



A Narrative Review of the Effects of Mindfulness on Sleep and Hypertension

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Abstract

Purpose of Review The prevalence of both insomnia and hypertension in the general population is vast and the health implications to individuals and society are costly. The current pharmacological treatment options for insomnia and hypertension are limited and patients are becoming increasingly interested in non-pharmacological treatment options. Mindfulness, a disciplined mental training practice rooted in Eastern traditions, has become a widely popular treatment method for multiple chronic health problems. The aim of this paper was to review research on mindfulness-based intervention effects on sleep, insomnia, and hypertension from the past 3 years. Theoretical foundations of mindfulness are discussed. Empirical evidence and potential mechanisms of how mindfulness impacts sleep and hypertension are provided.

Recent Findings Our findings suggest that mindfulness-based interventions are safe and effective for people with insomnia and hypertension. We saw consistent, albeit small to moderate, effects of mindfulness-based interventions on reducing insomnia symptoms, improving sleep quality, and lowering systolic and diastolic blood pressure readings.

Summary While mindfulness interventions have shown to be effective for improving sleep and lowering hypertension, future research is needed to further evaluate their efficacy on larger samples of patient populations with long-term follow-up measures. These high-quality studies could help researchers and clinicians identify treatment response tendencies in patient populations which can lead to better tailoring of mindfulness-based interventions for specific health concerns.

Keywords Mindfulness · Sleep · Hypertension · Insomnia · Mindfulness-based interventions

Introduction

Insomnia is a common sleep disorder that is estimated to affect up to half of all primary care patients [1]. Insomnia sufferers have trouble falling asleep, staying asleep, and/or experiencing problems waking up too early. Estimates may be biased, as not until the mid-2010s was insomnia considered a stand-alone disorder to be treated independently. This results in both patients and physicians underplaying the significance of poor sleep on health outcomes. Insomnia affects a wide range of people including young and older adults [2, 3]. Older adults with insomnia symptoms are more likely to visit the emergency department or become hospitalized compared to those without insomnia symptoms [3]. Additionally,

older adults with insomnia reported significant impacts of poor sleep on their health and quality of life [4]. Therefore, insomnia, a highly prevalent sleep disorder, can result in negative health consequences and impair quality of life.

Arterial hypertension is another common health concern that affects a large proportion of the population. Hypertension is defined as a consistent (average of ≥ 2 valid measurements obtained at ≥ 2 occasions) blood pressure (BP) reading of systolic blood pressure (SBP) ≥ 130 mm Hg or diastolic blood pressure (DBP) ≥ 80 mm Hg [5]. Recent estimates revealed that hypertension is affecting roughly 31% (~1.39 billion) of all people globally [6]. The prevalence of hypertension also appears to be increasing in low- and middle-income countries while high-income countries have seen a modest decline in recent years. Prolonged hypertension puts people at risk for a host of cardiovascular, neurological, and renal complications, including stroke, heart attack, and heart failure [7]. Globally, the cost of hypertension to society is enormous. In the US alone, \$316 billion total were spent on hypertension-related medical costs in 2017 [8]. The burden of these costs on patients is also high with an estimated

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average of \$6250 spent per person annually on hypertension-related health care in the US [8]. Therefore, hypertension is another prevalent and costly condition that affects many people in the US and abroad.

Mindfulness, a mental training practice derived from Buddhist teachings, has gained increasing attention as a non-pharmacological intervention for various psychological and physical health conditions, including sleep disorders and hypertension. Given the limitations and side effects of pharmacological treatments for sleep and hypertension, there is growing interest in exploring alternative, non-pharmacological approaches, such as mindfulness. Mindfulness has steadily increased in popularity and has even become as widely studied as cognitive behavioral therapy (CBT) in recent years [9]. Mindfulness-based interventions have provided beneficial effects on various mental and physical health conditions including insomnia, hypertension, and pain. Mindfulness is relatively safe and beneficial for health care providers, within schools, and in the workplace. Additional research is warranted as there exists a need for high-quality studies with sufficient sample sizes and long-term follow-up measures.

This review aims to provide an overview of the existing literature on the effects of mindfulness on sleep and hypertension, focusing on theoretical foundations, empirical evidence, and potential mechanisms. We utilized OpenAI's ChatGPT-4 large language model (LLM) to guide the framework of this paper. Specifically, we utilized the LLM to generate an initial outline to structure our review prior to writing it. The original outline suggested by the language model was as follows, with subtopics added in a later step: "I) [Introduction](#), II) [Theoretical foundations of mindfulness](#), III) [Empirical evidence on the benefits of mindfulness for sleep and hypertension](#), IV) [Potential mechanisms of mindfulness on sleep improvement and hypertension](#), V) [Integrating mindfulness into clinical practice for sleep disorders](#), VI) [Conclusion](#)."

We, the authors, refined this outline according to our expertise and decided to integrate the fifth section, "Integrating mindfulness into clinical practice for sleep disorders," throughout the other sections to ensure a thorough and informed discussion of the topic. It is important to clarify that the LLM was only utilized for generating the basic framework of the review; the development, synthesis, and interpretation of content within the framework were conducted entirely by the authors of this paper. We believe that the integration of such technology in the early stages of paper writing can enhance the structure of the scientific writing process, while maintaining the critical role of human judgement and expertise in the creation of informed content.

Once the framework was constructed, we used Google Scholar and PubMed to search for articles related to hypertension, mindfulness, sleep, insomnia, and the effects of

mindfulness on hypertension and sleep were selected if relevant. A filter was set to only select papers published from the years 2020–2023 and sorted by relevance. The search was conducted in May of 2023. Papers were selected based on their relevance to the topic and contribution to scientific literature.

Theoretical Foundations of Mindfulness

Mindfulness more broadly is a non-judgmental, present-centered awareness, and acceptance of one's thoughts, feelings, and bodily sensations. John Kabat-Zinn's (1994) definition of mindfulness is "the awareness that emerges through paying attention in a particular way; on purpose, in the present moment, and nonjudgmentally" [10]. Mindfulness practices can be done in formal (i.e., taking mindfulness classes) or informal settings (i.e., being mindful while walking to work). Mindfulness practices involve bringing attention to a single "object of awareness" and maintaining that attention through redirection of attention. The object could be internal sensory experiences such as the breath or external stimuli such as sounds. The goal is to bring awareness, acceptance, openness, and curiosity to whatever arises. Practices may involve sitting meditation, walking meditation, body scanning, or mindful eating among others. Mindfulness is not just a practice but also a state of being and a trait that can be cultivated to increase one's propensity for engaging in mindfulness [11]. Overall, mindfulness in the modern sense is a disciplined mental training practice, rooted in ancient Eastern traditions, and is developed and maintained by increasing one's engagement with the present moment without judgment. There are multiple avenues, direct and indirect, through which mindfulness may impact sleep and hypertension.

Empirical Evidence on the Benefits of Mindfulness for Sleep and Hypertension

In the increasingly sophisticated landscape of mindfulness research, a growing body of empirical evidence underscores the benefits of mindfulness-based interventions in addressing many prevalent health concerns, including sleep disorders and blood pressure among hypertensive individuals. The two conditions, though individually unique, intersect in their associations with stress, lifestyle behaviors, and emotional regulation. Several mindfulness techniques, including Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy (MBCT), and even specialized programs like Mindfulness-Based Blood Pressure Reduction (MB-BP) and Mindfulness-Based Therapy for Insomnia (MBTI) have demonstrated consistent benefits in improving

sleep quality and reducing blood pressure among hypertensive individuals. These interventions, while differing in their specific components and emphasis, each have a fundamental aim of utilizing mindfulness techniques to improve physical health [12].

Mindfulness-Based Stress Reduction

Mindfulness-Based Stress Reduction (MBSR) is an 8-week group program that was developed in the early 1980s to combat pain and distress in those with chronic health problems [10]. MBSR combines mindfulness meditation, yoga, and psychoeducation to enhance self-regulation and well-being. There is some support for the effects of MBSR on reducing stress overall by addressing contributors to stress such as depression, worry, and anxiety. MBSR can significantly improve sleep quality and overall mental health in patients with insomnia [13].

As for hypertension, several reviews of MBSR programs revealed that in most of the included studies, the MBSR participants demonstrated greater reductions in both systolic blood pressure (SBP) and diastolic blood pressure (DBP) relative to control groups [14, 15]. Despite the noted improvements among studies, the reduction in blood pressure was predominantly noted in clinical environments, with ambulatory measurements largely unaffected. MBSR presents as a promising intervention, demonstrating particularly marked efficacy in reducing DBP. However, further rigorous trials are required to substantiate these findings in out-of-office blood pressure.

Mindfulness-Based Cognitive Therapy

Mindfulness-Based Cognitive Therapy (MBCT) is another 8-week group intervention that integrates mindfulness meditation with cognitive therapy techniques. Two recent studies have been identified demonstrating that MBCT has a significant and positive impact on alleviating symptoms of insomnia across different populations. Zhao et al.'s [16•] study underlined the effectiveness of MBCT in improving sleep quality in breast cancer survivors, with not only self-reported measures but also objective actigraphy measures. Similarly, Camino et al. [17•] demonstrated the applicability and effectiveness of MBCT for insomnia in older adults, showcasing reduced insomnia symptoms even in subclinical populations. Collectively, these findings suggest that MBCT holds the potential as an effective non-pharmacological intervention for various degrees of insomnia in diverse populations.

Few studies have tested the effects of MBCT on hypertension and weight loss. One trial study by Alamout et al. evaluated the impact of MBCT on weight loss, hypertension, and attentional bias toward food cues among 45 overweight women [18]. This study found that the combination

of MBCT and conventional diet therapy surpassed diet therapy alone in promoting weight loss, reducing body mass index (BMI), managing hypertension, and mitigating attentional bias toward food cues. Notably, reductions in SBP and DBP were observed exclusively in the group receiving both MBCT and diet therapy by the eighth week, underscoring the enhanced effectiveness of this combined approach over diet therapy alone in lowering SBP and DBP.

Other Targeted Mindfulness-Based Therapies

Mindfulness-based therapy for insomnia (MBTI) and mindfulness-based blood pressure reduction (MB-BP) represent specialized mindfulness-based interventions, each uniquely tailored to address specific health concerns: insomnia and hypertension, respectively. Similar to other mindfulness-based interventions, MBTI and MB-BP function by segregating the experiences of physical sensations, thoughts, and emotions into distinct categories, thereby promoting deliberate awareness of each.

MBTI is a 6- to 8-week program specifically designed for insomnia treatment, blending mindfulness practices with behavioral sleep interventions. A recent RCT ($n = 127$) is one of the few trials done in the past 3 years on this intervention and it suggests MBTI can lead to significant improvements in overall sleep quality and insomnia symptoms in older adults [19]. Despite similar improvements in subjective sleep quality between the MBTI and Sleep Hygiene, Education, and Exercise Program (SHEEP) groups, only the MBTI group demonstrated reductions in key objective sleep parameters, such as wake after sleep onset and sleep onset latency. Thus, the authors conclude that MBTI may offer a valuable alternative therapy for improving both subjective and objective sleep quality, particularly for those who have limited access to or have not responded to standard frontline therapies.

While still in its early stages of development and evaluation, preliminary research on MB-BP has demonstrated promising results in reducing blood pressure and improving hypertension-related outcomes. This method aims to augment self-awareness among participants. A qualitative study ($n = 19$) explored the mechanisms behind MB-BP and its influence on cardiovascular health [20•]. Participants identified self-awareness, attention control, and emotion regulation as crucial contributors to cardiovascular health improvement. Many described a process where increased self-awareness promoted attention and emotion regulation, leading to better stress response. This heightened self-awareness also reportedly facilitated healthier behaviors, such as improved dietary choices. The study suggests that MB-BP practices fostered more effective self-regulation skills and behaviors, thereby reducing cardiovascular disease risk, aligning with recent theory and quantitative findings.

Mindfulness Interventions and Non-pharmacological Interventions

In a meta-analysis of RCTs comparing the effects of general mindfulness-based interventions on insomnia, participants in the MBI groups showed significant improvement in insomnia when compared to control groups [21]. Perini et al. [19], mentioned above, is one of the few recent RCTs that have compared mindfulness-based interventions for sleep to other non-pharmacological interventions and concluded that MBTI offers a suitable alternative to other types of sleep therapies.

Few studies have directly compared mindfulness-based interventions to other non-pharmacological treatments for hypertension, such as exercise, relaxation techniques, or dietary interventions. One RCT ($n = 36$) compared mindful awareness practices (MAP) and health promotion programs (HPP) [22•]. The study indicates that MAP modestly impacted lifestyle behaviors and significantly lowered blood pressure in adults with hypertension. Conversely, the HPP group exhibited a smaller decrease in blood pressure. The greater decrease in the MAP group may be attributed to the positive influence of MAP on lifestyle behaviors. This suggests a combination of mindful meditation and health education could be an effective strategy for hypertension self-management. Overall, participation in mindfulness-based interventions is linked to changes in cortisol and immune patterns indicative of decreased stress and mood disturbance and is associated with reduced blood pressure [15, 23]. More research is needed to determine the comparative effectiveness of these approaches in managing hypertension.

Potential Mechanisms of Mindfulness on Sleep Improvement and Hypertension

There are several possible mechanisms through which mindfulness practice (MP) may impact both sleep quality and hypertension: reducing hyperarousal, increasing relaxation, expanding emotion regulation, developing adaptive cognitions, increasing health behaviors, and modulating physiological pathways. MP may reduce hypertension indirectly through improved sleep [24•]. MP may also reduce hypertension directly. Most likely, MP impacts hypertension both directly and indirectly through improved sleep. What remains undefined are the channels through which MP affects both sleep and hypertension.

Effects of Mindfulness Practice on Hypertension Through Sleep Improvement

MP focuses on fostering a non-judgmental and present-centered awareness. This may reduce overall stress and

hyperarousal, thus improving sleep. A recent meta-analysis of 40 studies indicated a significant change in cortisol levels after mindfulness-based interventions, with a small effect size [25]. Recent research has robustly suggested that meditation practice induces a reduction in sympathetic nervous system activity, as measured by heart rate variability (HRV) [26, 27]. Cortisol and HRV are both indicators of sympathetic nervous system activation, which has been demonstrated to contribute to hyperarousal and reduced sleep quality [28, 29]. In addition to reducing sympathetic nervous system activation, some MP techniques like focused attention and body scan meditations can increase parasympathetic nervous system activation, or relaxation response [24•]. High-quality sleep reduces levels of hypertension [30•]. Thus, MP may reduce hypertension by enhancing sleep quality.

MP also promotes the development of adaptive emotion regulation strategies like cognitive reappraisal and acceptance. Often, emotional reactivity can be a sleep disruptor [31] (one recent study found that insecure attachment predicted poor sleep quality [32]), so increased emotion regulation skills may improve emotional resilience and therefore enhance sleep quality. High-quality sleep is associated with increased emotion regulation [33, 34]. Thus, it is easy to conclude that MP may increase sleep quality, and thus, decrease hypertension through reduced emotional reactivity and enhanced emotional resilience.

Another pathway through which MP may impact sleep is cognitive processes. Thought patterns like rumination and worry have been identified as perpetuating insomnia factors [35]. Furthermore, these processes have been identified as impacting daytime sleep-related impairment [36]. MP aims to increase recognition of and disengagement from unhelpful thought patterns like rumination and worry. Additionally, MP may foster a more adaptive relationship with sleep-related cognitions, reducing the impact of maladaptive beliefs about sleep and insomnia (like catastrophizing: “If I don’t get a good night of sleep, I will have the worst day ever tomorrow”). Thus, MP may increase sleep quality and decrease hypertension by improving sleep-related cognition.

Effects of Mindfulness Practice on Hypertension Directly

MP may impact hypertension directly by strengthening health-related behaviors such as improved diet and increased physical activity. MP centralizes self-awareness and has been shown to increase engagement in both self-regulation and health behaviors [20•, 37•]. Health behaviors like diet and exercise have been strongly linked to blood pressure reduction and improved cardiovascular health [38, 39].

Finally, MP may also impact hypertension directly by modulating physiological pathways. The renin–angiotensin–aldosterone system is a system of enzymes and hormones

that regulate blood pressure and fluid balance [40]. There is limited research on the direct effects of MP on the renin–angiotensin–aldosterone system and further research is needed to elucidate the specific mechanisms through which mindfulness practices may impact these pathways and contribute to blood pressure reduction.

Conclusion

Insomnia and hypertension are two leading health concerns affecting many people worldwide. Due to the side effects and limitations of pharmacological treatments, alternative interventions like mindfulness are being investigated for their effectiveness at improving sleep and reducing high blood pressure. While mindfulness-based interventions have increased dramatically in scientific literature recently, it is important to critically evaluate these studies. As mentioned earlier, we utilized OpenAI's ChatGPT-4 LLM to guide the writing process for this review. Our hope with this, is to demonstrate a clear and effective harnessing of LLMs as a tool for positively stimulating the writing process while continuing to maintain scientific integrity. As AI technology progresses, it is important to find a middle path of taking advantage of these powerful tools while simultaneously trying to avoid dependencies.

We found evidence for mindfulness-based interventions successfully reducing insomnia symptoms, improving sleep quality, and reducing hypertension. Overall, most studies report small to moderate effect sizes for the change in sleep and blood pressure after practicing mindfulness. This occurs through a heightened relaxation response and changes in both cognitive and emotional information processing. Mindfulness in the modern sense should be integrated into current health care practices for patients and clinicians. The authors believe that mindfulness-based interventions prove to be safe and effective for treating insomnia and arterial hypertension. However, due to the relatively small to medium benefits from incorporating mindfulness practices, we also believe that these treatments should be used in combination with current standard care practices.

While there is an increasing number of studies investigating mindfulness-based interventions, sample sizes tend to be small and long-term follow-ups are not consistently measured or reported. We believe that future research should focus on implementing mindfulness-based interventions to larger populations and use more follow-up measures. By applying these methods, researchers might be able to determine who in the population is a better responder to mindfulness interventions or tailor treatment to non-responders. Additionally, the effects of mindfulness-based intervention may be short lived, and the beneficial effects could be heightened immediately following the intervention period.

Due to the potential diminishing effects of mindfulness on sleep and blood pressure, more follow-up measures are needed to assess this change over time. Overall, it appears that mindfulness-based interventions are safe and effective at improving sleep and reducing high blood pressure. Future research should focus on implementing large scale randomized clinical trials with longitudinal measures to fully appreciate the feasibility and efficacy of mindfulness-based interventions for sleep and hypertension.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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