professionals and disciplines who have created bodies of knowledge that are used for education and training. These interventions are based on three important principles: (1) to treat the whole person; (2) to see the individual as a facilitator of health; (3) to see the body as having the inherent ability to heal itself." [18]

The three meditation-based programs discussed below are categorized under the Mind-Body therapies of NCCHI definition. Although there are other types of meditation-based programs that have also demonstrated CV health benefits, this review will evaluate practices that focus on the mind.[1] We start with TM, as this meditation practice is the oldest of the three (Figure 1).

Transcendental Meditation

Transcendental Meditation is a meditation practice utilized both in secular and clinical settings. In clinical settings, TM has shown to have beneficial cardiovascular effects such as reduced heart rate and blood pressure (BP).[11,12] Transcendental Meditation involves focused concentration while sitting comfortably with eyes closed for 15 to 20 minutes of practice, twice a day.

Practice of TM appears to have a calming effect on its practitioner as demonstrated in lower respiration rate and oxygen consumption, and an increased carbon dioxide elimination.[11,12] These

respiratory changes are called “wakeful hypometabolic physiologic,” and usually these alternations are associated with sleep, suggesting dominance of parasympathetic activity.[12,13] Other hypometabolic physiological changes have been observed, particularly in lowering BP. A meta-analysis found that on average, there was a 4.7 mmHg mean reduction in systolic blood pressure (SBP) and a 3.2 reduction in diastolic blood pressure (DBP) post TM practice.[19] However, the authors questioned the clinical relevancy of the BP results, citing that many of the studies reviewed lacked methodological rigor.[19]

A more recent meta-analysis found an average reduction in SBP of 4.26 mmHg (95% CI=−6.06, −2.23) and DBP of 2.33 mmHg (95% CI=−3.70, −0.97) in the TM groups compared to the control groups.[20] When subgroups (age and sex) were analyzed, greater effect in SBP was observed in those over 64 years of age.[21] An estimated 75% of adults have HTN over the age of 64 years, increasing to 82% over the age of 75 years.[22] The greater effect in SBP among older adult population may be due to higher baseline BP. Regardless, meditation may be a low cost intervention for better blood pressure control for this population.

Although there is evidence that TM is beneficial in reducing BP, few studies consider confounding factors such as antihypertensive medication adherence, diet changes, or physical activity level as these are considered lifestyle behaviors that have direct beneficial effect on BP control. Future studies may consider controlling for lifestyle behaviors when analyzing the effect of TM on BP in order to derive at a more accurate effect size. Nevertheless, evidence suggests TM is associated with positive physiological changes for overall CV health.

Relaxation Response

The second meditative approach is RR which is drawn on the principles found in TM. The RR focuses on the physiological benefits associated with TM practice devoid of any spiritual connotation. Benson wanted to evaluate the effects of RR on physiological changes, specifically the down regulation of the sympathetic drive. The first RR study enrolled 17 healthy subjects with no prior experience in

meditation practice. Each subject was given instructions to practice the RR technique for a period of 12 minutes. The subjects were given the following steps to elicit the RR: 1) repetition of a word or phrase audibly or silently, 2) a positive attitude (i.e., non-judgement of how well one is practicing), 3) a quiet environment, and 4) muscle relaxation (e.g., sitting comfortably). Five 12-minute consecutive sessions were observed, and subjects' physiological measurements were obtained. Three of the five, 12-minute sessions were control periods of which some subjects were instructed to sit comfortably while others were just told to have their eyes closed. Compared to the control sessions, the RR practice sessions resulted in a 13% decrease in oxygen consumption, 12% decrease in carbon dioxide elimination, and respiration rates decreased to 11.1 breaths/min from 15.7 breaths/min. Based on the previous findings, Benson hypothesized that eliciting the RR evokes the body's natural relaxation response and retrains the body's "fight or flight" reaction to stress. The body's "fight or flight" response system increases the sympathetic drive, whereby BP and heart rate increases, preparing the body for fight or flight. Benson's later studies supported his hypothesis. One study showed that the practice of RR lowered BP on pre-hypertensive adults while another study found similar results in patients with HTN on anti-hypertensive medications.[13,23]

Benson's most recent study suggests that the underlying mechanism of RR on BP may be through a set of biological transcription actions, particularly NF-kB, a protein complex that controls transcription DNA.[24] The NF-KB responds to cellular signaling associated with inflammation and stress. The subjects with HTN who did not respond to RR showed significant upregulation of NF-kB compared to subjects that did respond to RR. The subjects that responded to RR with down regulation of NF-kB showed significantly lower BP, suggesting that RR affects the biological mechanism associated with down regulation of sympathetic activity. Both RR and TM are well established meditation methods that have demonstrated CV health benefits. However, the positive CV health outcomes are physiological measurements in response to meditation practice. Besides the physiological changes that occurs with meditation, there is also a mental shift that occurs, most notability, mental calmness. The first meditation-

based program that focused on mental health was MBSR. Further discussion of MBSR and its impact on CV health is described below.

Mindfulness-based Stress Reduction

The MBSR addresses an important psychological outcome of meditation-based practice and that is stress reduction. Chronic stress is considered a risk factor for CVD; therefore, managing stress levels is important for overall CV health.[25] The MBSR was originally called Stress Reduction and Relaxation (SRR) program and was developed for chronic pain management for people where traditional pain management methods were unsuccessful.[26,27] Both TM and RR measured outcomes are associated with observable phenomena such as HR and BP, whereas MBSR focused on self-reported outcomes such as pain, anxiety, and stress levels. The first SRR program was applied to 21 subjects with unmanaged chronic pain. The subjects were required to practice mindfulness for 45 minutes daily and practice Hatha yoga (physical practice) in their homes. The control group participated in the usual care (nerve blocks, physical therapy, analgesic, antidepressants) for their chronic pain management. The SRR group reported a significant reduction in pain levels and mood disturbance, including anxiety and depression when compared to the control group. At 15-month follow-up, 70% of the subjects reported that they maintained their mindfulness practice, and continued to report lower pain levels.[26,28] Kabat-Zinn later changed the program name to Mindfulness-based Stress Reduction to emphasize the importance of mindfulness training in his program. Since then, the MBSR has been applied to a wide range of health conditions including anxiety, depression, and stress in healthy and clinical populations with CVD.[29]

Given that healthy eating habits are an important element for CV disease risk reduction, other mindfulness-based modalities such as The Mindfulness-Based Eating Awareness Training (MB-BET) are used to control binge eating typically associated with stress. The MB-BET method is based in MBSR, but is more focused on bringing acute awareness that underlies the emotions and feelings surrounding the binge eating behaviors.[30] The MB-BET has also been applied to increasing overall healthy diet habits such as reducing caloric intake as well as choosing healthier foods.[31] Regardless the meditation programs

used, promoting a healthy diet behavior is essential for not only overall CV health but also reducing CV risks. Many of the studies evaluated here used MB-BET as their meditation intervention for diet changes. The three meditation-based programs discussed in this focused review are also evaluated by AHA as part of a larger group of meditation programs on CVD risk reduction.[1] Similar to the findings in AHA's systematic review, the RR and TM studies reviewed here focused on physiological changes associated with CV health and risk reduction. Very few, if any, study exist that evaluate RR or TM as an intervention for diet and exercise behavior modification. Hence, all meditation-based programs listed in table 1 and table 2 are MBSR, some derivative of MBSR, or a brief mindfulness intervention.

Effects of Meditation on Dietary Habits

A healthy diet and exercise are essential component in CV risk reduction and in overall CV health. Therefore, we reviewed current evidence of meditation on dietary habits and exercise. We start with meditation on dietary habits. We evaluated 10 articles (Table 1) that used a meditative approach for addressing poor dietary habits. In Mason et al., subjects were randomized to the MB-EAT group or to the active control group where consumption of sweets was compared at month 6 and at month 12. No significant differences in sugar consumption was observed between the two groups at 6-month follow-up. However, at 12-month follow-up, the MB-EAT group reported less sweet consumption compared to the previous 6 month follow-up; whereas, the control group did not improve between the two time points.[31] Moreover, the MB-EAT group on average had a lower body weight at week 12 compared to the control group, which is consistent with the reduced sugar consumption reported by the MB-EAT group.

Meditation also appears to influence attitudes associated with certain types of foods. For instance, 36 men with recurring prostate cancer were randomized to receive an 11-week mindfulness training with dietary and cooking lessons or to the waitlisted group. Post mindfulness training, the intervention group reported negative attitude towards foods containing high sugar ($p = .017$), compared to a more positive attitude towards fruits ($p < .001$), which concurred with the subjects choosing healthier snacks over unhealthy snacks.[32] Furthermore, results showed significant changes in vegetable proteins (considered

healthier protein alternative to animal protein) consumption over animal proteins (p = .01).[32] However, because mindfulness training was integrated with the dietary and cooking classes, it is unclear how effective the mindfulness training was to the outcome of the food choices made by the subjects.

Other than choosing foods poor in nutritional value, people engage in eating habits related to stress such as emotional eating and binge eating. Meditation programs appear to help reduce mindless eating due to stress. The improved eating habits were lower sweet food consumption, smaller portions, and lower calorie intake.[32-35] Health benefits associated with these improved dietary habits include lower fasting glucose, lower HbA1, and weight loss.[34,36] A healthy weight is essential for overall CV health; however, some studies that did measure weight as a primary outcome did not find weight loss to be significant though the groups that received the mindfulness training did report a significance decrease in perceived stress and fasting glucose levels.[34,36]

Effects of Meditation on Exercise

Exercise is another important component of CV risk reduction. Observational studies show that people who do engage in physical activity also report higher levels of dispositional mindfulness (Table 2). Trait or dispositional mindfulness refers to one's ability to be more mindful in their daily activities.[37,38] Mothes et al. evaluated depositional mindfulness in healthy men, and found that aerobic exercise significantly improved their capacity for mindfulness.[38] Furthermore, people who have a higher propensity towards being mindful in their daily activities are more likely to adhere to exercise regularly.[39,40] A study of adults with type 2 diabetes (n = 148) found a significant relationship between healthier dietary behaviors (increase in fruits and vegetables) and higher dispositional mindfulness scores. However, diabetes care behaviors such as medication adherence, home glucose monitoring, and exercise were not associated with higher levels of dispositional mindfulness.[41] In a different study, healthy adults (n = 148) were evaluated on their dispositional mindfulness and these health behaviors: fruits and vegetable consumption, sleep, and physical activity. The mediational analysis showed a significant association between depositional mindfulness and lower perceived stress. The mediational analysis

showed a greater engagement in all three health behaviors, suggesting that lower perceive stress is a possible moderator for greater engagement of health behaviors.[42]

Meditative approaches may also improve exercise capacity an important component to overall CV health. For example, Younge and associates randomized adults with heart disease to a 12-week online mindfulness program (n = 215) or to usual care (n = 109). At the end of the study, subjects performed a 6-minute walk test, an exercise capacity measurement. The mindfulness group showed a significant improvement in their 6-minute walk test (effect size, meters: 13.2, 95%CI: -0.02; 26.4, p = 0.050) compared to the usual care group.[43] Moreover, at 12 month the mindfulness group continued to outperform the control group (6MWT: 17.9 meters, p = 0.055).[44] The improvement at 12 month suggest that mindfulness practice could have long lasting effect on CV health and performance. Furthermore, given that some studies found that meditation programs may moderate the enjoyment of the exercise performed, should improve both the exercise behavior and the meditation practice.[37,45,46]

Studies related to meditation and exercise have been published mostly in the last five years, indicating that this field of research is relatively new and more rigorous research in this area will forth coming. Studies evaluated in this focus review suggest that engaging in physical activity improves dispositional mindfulness. An important area of focus in future studies is whether meditation could facilitate people to adopt and maintain regular exercise regimes.

Summary

In this focused review, we provided a historical overview of meditation programs in the US and its impact on CVD reduction in the clinical context. Meditation programs, TM and RR are associated with observable physiological outcomes such as heart rate, BP, and biological markers. Because very few studies have yet to evaluate TM and RR for lifestyle behavior modifications, we were not able to determine their effectiveness on diet and exercise. The studies that have evaluated diet and exercise, typically incorporate MBSR or similar mindfulness-based programs. This may be the case today because MBSR was developed originally for stress reduction, rather than CV health. As this area of research

expands, meditation-based programs such as TM and RR could cross-over and applied to different clinical platforms and populations.

AHA stated in their review of on meditation on cardiovascular risk reduction that

"given the low costs and low risks of this intervention, meditation may be considered as an adjunct to guideline-directed cardiovascular risk reduction…with the understanding that the benefits of such intervention remain to be better established."[1]

Besides AHA recommendations for future studies on establishing a better understanding of meditation benefits, we propose these additional recommendations: standardizing outcome measurements and rational for the selected meditation program. Additionally, we agree with recent call for action by the National Institute of Health's Science of Behavior Change suggesting that more research should be focused on the mechanism that drives behavior change.[47] We would also add that more research should be focused on the mechanism of meditation-based programs on behavior change as we have highlighted in this review that meditation programs appears to facilitate positive health behaviors.

Chapter 5-Table 1: Meditation on dietary habits

Reference	Design	MI *n*/total *N*	Population	Intervention length	Primary outcomes(s) ~Secondary outcomes(s)	Main findings
Fanning et al. (2018)[41]	CS	148	Adults with type 2 diabetes		diet	Higher dispositional mindfulness associated with healthier eating. Non-significant in exercise and medication adherence,
Carmody et al. (2012)[48]	MI vs WLC	37	Men with prostate cancer	8 weeks	Ratio of animal:vegetable protein	Significant increase in vegetable protein than animal protein
Mason et al. (2016)[31]	MI vs AC	100/194	obese adults (BMI≥30)	6 months	Sweets (%Kal/24hr) Fasting glucose	%Kal (sweets) from 6-12 months, p=0.035, diff = 2.17, 95% CI (0.16, 4.18)
Corsica et al (2014)[32]	MI, MI+SEI, SEI	13/39	BMI≥23	6 weeks	Stress eating Weight	Significantly decreased stress/emotional eating ($F(2,7) = 17.39$, $p = .002$)
Cavanagh et al. (2014)[49]	MI, AC, Edu	96	female undergraduate students	6 mins	Portion size	no significance between 3 groups for portion size.
Arch et al. (2016)[50]	MI, AC, CTL	33/102	undergraduate students	30 mins	calorie consumption	Calorie consumption lowest for mindfulness group which was mediated by increase in taste
Levoy et al. (2017)[33]	pre-post	83	avg 48.3 y/o, 71% ♀, BMI avg 25.3	8 weeks	Three Factor Eating Questionnaire (Eating Inventory)	significant lower emotional eating scores
Raj-Khan et al. (2017)[34]	MI, AC	42/88	women with BMI≥25	8 weeks	Total Mindfulness Scale stress, ~fasting glucose, ~BP, ~weight	significantly decreased perceived stress and in fasting glucose
Kian et al. (2018)[36]	MI vs UC	30/60	adults with type II diabetes	8 weeks	fasting blood glucose, HbA1c, ~depression, ~anxiety	significant diff. between groups for all four outcomes
Mason et al. (2018)[35]	pre-post	104	BMI≥25	28 days	food craving (overeating behavior)	significant reduction in craving-related eating (40% reduction; $p < .001$)

CS = Cross Sectional, MI = meditation-based intervention, WLC = waitlist control, AC = active control, SEI = stress eating intervention, Edu = education; UC = usual care

Chapter 5-Table 2: Meditation on exercise

Reference	Design	MI *n*/total *N*	Population	Intervention length	Primary outcomes(s) ~Secondary outcomes(s)	Main findings
Ruffault et al. (2016)[37]	CS	280	Students between 18 and 37 y/o		PA level	DM moderate intrinsic motivation towards exercise
Sagui-Hensen et al. (2018)[42]	CS	233	Adults (mean age 40 y/o)		Health behaviors: PA, fruit/veg consumption, sleep quality	DM (β = -.21) on stress perception (SP). Total effect DM on PA (β = .12), on sleep (β = .11) both significant. Non-sign. fruits/veg (β = .07)
Tsafou et al. (2016)[45]	CS	398	Adults between 18 and 65 y/o		PA level Physical Activity Enjoyment Scale (PAES)	DB on PA ((β = .26, p< .001). PAES significant mediator between DM and PA.
Fanning et al. (2018)[41]	CS	148	Adults with type 2 diabetes		PA level, fruit/veg consumption, medication adherence	DM non-significant for PA and medication adherence. Significant for fruit/veg
Younge et al. (2015)[43]	MI vs US	215/324	Adults with heart disease	12 weeks	6 min walk test (6MWT) ~heart rate, blood pressure, respiratory rate	6MWT (effect size, meters: 13.2, 95%CI: -0.02; 26.4, p = 0.050) HR (effect size, beats per minute: -2.8, 95%CI: -5.4;-0.2, p =0.033).
***Follow-up to Younge (2015)** **Gotink et al. (2017)[44]**	MI vs US	215/324	Adults with heart disease	12 weeks	6 min walk test (6MWT) ~heart rate, blood pressure, respiratory rate	@12 month: sign (6MWT: 17.9 meters, p = 0.055) SBP (d = 0.19; 95%CI 0.03 to 0.36), mental functioning (d = 0.22; 95%CI 0.05 to 0.38) and depressive symptomatology (d = 0.18; 95%CI 0.02 to 0.35

CS = Cross Sectional, MI = Meditation-based intervention, WLC = waitlist control, DE=diet/exercise intervention, MCTL = match control, AET = Aerobic exercise training; UC = usual care, DM = dispositional mindfulness; PA = physical activity; *post-training follow-up

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Chapter 6: Relationship of Mindfulness to Health Behavior in HTN

Introduction

Primary hypertension (HTN) is a progressive medical condition that affects nearly half of the population over 20 years of age in the United States.[1-3] Poorly controlled HTN (high blood pressure) is attributed to 54% of all stroke incidences, 47% of ischemic heart diseases, and 40% of cardiovascular-related deaths.[4,5] Studies have shown that even small increments in blood pressure (BP) can adversely affect health outcomes, including an increase in mortality which doubles with each 20 mmHg increment of systolic BP or 10 mmHg increment of diastolic BP.[6] Therefore, it is imperative for those with HTN to comply with the recommended HTN therapeutic guidelines.

Hypertension is a physiological condition characterized by a persistent elevation in the systemic BP. Medically, two broad categorizations of HTN exists, primary (essential) HTN and secondary HTN. Secondary HTN is normally associated with a main causal factor, and when the source is identified and resolved, so too is the high BP.[7,8] Majority of the HTN diagnosis is primary HTN (~90%).[10,59] The cause of primary HTN is complex and multifactorial involving a combination of genetics, unhealthy lifestyle behaviors, and environmental factors.[6,9] This study focuses on improving the self-management health behaviors for those with primary HTN diagnosis.[8,9,59]

The recommended guidelines for managing HTN includes a healthy diet and engaging in regular physical activity.[6] A healthy diet for HTN such as Dietary Approaches to Stop Hypertension (DASH) has shown to decrease systolic BP by 11 mmHg in HTN and by 3 mmHg in normotensive.[3] Engaging in physical activity reduces systolic BP by 5 mm Hg in HTN and 3 mm Hg in normotensive.[3] Despite these well-known benefits, fewer than 10% of individuals with HTN adhere to a DASH diet, and close to a third report no regular physical activity.[10-12] Not surprisingly then, over 50% of adults with HTN report poor BP control, indicating that many either ignore the information or do not have the adequate resources or ability to follow through with the therapeutic guidelines.[13]

A reason for the lack of compliance to HTN therapeutic guidelines may be that the traditional method of offering information may be inadequate to prompt most people to adopt healthy behaviors, so other

approaches are needed. A possible approach to influence health behavior change is mindfulness practice, which has been used in diverse populations for various mental and physiological disorders.[14] Mindfulness-based therapies are beneficial for eliciting healthier food choices, better control of impulse eating, weight control, and smoking cessation.[15-17] Moreover, mindfulness-based therapies have shown to reduce BP in normotensive population and those with HTN.[18] To our knowledge, no studies have evaluated mindfulness practice and its effect on HTN self-management behaviors, specifically diet, exercise, and antihypertensive medication adherence. Therefore, the purpose of this study is to evaluate whether mindfulness practice improves HTN self-management behaviors.

Method

Study Design and Recruitment

This study was a prospective, single-site feasibility, 2-arm study that was conducted in Los Angeles between July 1, 2017, to August 1, 2018. Participants were recruited in and around UCLA medical and campus centers through posted recruitment flyers, UCLA campus newspaper advertisement, and online medical campus announcements. Recruitment was conducted in blocks (cap of 15 participants) to fill the preset training dates for the mindfulness training and the health promotion training. The participants were not aware of which block they were allocated until eligibility was confirmed. There were four groups, two groups received the UCLA Mindful Awareness Program (MAP), and the other two groups received the Health Promotion Program (HPP). Participants were allocated for the HPP were informed that they were eligible for a MAP class of their choosing at the conclusion of the study. All participants were provided with bus tokens and reimbursed for parking. This study was approved by the UCLA institutional review board, and informed consent was obtained from all participants.

Procedure

Participants who met study eligibility were invited to UCLA to sign the consent form and to fill out the baseline questionnaires which were completed in a private room. The study nurse obtained weight and

blood pressure measurements. Allocation of participants began with the MAP group and concluded with the HPP group. After the recruitment phase, we ended up with four groups total, two cohorts in MAP and two cohorts in HPP. All participants were provided an electronic BP monitor (Omron 3 Series) and instructed to measure their BP daily at home using the guidelines established by the American Heart Association. All subjects received weekly emails reminding them to fill out their questionnaires and their BP measurement logs. The MAP group was also reminded track their mindfulness practice minutes.

Participants

Eligible participants were adults over the 21 years of age with difficulty adhering to the therapeutic guidelines for HTN self-management. Inclusion criteria included those with HTN diagnosis and elevated BP who may or may not have been prescribed antihypertensive medications. Exclusion criteria were current pregnancy or lactation, substance abuse, and chemotherapy. We also excluded people currently practicing meditation or yoga, enrolled in weight loss program or other behavioral interventions, or unable to commit the length of the study. Additional exclusion included uncontrolled psychiatric problems and unable to speak or read English.

Intervention: UCLA Mindful Awareness Program

The MAP group received their mindfulness training from UCLA Mindful Awareness Research Center (MARC) located at the Jane and Terry Semel Institute for Neuroscience and Human Behavior. The mindfulness training sessions are 6-weeks, 2-hour weekly sessions, and attendance to each session is highly encouraged. Each class is a combination of lecture, practice, group feedback, and class discussion. Weekly in class topics included: Week 1 – Introduction to Mindfulness, Week 2 – Listening, Embodiment, and Obstacles, Week 3 – Working with Pain, Week 4 – Difficult emotions/positive emotions, Week 5 – Thoughtful and Mindful interactions, Week 6 – Loving Kindness. These classes lay the foundation for students to understand the basic principles of mindfulness practice and to develop a personal meditation practice for daily living. Participants were given a book on mindfulness practice authored by the founder of the MARC center and a compact disc containing audio recordings of guided

mindful meditations, ranging from five minutes to 20 minutes. The participants were encouraged to read the book at their leisure and listen to the recordings based on their level of practice. Participants were instructed to practice mindfulness at home beginning with five minutes and gradually increasing to 20 minutes. The MAP curriculum was delivered by a certified mindfulness instructor with over 20 years of experience. In addition to the mindfulness training, the MAP group received the same health promotion information provided to the HPP group via email and short in-person demonstration before or after the mindfulness training sessions.

Attention-Control: Health Promotion Program

The HPP group received weekly, 1-hour sessions for six weeks in which health information regarding healthy foods and the importance of exercise were emphasized. The weekly health information sessions were based on the health promotion educational material "Eat Healthy, Be Active Community Workshops" developed by the Office of Disease Prevention and Health Promotion (ODPHP). The ODPHP education material for the public included these one hour workshop sessions: Week 1 –Enjoy Healthy Food Choices that Taste Great, Week 2 – Quick, Healthy Meals and Snacks, Week 3 – Eating Healthy on a Budget, Week 4 – Tips for Losing Weight and Keeping it Off, Week 5 – Making Healthy Eating Part of Your Lifestyle, Week 6 – Physical Activity is Key to Living Well. The HPP was delivered by the study nurse.

Study Measure

The health behavior measurements were diet, exercise, and antihypertensive medication adherence. All three measurements were self-reports submitted by the participants weekly. For dietary intake, we used the Rapid Eating and Activity Assessment for Patients (REAP). The REAP is a 30-item questionnaire designed to quickly assess nutritional intake and requires only 10 minutes to complete.[19,20] REAP has been used in various settings across a diverse population.[19-22] Food groups included in the REAP are fruits, vegetables, dairy, meat, fried foods, snacks, sweets, and fats/oils. The REAP also contain questions related to sodium and alcohol consumption. For physical activity measurement, we used

the 6-item Exercise Behaviors (EB) questionnaire, developed and available to the public from the Stanford Self-management Chronic Disease center. The 6-item contains questions of minutes spent on various physical activities. The Brief Medication Questionnaire 1 (BMQ) questionnaire was used for antihypertensive medication adherence as this questionnaire is developed for measuring antihypertension medication adherence.[23]

Power Analysis

The proposed sample size was calculated using G*Power Version 3.[24] The power analysis indicated that a sample size of 52 would allow detection of a moderate (f = .30) effect size at alpha of 0.05 and power of 0.80. Effect sizes for this calculation were based on the differences in adherence to medication, diet, and exercise between baseline, 6-week, and 12-week follow-up as well as a covariate, age. Intention-to-treat analysis was used; hence, we were conservative in determining power based on the number of participants after attrition. Moderate effect size was used based on the results of a meta-analysis on the effectiveness of mindfulness-based practice on various medical conditions.[25]

Statistical Analyses

Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 25, and SAS. Effect sizes were calculated from results of a mixed model with the group as a between-group factor and week (1-13) as a repeated factor with ARMA(1,1) covariance pattern over time, using SAS Proc Mixed, following the procedure outlined by Selya et al., 2012.[26] Intent-to-treat analysis was performed. The Cohen's f2 sizes were translated into the d metric for easier interpretation using procedure previously described in Calculation of Effect Sizes.[27] Additionally, a detailed examination of the pattern across time within each group was examined for systolic blood pressure (SBP) and diastolic blood pressure (DBP).

Results

Study Participants Baseline Characteristics

Figure 1 shows participant flow from screening to analysis. We randomized 46 participants; 10 people who were randomized failed to initiate the study intervention. A total of 36 study participants were allocated to the MAP group and to the HPP group (table 1). One person from the HPP group was removed from analysis because the participant was placed on new antihypertensive medications during the 12-week study period. Except for the body mass index, no other baseline group differences were significant. The HPP group had a higher mean BMI and a wider standard deviation of 6.4. Majority of study participants reported a diagnosis of HTN and on at least one antihypertensive medication. Most reported good or above level health status. Female study participants outnumbered the male study participants, which is typical for this type of study.

Chapter 6-Table 1: Baseline demographic characteristics of enrolled participants

Characteristics	**MAP (N=20)**	**HPP (N=16)**
Age	58 ± 12.6	64 ± 9.0
Female, n (%)	14 (70)	13 (81)
*BMI (weight (kg) / [height (m)]2)	26 ± 3.7	30 ± 6.4
Blood pressure at baseline, mm Hg		
Systolic	138 ± 14.6	133.7 ± 17.9
Diastolic	89 ± 11.2	81 ± 16.3
Hx of HTN Dx (on at least 1 antihypertensive), n (%)	15 (75)	13 (81)
Health status: In general, would you say your health is: n (%)		
Excellent	2 (10)	1 (6)
Very good	5 (25)	4 (25)
Good	13 (65)	9 (25)
Fair	--	2 (13)
Poor	--	--
Ethnicity/race, n (%)		
Asian or Pacific Islander	7 (35)	1 (6)
Black not Hispanic	4 (20)	9 (56)
Hispanic	2 (10)	--
White not Hispanic	7 (35)	6 (38)

Values are mean ± standard deviation or no. (%) of subjects, *p < .05
Abbreviations: Body Mass Index BMI; History Hx

Health Behavior Outcomes

Table 2 provides the list of primary outcomes and p values for the interaction between time (13 weeks) and group. For diet-related questions, there were no statistical differences between the groups except for the two diet behavior questions, "Choose higher fat red meats like prime rib, T-bone steak, hamburger, ribs, etc. instead of lean red meats" and "Eat regular ice cream instead of sherbet, sorbet, low fat or fat-free ice cream, frozen yogurt, etc"? For physical activity, there was no significant difference between the groups (p = .091); however, there was a greater increase in physical activity with the MAP group from baseline to week 13 compared to the HPP group (Figure 2), and therefore, we included the Cohen's f^2 and Cohen's d values. Lastly, compared to the current literature, this study group showed better antihypertension medication adherence levels Figure 3. The interaction between time and group was not significant for the outcome of antihypertensive medication adherence.

Chapter 6-Table 2: Health behavior primary outcomes and effect sizes

Primary Outcome	Interaction between Time and Group p value	Standardized effect size [Cohen's f^2], [Cohen's d]
Blood pressure medication adherence		
Missed medication days	.912	
Diet behavior		
Eat high sodium processed foods	.914	
Add salt to foods during cooking	.104	
Eat less than 2-3 servings of fruit/day	511	
Eat less than 3-4 servings of veg/day	.351	
Eat beef, dark meat chicken > 2/week	.480	
*Choose higher fat red meats	**.015**	[.094], [.61]
Eat regular sweets instead of low fat	.209	
*Eat regular ice cream instead of	**.013**	[.097], [.62]
Physical activity level	.091	[.071], [.538]

*p < .05

Blood Pressure Outcomes

Weekly BP measurements were averaged, and a total of 13 data points (13 weeks) was analyzed. Intent-to-treat analysis was performed. There was a significant interaction of SBP (p = .005) and DBP (p = .003) and time (13 weeks) difference between the groups (Table 3). The mean difference of SBP from

baseline to week 13 for the MAP group was 19 mmHg (138 mmHg - 119 mmHg) compared to 7 mmHg (134 mmHg - 127 mmHg) in the HPP group. Similarly, a greater reduction in DBP was observed in the MAP group compared to the HPP group, 12 mmHg (89 mmHg - 77 mmHg) and 1 mm Hg (81 mmHg - 80 mmHg) respectively. The SBP was on average lower each week for the MAP group compared to the HPP group despite two subjects in the MAP group having discontinued their antihypertensive medications. This trend was also observed for the DBP, but the difference was much smaller between the two groups. A detailed examination of the pattern across time within each group was examined for SBP and DBP. For SBP, there is a significant time effect for the MAP group ($F(12,145)=7.44$, $p<.001$), with post hoc tests showing that baseline is significantly different from each of the other time points (weeks 2-13). However, the time effect was not significant for the HPP group ($F(12,137)=1.30$, $p=.225$), even though the baseline value was significantly different from weeks 7 and 13. For DBP, there was a significant time effect for the MAP group ($F(12,145)=5.51$, $p<.001$), with post hoc tests showing baseline significantly different from each of the other time points. The time effect is not significant for the HPP group ($F(12,137)=1.37$, $p=.190$)).

Chapter 6-Table 3: Systolic blood pressure and diastolic blood pressure differences and effect sizes

BP	Interaction between Time and Group p value	Standardized effect size [Cohen's f^2], [Cohen's d]	Mindfulness Group SBP mean [95% CI] DBP mean [95% CI] Baseline – week 12	Control Group SBP mean [95% CI] DBP mean [95% CI] Baseline – week 12
*SBP *DBP	**.005** **.003**	[.096], [.620] [.102], [.638]	138 [131,145] – 119 [115,123] 89 [84,95] – 77 [72,81]	134 [124,143] – 127 [114,140] 81 [72,90] – 80 [69,91]

*$p < .05$

Discussion

This study aimed to evaluate whether mindfulness practice improved HTN self-management behaviors, specifically diet, exercise, and medication adherence. Although there was a significant BP change over the 13 weeks between the groups, there were no overall significant changes in HTN self-management health behaviors that would explain the greater reduction in BP observed in the MAP group.

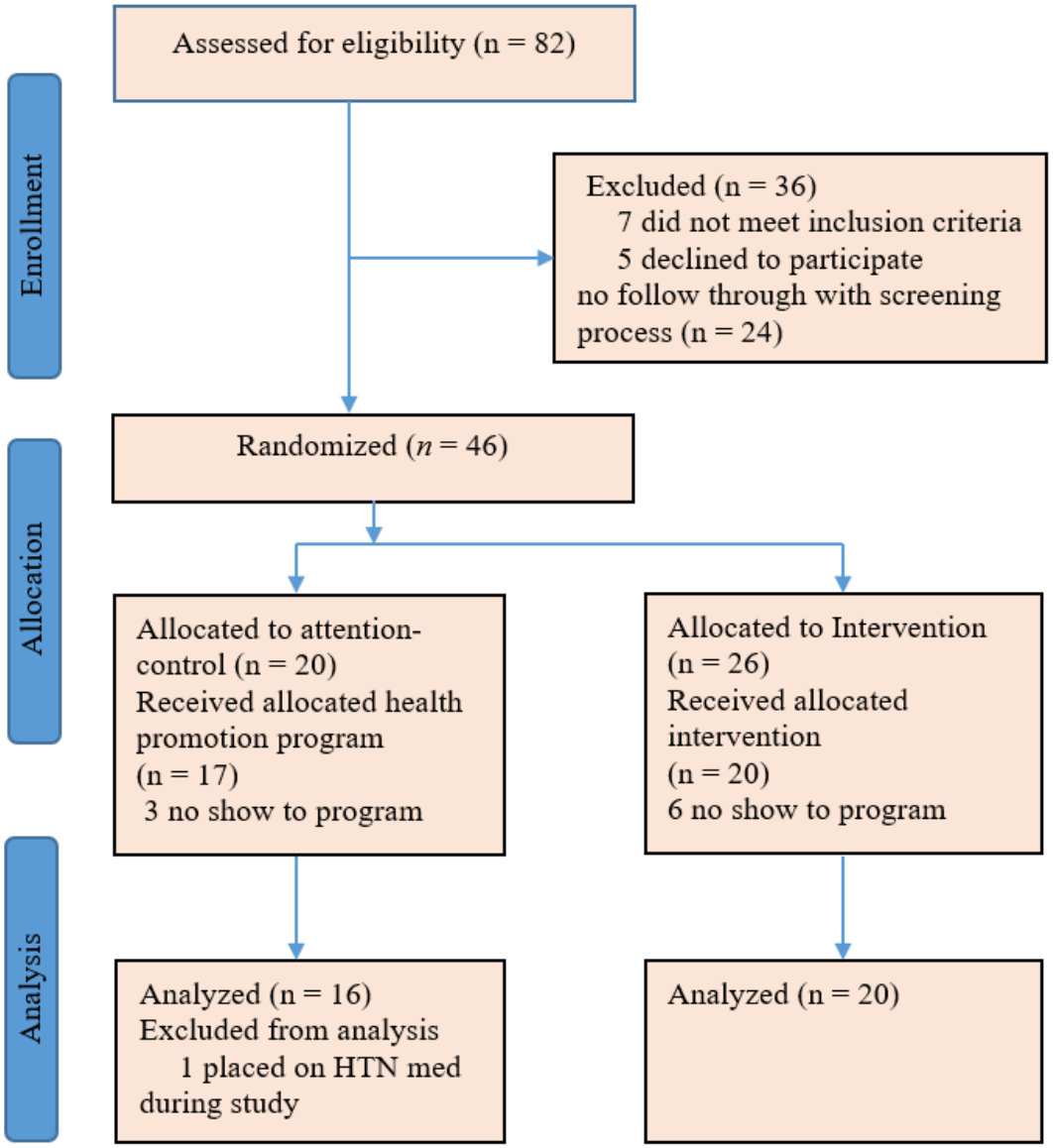
Therefore, it is unclear as to what impact, if any, mindfulness practice had on HTN self-management. This ambiguity may be related to the following study limitations. First, the self-reports may not accurately measure diet and exercise behaviors as participants tend to either underestimate or overestimate in their responses. Future studies should utilize a more objective instrument such as 24-hr food recall to determine diet behavior; and an actigraphy such as Fitbit© to determine physical activity level. Actigraphy is a non-invasive, smart device that measures and collects rest and activity cycles. Second, the sample size for this study was 36 participants and did not meet the sample size of 52 of the power analysis. Therefore, unclear whether the results of this study would be the same with a sample size of 52. Regardless, this is one of the first studies to evaluate multiple health behaviors within the scope of HTN self-management using mindfulness practice, and even with the smaller sample size, we provided effect sizes for some of the health outcomes and BP.

Although this study did not yield the results that were hypothesized, there were a couple of notable findings worth further discussion. Two participants from the MAP group had their antihypertensive medications discontinued by week 13 due to their BP reduction; whereas, no subjects from the HPP group stopped their BP medication. Additionally, the MAP group had a slightly higher mean for missed BP medication days despite a more substantial reduction in SBP and DBP. Although both interventions resulted in similar health behavior changes, the MAP group showed a substantial BP reduction compared to HPP group. Therefore, mindfulness shows promise as an intervention for lowering BP in patients with HTN, although the mechanism of mindfulness practice on HTN self-management behaviors and BP remain unclear.

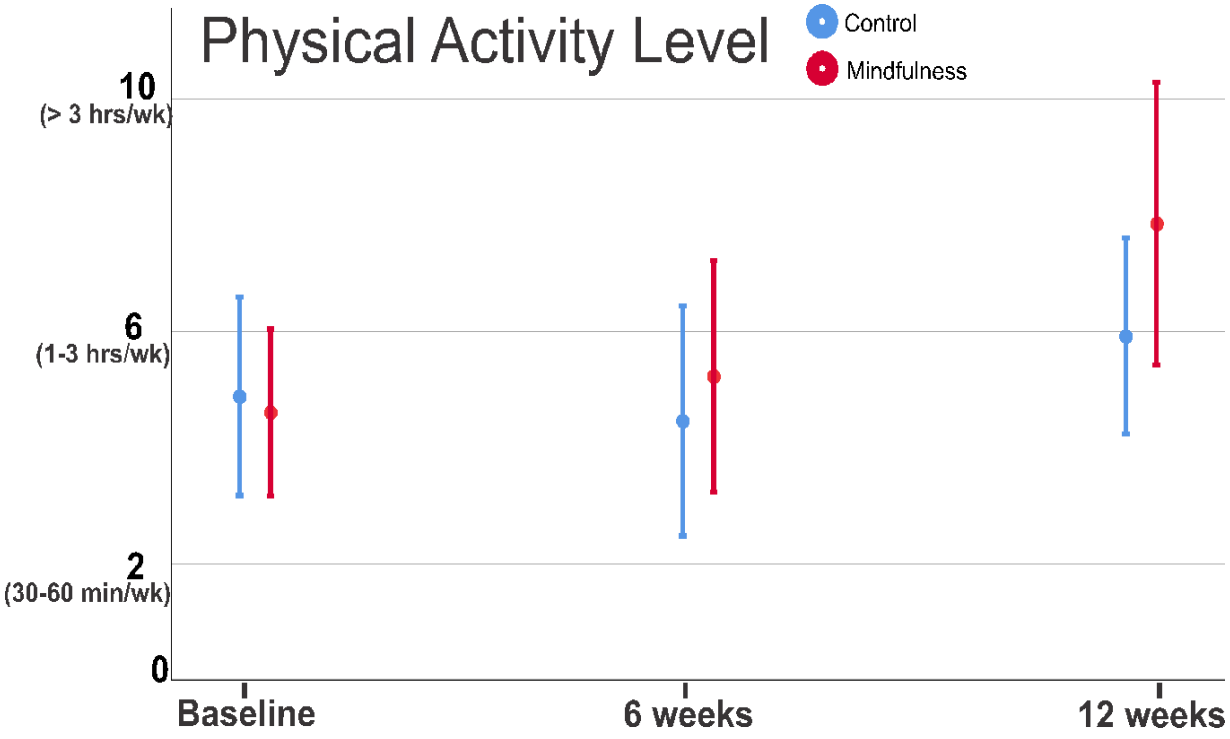
In conclusion, this study demonstrates that mindfulness practice could be a non-invasive, affordable approach to reducing BP in patients with HTN. Further research is needed to understand better whether mindfulness practice improves HTN self-management behaviors in this population, and to elucidate the physiological changes associated with mindfulness practice and BP reduction. Regardless of the limitations seen in this study, the decrease in BP shown in the MAP group is a way to address and help

those overwhelming number of people who do not have their BP well controlled, possibly reducing their risk for a life-threatening cardiovascular event.

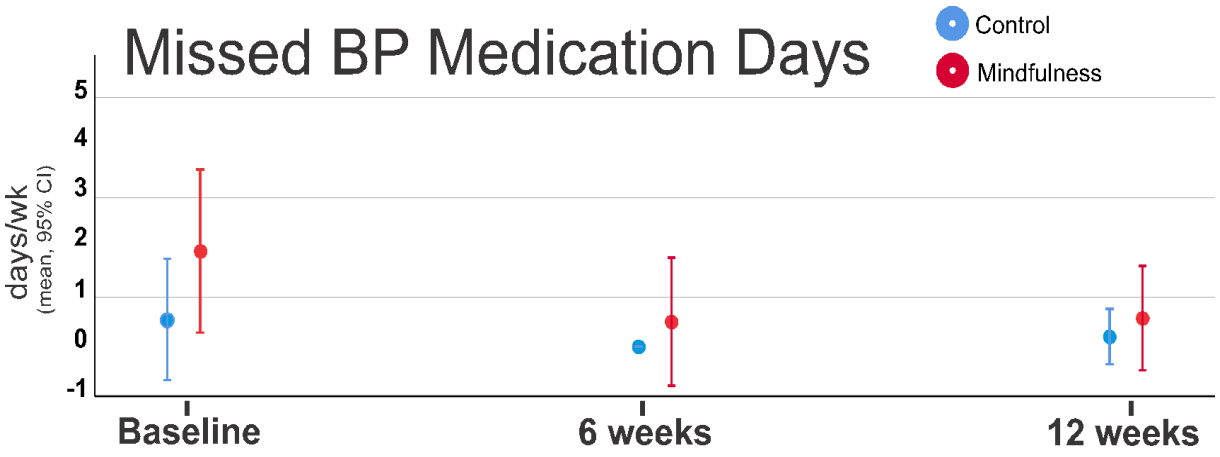
Chapter 6-Figure 1: Study flow



Chapter 6-Figure 2: Physical activity level between groups



Chapter 6-Figure 3: Missed BP medication days between groups



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Chapter 7: Mindfulness and Reduction in Blood Pressure: Mediation by Health Behaviors

Introduction

Hypertension (HTN) is considered the leading modifiable risk factor for cardiovascular complications, including myocardial infarction and stroke.[1] Yet, close to 50% of those with HTN report poor blood pressure (BP) control. The most recent guidelines for the treatment of HTN emphasize the importance of lifestyle behaviors such as a healthy diet, engaging in regular physical activity, and medication adherence for maintaining normal BP control.[2] Although, these lifestyle behaviors are simple in concept, most Americans with HTN have difficulty initiating and maintaining a healthier lifestyle approach. For instance, fewer than 10% of individuals with HTN adhere to a Dietary Approaches to Stop Hypertension diet, and close to a third report no regular physical activity.[3-5] Medication adherence is equally low.[6] Moreover, a Cochrane systematic review on medication adherence found that almost 50% of interventions designed to increase adherence to therapeutic regime are ineffective in the long term.[7] Despite growing evidence that lifestyle behavior changes are equally impactful in BP control, the focus for the last three decades has been on improving medication adherence.[2] Alternative approaches are needed to improve adoption and maintenance of lifestyle behaviors.

Given that lifestyle behaviors are habitual, and therefore, more difficult to break or modify, we needed a novel approach to guide and help those trying to manage their HTN better. Our research aim is to provide an alternative method to supplement the current education-only approach. We utilized a mind-body method called Mindful Awareness Program (MAP), which is offered through the UCLA Mindful Awareness Research Center. The goal of this research is to evaluate the effectiveness of MAP as a patient centered tool for improving HTN self-management. We hypothesize that the mindfulness practice will improve lifestyle behaviors in patients with HTN. Chapter 3 details the study method and the within group differences. Here, we present a detailed look at the intervention group using mediational analysis to evaluate mindfulness practice and health behaviors as mediators on BP.

Blood Pressure and Mindfulness

In the last five years, studies on mindfulness-based practice have grown exponentially, particularly studies that demonstrate mindfulness practice to reduce BP.[8-10] For example, a randomized control study of 52 subjects with un-medicated prehypertension compared Mindfulness-based Stress Reduction (MBSR) training and progressive muscle relaxation training on BP. Subjects in the MBSR group showed a significant reduction in clinical systolic blood pressure (4.8 mmHg), whereas the muscle relaxation group had a small reduction of 1.9 mmHg.[11] In a similar study of subjects with un-medicated stage-1 HTN, the results of 24-hour ambulatory blood pressure readings found no significance between the intervention group (−0.4 ± 6.7/0.0 ± 4.8 mm Hg) compared with the group randomized to the wait-list (−0.4 ± 7.8/−0.4 ± 4.6 mm Hg).[12] Researchers have hypothesized that BP reduction observed is likely associated with the destressing of the mind, which reduces the sympathetic drive and consequently shifts the balance to a parasympathetic dominance resulting in lower BP.[13-15]

The mindfulness practice in this study shares similar principles found in the MBSR program, developed by Jon Kabat-Zinn in the 1980s, whose work helped popularize the term 'mindfulness'. Kabat-Zinn defines mindfulness as "an awareness that arises through paying attention, on purpose, in the present moment, non-judgementally," and most of the other mindfulness-based programs incorporate similar concepts in their training. Details of the mindfulness program used in the study are described in a later section.

The Difficulty in Lifestyle Behavior Modification

The American Medical Association (AMA) states that along with prescribed antihypertensive medications, adoption of lifestyle changes is key for the successful management of HTN.[16] The AMA advises healthcare providers to continuously attempt to reinforce lifestyle adherence until BP goals are met.[2] However, even though most people with HTN acknowledge their understanding of the benefits associated with lifestyle modification, this understanding in itself does not prompt most individuals to

make better lifestyle behavior choices.[17] The difficulty in altering lifestyle behaviors is that lifestyle is just that – behaviors that have been performed for years and are for the most part habitual. Hence, most people do not sway too far from their current lifestyles.

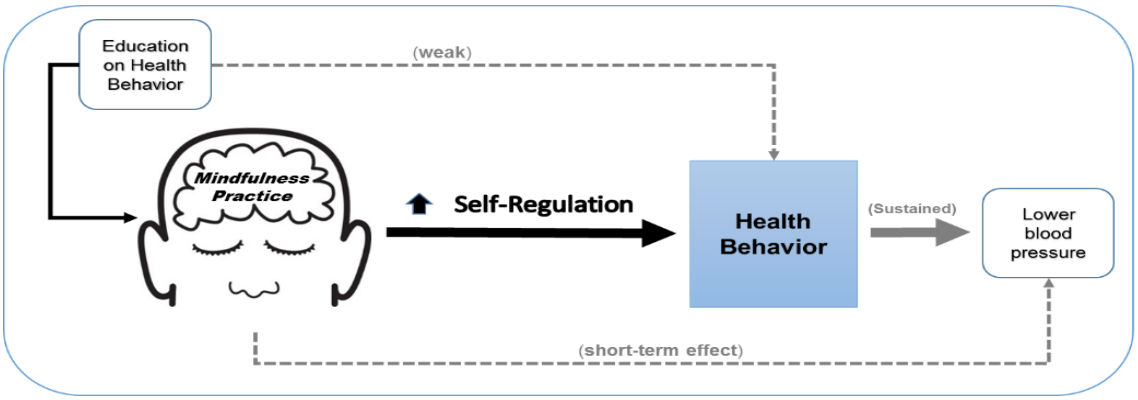
The mind-body oriented therapies for behavior modifications have gained popularity in recent decades. There is new evidence that changing one's mind (thoughts) can, to a limited extent, "rewire" the brain. This is commonly referred to as neuroplasticity.[18] Hölzel and associates (2011) found that when 17 healthy individuals participated in MBSR, magnetic resonance imaging scans showed improvements in the brain regions that controlled memory processing and areas that regulated emotions.[19] In a similar study, 154 participants with cardiovascular risk factors were randomized to a comprehensive and individualized health planning program. These custom plans included guidance from health coaches in goal setting and management of mind-body oriented therapies. These mind-body sessions provided techniques and behavior modifications to effect better choices in foods and adoption of exercise regimes.[20] After 10 months, there was a statistically significant reduction in 10-year risk of cardiovascular health disease for the intervention group compared to the usual care group.[20] Furthermore, there were significant increases of the number of days per week that individuals participated in some form of physical exercise. Secondary analysis revealed significant improvements in BP and low-density cholesterol lipid levels at the 5-month study mark but not at the 10 month mark, suggesting possible confounding effects related to personal variation in diet and medication adherence, or possible long-term influence of treatment time.[20] Although habitual behaviors are harder to eliminate or alter, these mind-body approaches appear promising as novel therapies for influencing behavior change.

Improving HTN Self-Management through Mindfulness Practice

The ability to successfully self-manage a chronic condition such as HTN requires a high level of self-control and internal motivation. Self-control is a manifestation of self-regulation, and those with better self-regulation tend to foster healthier behaviors.[21] The process of self-regulation is a key concept in behavior change.[22,23] When the self-regulatory process is functioning optimally, the behavior is typically

purposeful and goal oriented.[24] Purposeful action is associated with greater control in adoption and maintenance of positive health behaviors.[23,25]

The self-regulatory process is likened to an energy source, and therefore depletable.[26,27] The depletion of the self-regulatory process is usually associated with one's lack of motivation or self-drive towards a particular behavior.[26,27] When the self-regulatory process performs sub-optimally, the 'self' is in the state of ego depletion, resulting in the 'self' engaging in less than ideal choices and actions.[26,27] An important aspect of the self-regulatory depletion is that the process can be strengthened or restored to baseline.[26] Colloquially, the act of self-regulation is known as willpower or self-control.[26] A possible mechanism to restore the self-regulatory process is the practice of mindfulness (Figure 1).[28] Mindfulness is a state of consciousness that is inherent in all of us, and therefore it is possible to train and tune our mind into the state of mindfulness.



Chapter 7-Figure 1. Mindfulness training with education on health behaviors leads to an increase in self-management behaviors.

Studies have shown that self-regulation is an essential component of the self-management process, particularly important in adoption and maintenance of positive health behaviors.[22,23,29-31] A study on improving diabetes self-management behaviors found that those who received mindfulness training resulted in significant change in hemoglobin $A1_c$ ($HbA1_c$) compared to those who received only education.[32] The increase in self-management health behaviors related to diabetes care was the basis for the change in HbA_{1c}.[32] Therefore, it is possible that mindfulness practice could lead to improved BP

control by way of restoring the self-regulatory process through enhancing one's ability to make healthier lifestyle choices.

Material and Methods

Described in Chapter 6.

Statistical Analysis

Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 25, and SAS. Simple mediation models were tested using the Model 4 of the regression-based approach programmed in the PROCESS macro developed by Hayes. The PROCESS macro was installed to SPSS, version 25. The bootstrapping method with 5000 samples was used in all analyses.

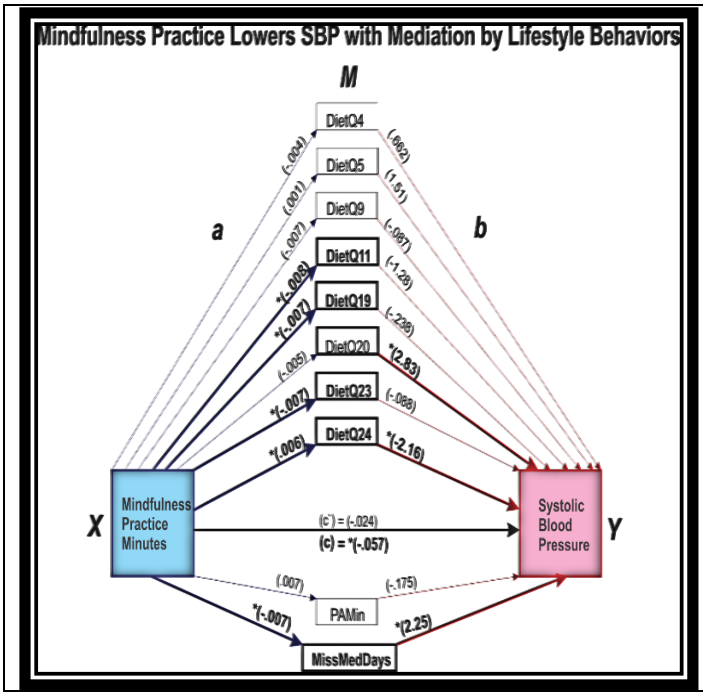
Results

Mindfulness group's baseline characteristics are available in the results section of Chapter 6.

Health Behavior Mediators on Blood Pressure

Ten mediators were included in mediation analysis, eight of which are diet related questions (Table 3). The other mediators are PAMin (physical activity minutes) and MissMedDays (antihypertensive medication missed days). In Figure 2 the coefficients of the various paths are shown; e.g. for every one unit in Mindfulness Practice Minutes (MPM), a decrease in MissMedDays of -.007 was seen, and for every one unit increase of MissMedDays, an increase in systolic blood pressure (SBP) of 2.25 was seen. The direct effect of MPM on SBP (-.024) was not significant, however the total effect of MPM on SBP with indirect effect (ab) of (-.057) was significant, resulting in a 40% increase in SBP reduction in total effect (c) compared to direct effect (c`) alone. The direct effect and total effect of MPM on DBP was not significant, .012 and -.022 respectively. The 95% conference intervals for path a and path b are listed in Figure 2. Overall, healthier eating behaviors (M) appear to improve BP control, particularly diet questions 23 and 24. The lower the sodium consumption the greater reduction in BP. Whereas, higher sugar

consumption (DietQ19 and DietQ20) shows an increase in BP suggesting weight gain as a possible confounder.



SBP Mediators	*a* 95% [CI]	*b* 95% [CI]
DietQ4	[-.022, .004]	[-.952, 2.28]
DietQ5	[-.007, .008]	[-.843, 3.87]
DietQ9	[-.015, .001]	[-1.77, 1.59]
DietQ11	***[-.015, -.002]**	[-3.47, .913]
DietQ19	***[-.014, -.000]**	[-2.65, 2.18]
DietQ20	[-.011, .001]	***[.101, 5.57]**
DietQ23	***[.000, .013]**	[-3.16, 2.99]
DietQ24	***[.000, .013]**	***[-4.17, -.155]**
PAMin	[-.009, .022]	[-.968, .619]
MissMedDays	***[-.013, -.000]**	***[.630, 3.86]**

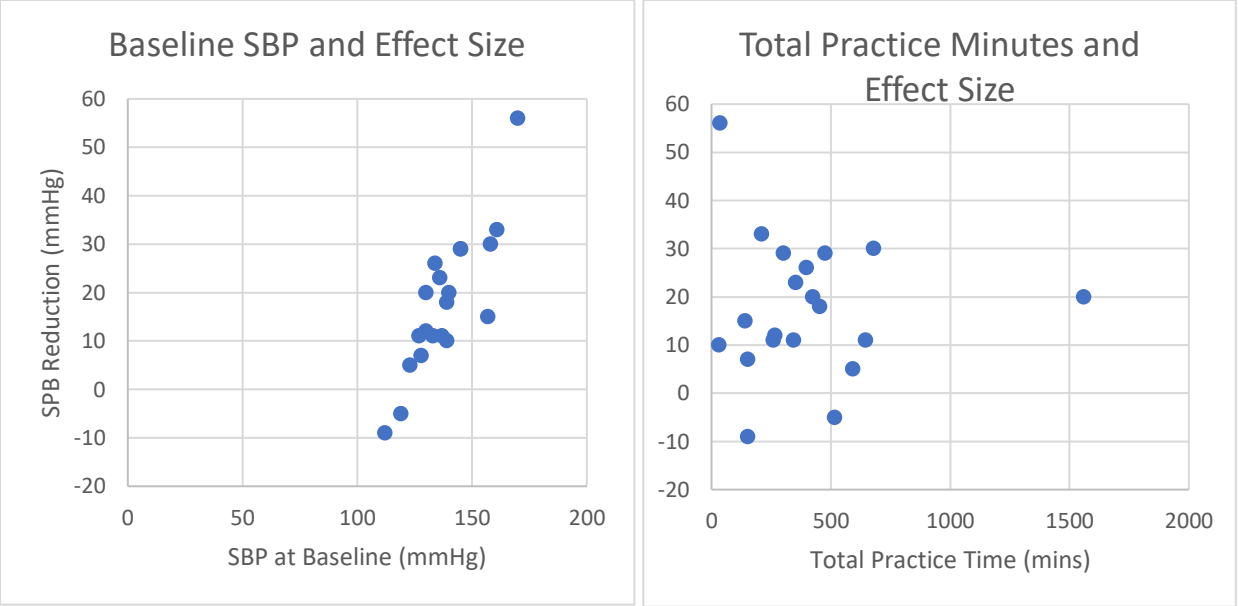
DBP Mediators	*a* 95% [CI]	*b* 95% [CI]
DietQ4	[-.012, .004]	[-.562, 1.44]
DietQ5	[-.007, .008]	[-1.41, 1.51]
DietQ9	[-.015, .001]	[-1.65, .438]
DietQ11	***[-.015, -.002]**	**[-3.00, -.284]**
DietQ19	***[-.014, -.000]**	**[-.217, 3.21]**
DietQ20	[-.011, .001]	***[.009, 3.39]**
DietQ23	***[.002, .011]**	[-3.00, .815]
DietQ24	***[.000, .013]**	*[-2.14, -.351]
PAMin	[-.009, .223]	**[-1.19, .207]**
MissMedDays	***[-.013, -.000]**	***[.739, 2.74]**

Chapter 7-Figure 2: Mediation models between lifestyle behaviors and blood pressure through mindfulness practice. Bold and "*" indicate significant ($p \leq 0.05$) effects. Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP)

Table 2 lists individual variation in BP at baseline and mindfulness practice minutes (12 weeks total) and BP reduction relative to the difference in last BP measurement. Understandably, larger reduction in BP is seen with higher baseline BP, regardless of the total practice minutes. Figure 2 are two scatter plots representing the individual BP reduction based on baseline BP and minutes practiced.

Chapter 7-Table 2: Individual variation in baseline BP and mindfulness on final BP reduction

Subject ID	SBP Baseline	DBP Baseline	Mindfulness Practice Minutes (MPM)	SBP Reduction	DBP Reduction
10001	170	108	35	56	31
10002	161	109	210	33	25
10003	158	90	680	30	9
10004	157	90	140	15	5
10005	145	109	302	29	23
10006	145	96	475	29	13
10007	140	90	1560	20	14
10008	139	98	32	10	15
10009	139	85	453	18	10
10010	137	77	645	11	-1
10011	136	84	353	23	21
10012	134	75	397	26	10
10013	133	79	343	11	1
10014	130	80	265	12	-7
10015	130	100	425	20	-4
10016	128	94	151	7	3
10017	127	85	259	11	7
10018	123	71	593	5	-11
10019	119	83	517	-5	8
10020	112	84	151	-9	1



Chapter 7-Figure 3: Scatter plot of BP reduction with SBP at baseline and Total Practice Time; Effect size is not standardized.

Table 3: Diet questions

Variables	**Diet Questions**
DietQ4	Eat less than 2-3 servings of fruit a day?
DietQ5	Eat less than 3-5 servings of vegetables/potatoes a day?
DietQ9	Eat beef, pork, or dark meat chicken more than 2 times a week?
DietQ11	Choose higher fat red meats like prime rib, T-bone steak, hamburger, ribs, etc. instead of lean read meats?
DietQ19	Eat regular sweets like cake, cookies, pastries, donuts, muffins, and chocolate instead of low fat or fat-free sweets?
DietQ20	Eat regular ice cream instead of sherbet, sorbet, low fact or fat-free ice cream, frozen yogurt, etc.?
DietQ23	Eat high sodium processed foods like canned soup or pasta, frozen/packaged meals (TV dinners, etc.), chips?
DietQ24	Add salt to foods during cooking or at the table?

Discussion

This study evaluated whether mindfulness practice facilitates healthy behavior modification, thereby resulting in better BP control. The results of the mediational analysis (Figure 2) suggests there is a greater reduction in BP when mindfulness practice mediates the health behaviors, rather than the health behaviors alone. Hence, these findings suggest that mindfulness practice does facilitate health behavior modification, resulting in better BP control. There are several limitations to this study. First, self-reports are inherently weak, as subjects may underestimate or overestimate their responses. Second, the study was not able to meet the target recruitment goal of 52 subjects, and therefore likely under powered. Hence, analysis did not a detect a significance in the indirect effect (*ab)* for all health behaviors on BP. Third, there is evidence that mindfulness practice temporarily lowers BP due to its calming effect, however, the temporal effect of mindfulness practice on BP was not controlled for in this analysis. Despite these limitations, the present findings are important for two reasons: (1) this is the first study to investigate mindfulness practice on health behavior for HTN self-management, and (2) the results validate previous findings related to health behavior and BP. These results indicate that mindfulness shows promise as an intervention for lowering BP in adults with HTN through the mediating effect of mindfulness practice on health behaviors.

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Chapter 8: Which Came First, Obstructive Sleep Apnea or Hypertension?

Introduction

Obstructive sleep apnea (OSA), a breathing disorder that effects around 30 million people nationally, is considered a primary risk factor for hypertension (HTN).[1] A common model is that OSA pathophysiology leads to HTN,[2] implying that treating OSA would help prevent or resolve HTN.[3] However, randomized trials of treating OSA with continuous positive airway pressure (CPAP) show inconclusive effects on HTN,[3] raising questions about the links between the two conditions. Since the CPAP findings are inconsistent with the OSA-causes-HTN model, we sought to assess clinical evidence that OSA precedes HTN. Despite the accepted model, there is little clinical evidence on the question of whether OSA or HTN develop first.

Assuming OSA is a precursor to HTN, we initially hypothesized that in patients with both conditions a diagnosis of OSA precedes a diagnosis of HTN. This hypothesis assumes equivalent screening for both HTN and OSA. However, because HTN and OSA are conditions that progress gradually, clinical diagnoses occur months to years after condition onsets. Moreover, screening for OSA is less frequent than for HTN, the delay between onset and diagnosis likely differs between the two conditions, with OSA probably having a longer delay than HTN.[3] Since there is strong circumstantial evidence that OSA screening is far less occurance than HTN screening, a finding that OSA precedes HTN clinically would strongly support the model of OSA preceding HTN; alternatively, if HTN precede OSA diagnoses, we could not rule out a longer delay OSA screening. Regardless of the direction of the findings, an estimate of the time between diagnoses would allow data to place inference on the question of the OSA-causes-HTN model.

Our objective was to test the hypothesis that OSA precedes HTN using electronic health records (EHR) within the University of California, Los Angeles (UCLA) Health System. We assessed the time between OSA and HTN diagnoses in patients with both conditions. We also aimed to describe timing of diagnoses with respect to age and gender, since both factors influence prevalence and severity of both conditions.

Methods

We evaluated EHR over a 10-year period beginning January 2006. The patient records containing diagnoses of HTN or OSA were retrieved. In patients with both conditions, the time from first diagnosis of OSA to first diagnosis of HTN was calculated. The month and day of the first encounter date was converted to January 1 to remove personal identifiers, but otherwise times between diagnoses were accurate to within a day. The day of first OSA diagnosis was set as 0 (relative starting point), and the time difference represented as days to first HTN diagnosis.

We calculated descriptive statistics of time from OSA to HTN, including the mean which was tested for being non-zero with a 1 sample t-test. The relationship between age and time from OSA to HTN was calculated using a linear regression. We repeated these analyses for females and males separately. The location of diagnoses (outpatient vs inpatient) within the 10-year period affects possible OSA to HTN times, so we viewed these times separately by year and by gender. Statistics were performed with MATLAB 9.3.

Results

Of the 1.6 million patient records evaluated (n = 1,654,067) with at least one diagnosis, approximately 2% (29,764) contained OSA diagnoses and 14% (192,771) contained HTN diagnoses. There were 16,974 (1%) patient records with both diagnoses of OSA and HTN, of which 36% (6124) had a sleep study within the UCLA Health System (A sleep study is required to diagnose OSA). We defined long-term care as patients with encounters at least a year before and after OSA diagnosis, who comprise 29% (4848) of records the OSA/HTN patients.

Table 1 shows characteristics of OSA and HTN diagnoses and patient demographics, separated by gender. Hypertension was typically diagnosed earlier than OSA ($P < 0.05$; mean time difference = -732 days; median = -532 days). Females showed earlier HTN diagnosis than males ($P < 0.05$ female vs. male; days delay: females mean = -815.9 days/median = -610, males mean = -668.6 days/median = -451). Age

was negatively related to time from OSA to HTN diagnosis in both sexes ($P < 0.05$). These findings are illustrated in Figures 1 and 2. We repeated these analyses for the 16,974 records of all patients with HTN and OSA diagnoses and the 6124 with a sleep study, and the direction of effects did not change for either set.

Discussion

From 2006 to 2016 in the UCLA Health System, HTN was on average diagnosed years prior to OSA, with a longer separation in females. The time between diagnoses could reflect differences in screening, specifically that HTN is more frequently screened than OSA. Assuming the OSA-causes-HTN model, these findings would reflect a delay in OSA relative to HTN screening of several years. An alternative possibility is that OSA is not a principal mechanism of HTN – the findings could reflect both conditions co-occurring or that HTN may precede the development of OSA. The findings cannot distinguish between such possibilities, but they do suggest that either the OSA-to-HTN model is incorrect or that screening of OSA is poor. Practically speaking, a combination of effects is likely at play, and there is more than one cause of HTN, just as OSA is a heterogenous disorder. However, the relatively large dataset should allow major influences to be observed and questioned.

Considering possible common factors, the co-occurrence of OSA and HTN[2] may be associated with structural and biological effects of obesity, which is highly prevalent in both conditions.[4] In OSA, the extra layer of adipose tissue surrounding the neck may contribute to the narrowing of the upper airway, and rigidity of the thoracic and abdomen walls due to the adipose tissue deposits surrounding tissues, further compromising the air flow.[5] In HTN, an increase in adipose tissue, especially surrounding the abdomen wall, may contribute to progression of HTN due to excess amount of bio-actives (adipokines) produced.[6,7] These adipokines play a key role in body homeostasis, including insulin regulation, lipid and glucose metabolism, coagulation, and angiogenesis and vascular remodeling, which all affect blood pressure regulation.[7]

The longer separation seen in females may be partially explained by more frequent screening in males due to differences in clinical presentation between the genders. For instance, women typically report fatigue, insomnia, and depression, symptoms not classically associated with OSA, whereas, men typically report daytime sleepiness, the defining symptom of the sleep disorder.[8] Sex differences in OSA, such as structural changes in the brain[9] and menopause,[10] mean that the OSA-HTN relationship may differ between males and females. Pre-menopausal women and postmenopausal women on hormone replacement therapy have significantly lower OSA prevalence, suggesting hormones may have a protective role women.[11] Other major differences between the sexes are that men have a higher prevalence of OSA than women by a factor of 2:1.[4]

While this evaluated one health system and may not be applied to the generalize population, our analysis could be replicated with other EHR datasets. The analysis could also be replicated in future time periods, since screening for OSA may improve with time. OSA is a relatively recently discovered disease, and awareness has been an increasing over the past two decades.[4] Similarly, screening for HTN, perhaps with home testing, may also lead to earlier diagnosis, so the patterns seen from 2006 to 2016 may well differ in the future. Additionally, the present data and the refractory nature of HTN in CPAP-treated OSA leave open the possibility that the assumption around OSA as principal mechanism of high blood pressure is inaccurate and warrant further investigation of the relationship between OSA and HTN development and progression.

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Tables

Chapter 8-Table 1: Patient characteristics separated by gender. **A.** Days from first OSA to first HTN diagnosis ($t_{O \rightarrow H}$;) mean and 95% confidence intervals [CI], median, and regression model by age. **B.** Demographics. Approximate age at time of OSA diagnosis. BMI was the closest recorded value to the date of OSA diagnosis; N indicates subset of patients with BMI values. Race and ethnicity were as recorded in EHR.

A

Time from OSA to HTN ($t_{O \rightarrow H}$) days	**All (n=4848)**	**Females (n=2086)**	**Males (n=2762)**
mean ± std [95% CI]	-732 ± 1094.9 [-764.6, -701.8]	-815.9 ± 1127.3 [-867.3, -764.2]	-668.6 ± 1065.6 [-708.1, -626.8]
median	-532	-610	-451
model by age (all $p < 0.05$) $t_{O \rightarrow H} = \beta_1 \times \text{Age} + \beta_0$	-16.9 × Age + 299.3	-18.3 × Age + 301.2	-15.9 × Age + 302.5
Distribution			
HTN before OSA	71.7%	75.2%	69.1%
HTN with OSA (within 40 days)	7.0%	5.9%	7.9%
HTN after OSA	21.2%	18.9%	23.0%
Encounters			
N total	299 ± 247	345 ± 256	263 ± 234
N before OSA	81 ± 92	98.4 ± 99	67 ± 83
N after OSA	218 ± 211	248 ± 223	195 ± 199

B

Demographics		**All (n=4848)**	**Females (n=2086)**	**Males (n=2762)**
Age at OSA diagnosis mean ± std (years)		53.3 ± 13.4	52.8 ± 13.2	53.8 ± 13.5
BMI m^2/kg N measurements		30.9 ± 7.5 N = 3149/4848	32.6 ± 8.4 N = 1411/2086	29.6 ± 6.3 N = 1738/2762
Race	Native American /Pacific Islander	<1%	<1%	<1%
	Asian	9.8%	9.5%	10.1%
	Black or African American	12.5%	18.7%	7.8%
	White or Caucasian	66.7%	61.5%	70.6%
	Not specified/multiple	10.3%	9.5%	10.9%
Ethnicity	Hispanic/Latino	12.9%	16.3%	10.3%
	Not Hispanic Latino	84.9%	82.6%	86.7%
	Not specified	2.2%	1.2%	3.0%

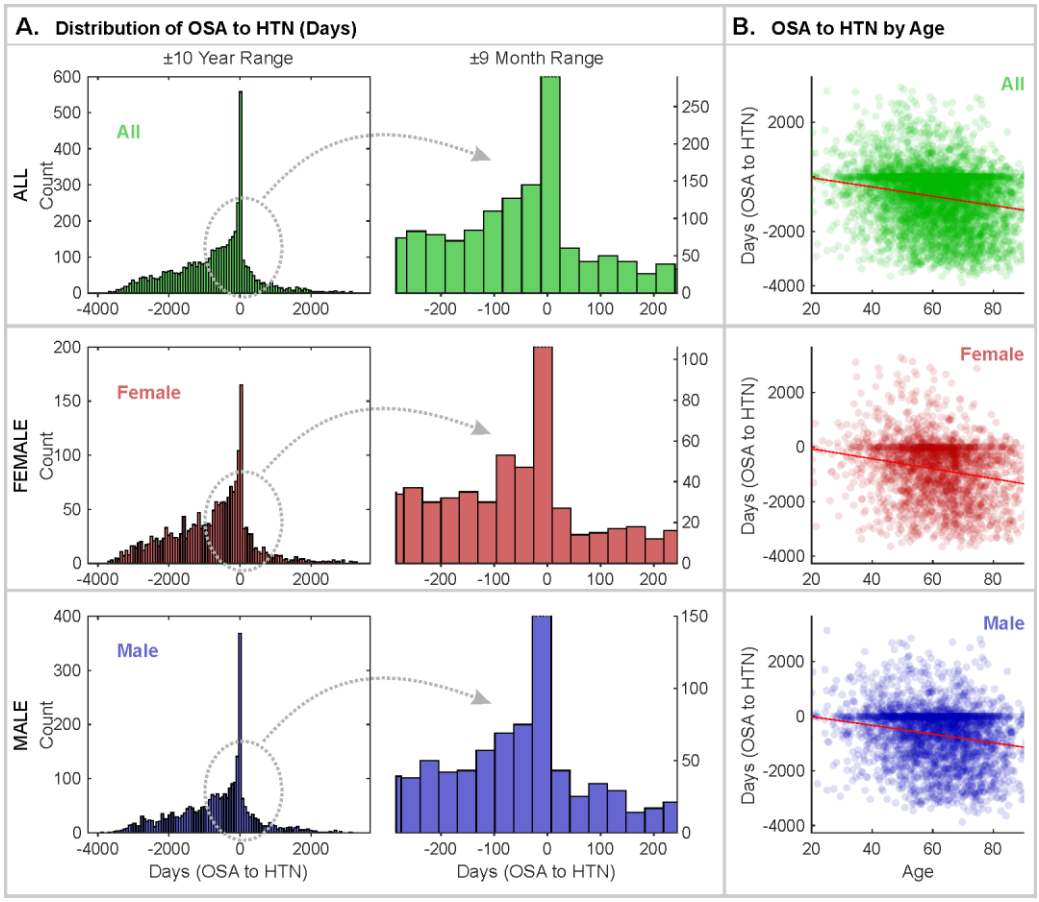
Figure Legends

Chapter 8-**Figure 1: A.** Distribution of time from OSA to HTN diagnoses, for combined ("ALL") and female and male patients; ±10 year and ±9 month ranges are shown. **B.** Scatterplots of time from OSA to HTN diagnoses with respec to age at OSA diagnosis, for combined ("ALL") and female and male patients.

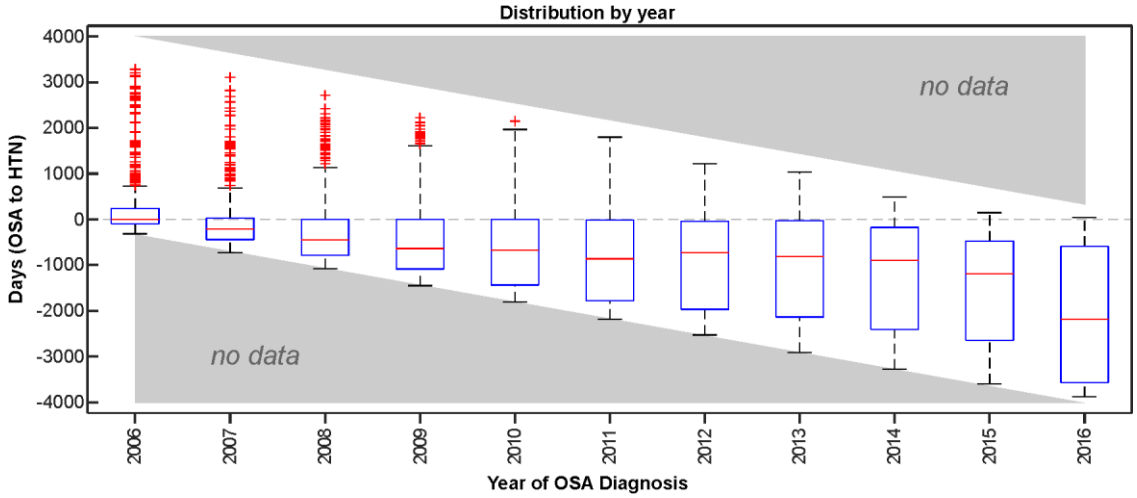
Chapter 8-**Figure 2:** Distribution by year of time from OSA to HTN diagnoses, with box plots by year of OSA diagnosis. No data are available for diagnoses prior to 2006 or after 2016 (so a delay from before 2006 or after 2016 could not be observed).

Figures

Chapter 8-**Figure 1.** OSA and HTN: Time to diagnosis, Time to diagnosis by age



Chapter 8-**Figure 2. Females with OSA and HTN: Time to diagnosis, Time to diagnosis by age**



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