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Using Mindfulness for the Treatment of Insomnia

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Abstract

Purpose of review—The goal of this review is to provide an update on the use of mindfulness meditation for the treatment of insomnia, including conceptual models and empirical evidence from randomized controlled trials.

Recent findings—A metacognitive model of insomnia has been proposed as a conceptual model to explain the application of mindfulness principles for reducing insomnia-related arousal. Furthermore, the evidence base for mindfulness-based therapies has grown with the results of several randomized controlled trials published in the past three years. Treatment effects appear to be strongest on self-report measures compared to objective measures of sleep.

Summary—Treatment programs featuring mindfulness meditation appear to be viable treatment options for people with insomnia. Further research is needed to determine who is likely to benefit from mindfulness-based therapies and how these interventions work. Additionally, further work is needed to resolve issues related to the delivery and implementation of mindfulness-based therapies.

Keywords

insomnia; mindfulness; meditation; complementary and alternative medicine; metacognitions; cognitive therapy

Introduction

Insomnia is characterized by difficulty falling or staying asleep that is accompanied by daytime dysfunction. Although the etiology of insomnia remains inconclusive, many theories center on the notion of arousal dysregulation that perpetuates the sleep disturbance and daytime dysfunction. There is evidence of elevations in arousal driven by a sympathetic

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Conflict of Interest

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response such as elevations in cortisol (1, 2), daytime body temperature (3), and increased alertness on the multiple sleep latency test (4). There is also evidence of a failure to de-arouse (5) as seen in imaging studies that have demonstrated activity in the wake-promoting systems during NREM sleep among people with insomnia compared to healthy controls (6). Furthermore, evidence of psychological arousal is seen with greater levels of pre-sleep cognitive activity (7), more negative tone of sleep-related cognitions (8) and more dysfunctional sleep-related cognitions (9, 10).

Given the evidence for psychophysiological arousal, early treatments for insomnia focused on psychological and physiological relaxation. Behavioral techniques such as progressive muscle relaxation, deep breathing, and mental imagery were used to reduce arousal and promote sleep. These techniques had some evidence to support efficacy for insomnia but it appeared that these behavioral techniques alone were insufficient to effectively manage the cognitive aspects of insomnia. Indeed, the rise of cognitive-behavior therapy for insomnia (CBT-I) has demonstrated efficacy with behavioral strategies aimed primarily at restoring sleep regulation and the cognitive components aimed at restructuring maladaptive sleep-related cognitions. CBT-I is now recommended as the first line of treatment for insomnia (11).

Despite the promise of CBT-I, only about 30% to 40% of patients achieve full remission from insomnia following treatment (12–15). Furthermore, the rates for re-occurrence of insomnia are higher for patients who still report elevations in pre-sleep arousal at the end of treatment (16). Therefore, alternative approaches to directly address arousal dysregulation are needed. Mindfulness-based therapies (MBT) offer one such approach. MBTs use the practice of meditation to cultivate non-judgmental, present-moment awareness as a means of living with intention, self-compassion, and non-attachment to outcomes. As a group, MBTs have been used to improve psychological functioning in healthy individuals and to reduce symptoms related to chronic health conditions in clinical populations. In the following discussion, we explain how the concepts of mindfulness can be used for the treatment of insomnia followed by a review of the current literature on MBTs for insomnia. We conclude by offering an agenda for future research on mindfulness and insomnia.

A Conceptualization of Insomnia from a Framework of Mindfulness

Mindfulness is a state of being that embodies non-judgmental awareness and acknowledgement of the thoughts, feelings, and bodily sensations in the present moment. Originating from Buddhist philosophy, mindfulness is cultivated through meditation practice of *intentionally* paying *attention* to the present experience with an *attitude* that is accepting and non-judging (17). Through regular practice, mindfulness allows for shifts in metacognitions (i.e., thinking about thinking), which involves a higher level of governing thoughts and beliefs rather than the content of the thoughts themselves. For example, when encountering stressful events a shift in metacognitions would involve moving from an outcome-oriented approach (e.g., taking action to relieve stress) to a process-oriented approach (e.g., observing that one is stressed). This metacognitive shift is posited to reduce emotional distress by changing the *relationship with* stress rather than changing the environment or source of stress (17–19). Neurobiological models indicate that mindfulness

meditation practice is associated with changes in several brain regions, including those related to emotion regulation (e.g., prefrontal cortex) (20–23) and self-referential processing (e.g., default mode network) (22, 24, 25). In a review of the self-report and neurobiological literature, Hölzel and colleagues (26) propose that the mechanisms of mindfulness meditation involve the synergistic action of attention regulation, body awareness, emotion regulation, and changes in self-perspective, which together promote well-being.

In the context of insomnia, mindfulness has been hypothesized to target sleep-related stress that arises from the inability to sleep. Ong and colleagues (27) proposed a metacognitive model of insomnia to extend previous theories of arousal dysregulation by separating cognitive arousal into two levels (see Figure 1). Primary arousal consists of the thoughts and attitudes about sleep that are directly related to the inability to sleep. This includes thoughts that interfere with sleep and the beliefs about daytime consequences of poor or insufficient sleep. Secondary arousal consists of metacognitions about sleep, including absorption of the problem, rigidity in sleep-related thoughts and behaviors, attachment to the need for sleep, and bias towards sleep-related cues. These metacognitions involve the relationship with thoughts and behaviors rather than the actual thoughts themselves. Furthermore, secondary cognitive arousal tends to amplify the negative emotion or create a bias in the attention given to sleep-related thoughts.

This model was also informed by the clinical observation that many patients with insomnia are very obsessed with solving their sleep problem and will make statements such as “If only I could sleep better, my whole life would be much better.” This statement shows a strong attachment to the need for sleep, the absorption with solving the sleep problem, and the bias that solving this problem is the key to well-being. However, when asked to make changes to their thoughts and behaviors about sleep, they might become resistant and attempts to convince the patient are generally futile. This demonstrates the rigidity in thoughts and behaviors which are characteristic of insomnia patients. Mindfulness allows one to let go of the attachment for sleep, increase flexibility in the response to insufficient sleep, and accept alternative pathways to well-being.

How Can Mindfulness Principles be used to Treat Insomnia?

Using the metacognitive model of insomnia, mindfulness principles are primarily aimed at reducing secondary arousal with downstream effects on reducing primary arousal, leading to the reduction in the symptoms of insomnia (27). These principles are implemented at three levels: 1) increasing *awareness* of the mental and physical states that arise when experiencing insomnia symptoms, 2) *shifting* mental processes to reduce sleep-related arousal, and 3) promoting a *mindful stance* to respond when symptoms of insomnia arise. Progression across levels requires regular mindfulness meditation practice which typically involves frequent iterations of awareness and shifting rather than a linear progression from level to level. Further details on these levels are described below.

Mindful awareness

The cultivation of mindful awareness includes a present-moment, non-judgmental awareness of mental events and physical sensations. This is essentially a self-assessment to become

more aware of the current state of mind and body, including sensations of sleepiness and wakefulness. It also includes awareness of thoughts and behaviors that are interfering with sleep or perpetuating sleep-related arousal. Typically, people with insomnia will engage in certain thoughts and behaviors that are reactive rather than intentional. In particular, the sleep-related thoughts and behaviors tend to be focused on achieving immediate relief from the aversion of being awake. As a result of this myopic perspective, frustration and negative emotion escalates and rational thinking dissipates. The practice of mindfulness meditation allows one to pay attention to the sleep-related thoughts that arise without analyzing, judging, or acting upon these thoughts. Initially, patients might notice a tendency to automatically judge any sign or symptom of insomnia as negative and automatically attempt to fix the problem. This is a sign of absorption with solving the sleep problem which can provide an opportunity to engage in metacognitive shifting.

Metacognitive shifting

Metacognitive shifting involves changing the relationship with thoughts rather than changing the content of thoughts. Rather than engaging in a sleep-related thought as something to analyze and solve, thoughts and feelings are treated as mental events to observe without judgment or action. This has also been called de-centering (28), re-perceiving (17), or reappraising (29). This is a challenging level for many patients and the use of a metaphor can aid in the meditation practice. For example, the imagery of trains (thoughts) passing through a busy train station (the mind) can be used to create a visualization for observing thoughts (30). In this meditation, patients are instructed to “be a trainspotter of the mind” by observing the trains go by rather than getting on the train (analyzing thoughts or engaging in problem-solving). Inevitably, a patient will find himself or herself on a train. The patient is then instructed to gently step off the train and return to the platform of the train station without admonishment or judgment, representing a metacognitive shift. The key to this meditation is to practice observing from the platform of the train station and to practice stepping off the train without any goals. In other words, there is no preference for reducing the number of times a patient steps on the train or preventing one from getting on a train. By taking an objective, non-judgmental perspective outside of the desire to solve the sleep problem, the practice of metacognitive shifting can provide a new perspective on the signs and symptoms of insomnia.

Mindful stance

By cultivating awareness and practicing metacognitive shifting, patients can develop a mindful stance for working with insomnia. A mindful stance is a state of mind that is balanced in the appraisal of sleep expectations and daytime functioning. It embodies cognitive flexibility when confronted with symptoms of insomnia and non-attachment to sleep-related outcomes. Thoughts are not facts but dynamic mental events. This allows one to let go of the need to achieve a certain amount of sleep or a certain level of daytime functioning, thus reducing sleep-related arousal. A mindful stance also upholds a commitment to values outside of the need for sleep that are important to the individual. By letting go of the need to solve the sleep problem, one can re-establish important life goals or social activities that might have been abandoned or postponed during the absorption with the sleep problem. By adopting a mindful stance, the patient can choose how to respond to

sleep-related distress with greater degrees of freedom rather than being bound by the attachment to getting more sleep. From a mindfulness framework, this is seen as an act of self-compassion. Maintaining a mindful stance involves a continuation of meditation practice which can increase the likelihood of long-term remission from insomnia or prevent of the recurrence of future episodes of insomnia.

It is important to note that a mindful stance should not be confused with inappropriate acquiescence to the symptoms of insomnia. In this context, acceptance of the thoughts and feelings in the present moment is an active process (i.e., intentional choice) involving metacognitive shifts and self-compassion. This is distinguished from giving into the situation which is a passive process that is usually incongruent with one's values and driven by despair rather than self-compassion. However, there are situations where the insomnia disorder might persist despite mindfulness practice. In these cases, awareness, shifting, and adopting a mindful stance can still be used to seek further assessment of the sleep problem and consider an alternative treatment.

Practicing Mindfulness Principles through Meditation

Many of the perpetuating factors of insomnia develop as maladaptive habits and are reinforced over time. Consequently, establishing new patterns of response to sleep-related stress requires repeated practice and reinforcement. In MBTs, the practice of mindfulness meditation serves as the primary method of learning mindfulness principles. During mindfulness meditations, principles such as non-judging, letting go, and acceptance are cultivated. This provides an opportunity to practice mindful awareness, metacognitive shifting, and adoption of a mindful stance. Formal guided meditation practices include quiet meditations such as breathing awareness or the body scan meditation and movement meditations such as the walking meditation or hatha yoga. In most MBTs, formal meditation is led by an instructor in session or by audio (e.g., mp3 or app) at home. Meditation practices typically last 30 to 45 minutes to allow for time to settle into the meditation. A common misconception is that these meditations are meant to clear the mind of thoughts or to focus on positive thoughts. As noted above in the trainspotting meditation example, the principles of mindfulness are to bring awareness to thoughts in a non-judgmental manner. Thus, the goal is not to reduce mental activity or to prefer positive thoughts but to practice mindful awareness and metacognitive shifting. Other informal meditations, such as mindful eating or mindful listening can provide an opportunity to practice mindfulness principles with everyday activities, enhancing the generalization of these principles.

It should be noted that the practice of mindfulness meditation is not intended to promote sleep onset. In some MBT programs such as mindfulness-based therapy for insomnia (MBTI; see description below), the meditations might be used to distinguish the state of sleepiness from other states, which can then lead to taking specific sleep-related action (e.g., going to bed only when sleepy). Although relaxation and sleepiness might emerge during a meditation, mindfulness meditation is not goal-directed. Instead, the meditations serve as an opportunity to practice using mindfulness principles to work with sleep-related distress.

Treatment of Insomnia using Mindfulness: Research Evidence

The concepts of mindfulness and the practice of mindfulness meditation are usually taught in a treatment program known as mindfulness-based treatments (MBT). MBTs are typically taught in groups or classes with a teacher leading guided meditations and group discussions during the session and assigning meditation practices for homework between the sessions. Although there are some variations in the program components, types of meditations, and the length of the program across the different programs, all MBTs feature mindfulness principles and meditation practices (as described above) as the core components. Some forms of psychotherapy might include components of mindfulness, such as Acceptance and Commitment Therapy (ACT) and Dialectical Behavior Therapy (DBT). However, these are not considered to fall under the umbrella of MBTs because meditation is not a featured method of practicing mindfulness in these types of therapy.

The evidence base for using MBTs in treating insomnia has grown considerably over the past five years with the results of several randomized controlled trials. While previous reviews have included a broader set of studies that reported on sleep quality or sleep disturbance (e.g., (31)) as secondary outcomes, this review focuses on randomized controlled trials using MBTs where the purpose is to improve sleep in people with insomnia or significant sleep disturbances. A summary of the results from baseline to post-treatment are found in Table 1.

Mindfulness Based Stress Reduction (MBSR) was the original MBT developed by Jon Kabat-Zinn and is now delivered in over 500 clinics (32). It is an 8-week program that teaches mindfulness principles and practices for reducing stress and coping with chronic illnesses. Although it was developed as a general program rather than a tailored program for a specific clinical population, MBSR has been shown to improve symptoms related to a number of medical and psychiatric conditions including fibromyalgia, cancer, substance abuse, and eating disorders (33). Three randomized controlled studies have examined the impact of MBSR for insomnia. In a comparative efficacy study, Gross, Kreitzer (34) compared MBSR to eszopiclone for 30 patients with chronic insomnia. Within the MBSR group, significant improvements with large effect sizes were found from baseline to post-treatment on the insomnia severity index (ISI; $d=2.03$) and the Pittsburgh Sleep Quality Index (PSQI; $d=1.68$). In addition, significant changes with medium effect sizes were found from baseline to post-treatment on sleep-diary measured sleep onset latency ($d=0.57$), wake after sleep onset ($d=0.46$), and sleep efficiency ($d=0.61$) as well as actigraphy measured sleep onset latency ($d=0.31$). However, the eszopiclone group showed improvements that were mostly comparable and in some cases larger than the MBSR group. Using a non-inferiority design, Garland et al. (35) compared MBSR to CBT-I for people with insomnia in cancer. CBT-I ($d=2.65$) was superior to MBSR ($d=1.39$) in reductions on the ISI at post-treatment, but MBSR ($d=1.52$) was non-inferior to CBT-I ($d=2.37$) at the 3-month follow-up. The effect sizes were generally larger for CBT-I relative to MBSR on sleep diary and actigraphy, with significant differences found on diary-measured sleep onset latency and sleep efficiency. Finally, Zhang and colleagues (36) compared MBSR to a wait-list control group for older adults over 75 years of age with insomnia. They found a significant reduction in the PSQI score for the MBSR group ($d=1.12$) compared to the wait-list.

Mindfulness Awareness Practices (MAPs) is a six-week mindfulness-based group intervention that teaches general mindfulness principles and practices and has been shown to be effective for ADHD (37) and cancer (38). The MAPs class is similar to MBSR but uses slightly shorter class sessions (2 hours versus 2.5 hours) with shorter home meditation practices (5 to 20 minutes versus 45 minutes). Using a group of adults aged 55 and older with significant sleep disturbances (PSQI > 5), Black and colleagues (39) compared MAPs to an attention-controlled sleep hygiene education group. They found that those in the MAPs group experienced significantly greater improvement on the PSQI compared to those who received sleep hygiene education (between group $d=0.89$). Furthermore, significant improvements were also observed in the MAPs group for daytime symptoms of insomnia (e.g., fatigue) and depression. Finally, the change in PSQI score for the MAPs group was significantly correlated with the change in scores on the Five Facets of Mindfulness scale, indicating that increased mindfulness skills were associated with decreased symptoms of sleep disturbances among participants who received MAPs. This supports the mechanistic hypothesis that the acquisition of mindfulness is associated with improvements in insomnia symptoms.

Mindfulness-Based Therapy for Insomnia (MBTI) is an 8-week program which uses some behavioral strategies for insomnia (stimulus control and sleep restriction) with mindfulness principles and meditations (30). In contrast to MBSR and MAP, MBTI was developed specifically for insomnia by tailoring the application of mindfulness principles to directly address symptoms related to insomnia. In a three-arm randomized controlled trial comparing MBTI vs MBSR vs a self-monitoring control, Ong et al. (19) found that participants in both the MBTI ($d=2.07$) and MBSR ($d=1.33$) groups reported significantly greater improvements on the ISI from baseline to post-treatment compared to the control group. In addition, MBTI ($d=2.56$) showed a greater improvement from baseline to the 6-month follow-up compared to MBSR ($d=1.57$). Using validated cut-offs for remission and response, MBSR was largely stable over time with remission rates of 46.2% at post-treatment, 38.5% at 3-months, and 41.7% at 6-months. MBTI showed a steady increase with remission rates rising from 33.3% at post-treatment up to 50% at 6-month follow-up. Similarly, treatment response remained relatively steady between post and follow-up in MBSR (38.5% and 41.7%) but showed a steady increase from 60% at post-treatment up to 78.6% at 6-month follow-up in MBTI. Secondary analyses examining the pattern of change during treatment revealed that MBSR demonstrated more stability (i.e., less day-to-day variability) in sleep efficiency early in treatment that was maintained through post-treatment while MBTI demonstrated less stability in sleep efficiency early in treatment with more stability achieved during the later stages of treatment (40).

Mindfulness-Based Cognitive Therapy (MBCT) is an 8-week program using mindfulness principles to prevent the relapse of depression. MBCT was developed by Segal and colleagues (28) with the intention of using mindfulness principles to disrupt negative ruminative thinking patterns which may contribute to relapse of depression. Britton and colleagues have examined the efficacy of MBCT for people with depression and insomnia symptoms in two small studies. In one study(41), individuals with depression and comorbid insomnia who were not on anti-depressant medications were randomized to receive MBCT or a wait-list control. The MBCT group reported significant baseline to post-treatment

reductions in sleep onset latency, number of awakenings, and wake after sleep onset, and a significant increase in sleep efficiency. However, this was not significantly different than the control group. Unexpectedly, the MBCT group exhibited signs of cortical arousal on the polysomnography (PSG) with significantly more awakenings, more time in NREM 1 sleep, and less time in slow-wave sleep compared to the control group. The authors speculated that in people with depression and insomnia, MBCT might mimic the effects of antidepressants, which have been noted to produce similar effects of cortical arousal. The second study by Britton and colleagues (42) examined individuals with depression and comorbid insomnia who were taking antidepressant medication. The results revealed that those who received MBCT had less total wake time and higher sleep efficiencies compared to the control group on PSG and sleep diaries.

In general, the evidence from randomized controlled trials supports the benefits of MBTs for reducing acute and long-term symptoms of insomnia. At post-treatment, the strongest effects were found on self-reported global measures of insomnia with robust effect sizes on the ISI and PSQI that were consistent across studies. Of the five studies that used sleep diaries, there was an increase in total sleep time between 3 and 28 minutes with an increase in sleep efficiency between 5% and 8% and decrease of about 20 to 40 minutes in total wake time. Data across the 3 studies that used PSG found more modest effects, with an increase in sleep efficiency of about 2% to 3%, a decrease in total wake time between 7 to 11 minutes, and total sleep time ranging from a decrease of 1 minute to an increase of 16 minutes. Data across the 3 studies that used actigraphy showed an increase of sleep efficiency from 1% to 2%, a decrease in total wake time between 11 to 24 minutes, and total sleep time ranging from a decrease of 32 minutes to an increase of 2 minutes. The small number of studies (n=3) which used actigraphy or PSG led to variability in the outcomes, with some indication that MBT might decrease objectively-measured total sleep time at post-treatment.

The overall pattern indicates that MBTs have stronger within-group effects on self-reported measures relative to objective measures, which is similar to the pattern found for other treatments for insomnia. When comparing between groups, MBTs were superior to control conditions that used wait-list, self-monitoring, and sleep hygiene. When MBTs were compared to current standard treatments (i.e., eszopiclone, CBT-I), they were less effective than CBT-I at post-treatment but within a comparable range at 3-month follow-up. The evidence is not yet clear if there are any relative benefits between the types of MBTs, although one study found some evidence that MBTI was superior to MBSR on reducing long-term ISI scores (19). Finally, the three studies that included a follow-up assessment found that effect sizes continued to increase at 3 and/or 6 months after completion of the MBT. The accumulating evidence indicates that MBTs can serve as a viable treatment option for people with chronic insomnia.

Conclusions and Future Directions

The principles and practices of mindfulness can provide patients with a set of metacognitive skills for working with the problem of insomnia. Several randomized controlled trials support the efficacy of MBTs for improving sleep quality and reducing sleep disturbance,

indicating that these interventions could serve as a viable alternative to CBT-I and pharmacotherapy for insomnia.

While these are exciting developments, further work is needed to advance the science and practice of using mindfulness for insomnia. While the evidence for efficacy of MBTs is favorable, further research is needed to determine the conditions under which MBTs work and the mechanisms of treatment. Studies examining moderators or patient characteristics are needed to determine who is likely to benefit from MBTs or under what conditions a patient should consider an MBT versus CBT-I or a hypnotic medication. Also, studies are needed to answer questions about how MBTs work by elucidating the psychological and physiological mechanisms of treatment. Studies could apply the metacognitive model of insomnia (27) or other conceptual models of mindfulness to examine activity in specific brain regions. For example, Brewer et al. (24, 43) found evidence for an association between meditation and deactivation of brain regions related to self-referential or ruminating activities (e.g., posterior cingulate cortex), suggesting that mindfulness meditation is associated with decreased mind-wandering. In insomnia patients, Kay et al. (2016) found evidence for altered glucose metabolism in certain regions of the brain including the posterior cingulate cortex, indicating regional hyperarousal. Therefore, imaging studies could examine the impact of an MBT program for people with insomnia who exhibit this pattern of impaired brain activity. Such studies could improve the understanding of the pathophysiology of insomnia and provide insight into the treatment mechanism of MBTs. Finally, comparative effectiveness studies are needed to determine the relative effectiveness of MBTs compared to CBT and hypnotics. While there are many challenges to conducting such a large-scale study, the findings could have a significant impact on the treatment guidelines for chronic insomnia and help clinicians decide which treatment is best and for whom.

In addition to a research agenda, work is needed to resolve several clinical issues related to the delivery of MBTs for insomnia. First, it remains unclear what qualifications are needed for practitioners to deliver MBTs. Training programs are available for MBSR and MBCT but there are currently no restrictions regarding licensure or certifications. While it might be acceptable for a non-licensed practitioner to teach MBSR or MAP to a general audience, clinical training in sleep and/or insomnia is advisable when delivering an MBT to a patient population (i.e., patients with an insomnia disorder) for safety and medical reasons. The format of delivery is also an important clinical issue. Currently, most MBTs are delivered in groups but it is unclear if MBTs can be delivered individually or through the use of technology (e.g., internet-based delivery) with the same level of effectiveness. Some internet-based programs for insomnia include a mindfulness component but to our knowledge no internet-delivered MBTs for insomnia are available. Finally, issues related to the use of hypnotic medications while receiving an MBT should be addressed. Research aimed at implementation and health services could provide further insights into these clinical questions.

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Figure 1.
Metacognitive Model of Insomnia

In the metacognitive model of insomnia, primary arousal refers to the thoughts and mental activities that interfere with sleep while secondary arousal consists of the relationship with thoughts and behaviors (i.e., metacognitions) rather than the actual thoughts themselves. From Ong, Ulmer, & Manber (2012).

Table 1
Baseline to post-treatment outcomes from randomized controlled trials on mindfulness-based therapies for insomnia.

Outcomes									
Reference	Sample	Sleep Diary	PSG/Actigraphy			Self-Reported Sleep Measures			
			MBCT	WLC	PSG	MBCT	WLC	N/A	
Britton et al., 2010	26 adults with partially remitted chronic depression and complaints of poor sleep	SOL	- 4.30*	- 14.20*	SOL	- 2.70	- 8.90		
		WASO	- 15.50*	- 6.20*	WASO	+ 5.00	+ 2.90		
		NWAK	- 0.80*	- 0.50*	NWAK	+ 12.40*	- 1.90		
		SE	+ 5.80*	+ 5.40*	Arousals	+ 23.60	- 2.10		
		TST	+ 24.60*	+ 33.60*	Stage 1	+ 9.80	- 1.60		
		TIB	- 3.10	+ 7.50	SWS	+ 0.30*	+ 12.80*		
		SQ	+ 0.10	+ 0.50	SE	+ 1.50	+ 1.00		
Gross et al., 2011	30 adults with primary chronic insomnia				TST	+ 15.60	+ 25.70		
					TIB	+ 16.00	+ 15.60		
		SOL	- 15.85* (0.57)	- 10.03 (0.36)	Actigraphy	MBSR (<i>d</i>)	PCT (<i>d</i>)	MBSR (<i>d</i>)	PCT (<i>d</i>)
		WASO	- 14.80* (0.46)	- 39.66* (1.24)	WASO	- 2.79 (0.10)	- 14.83 (0.51)	ISI	- 6.89* (2.03)
		SE	+ 5.27* (0.61)	+ 9.57* (1.11)	SE	+ 0.88 (0.10)	+ 4.81* (0.52)	PSQI	- 4.25* (1.68)
		TST (hr)	+ 0.20* (0.25)	+ 0.60* (0.74)	TST (hr)	- 0.12 (0.21)	+ 0.37* (0.63)	SSES	+ 2.19* (1.19)
Britton et al., 2012	23 adults with antidepressant medication use and complaints of poor sleep							DBAS	- 1.05* (0.80)
		SOL	- 7.50	- 1.50	PSG	MBCT	WLC	N/A	
		WASO	- 11.60	+ 2.40	WASO	- 6.40	+ 7.80		
		SE	+ 7.50*	+ 1.00	Stage 1	- 7.40	+ 3.30		
		TST	+ 16.70	- 11.10	SWS	+ 2.50	+ 6.60		
		TWT	- 19.10	+ 0.80	SE	+ 2.70	- 5.00		
		TIB	- 25.00	- 18.80	TST	+ 1.50	- 16.30		
Ong et al., 2014	54 adults with chronic psycho-physiological insomnia	SQ	+ 0.40	- 0.20	TWT	- 10.30*	+ 16.80		
					TIB	- 18.30	+ 9.20		
								SM (<i>d</i>)	SM (<i>d</i>)
			MBSR (<i>d</i>)	SM (<i>d</i>)	PSG	MBSR (<i>d</i>)	MBTI (<i>d</i>)	MBTI (<i>d</i>)	SM (<i>d</i>)

Outcomes												
Reference	Sample	PSG/Actigraphy				Self-Reported Sleep Measures						
Sleep Diary												
Garland et al., 2014	111 adults with non-metastatic cancer and comorbid insomnia	TWT	- 45.32* (0.80)	- 42.18* (0.92)	- 1.09 (0.06)	TWT	- 6.94 (0.21)	- 11.06 (0.24)	- 5.66 (0.19)	ISI	- 6.23* (1.33) - 7.84* (2.07) + 0.06 (0.01)	
		TST	+ 27.68 (0.17)	+ 2.50 (0.12)	+ 6.53 (0.11)	TST	+ 9.97 (0.31)	- 1.03 (0.02)	+ 0.12 (0.04)	PSAS	- 7.84* (1.02) - 6.42* (0.89) - 0.16 (0.01)	
		SE	+ 8.15 (0.60)	+ 7.62 (0.66)	- 0.96 (0.03)	SE	+ 1.63 (0.24)	+ 1.93 (0.21)	+ 1.86 (0.26)			
						Acti-graphy	MBSR (<i>d</i>)	MBTI (<i>d</i>)	SM (<i>d</i>)			
						TWT	- 11.08*(0.48)	- 22.36*(0.76)	- 0.38 (0.38)			
						TST	+ 1.71 (0.01)	- 31.67*(0.81)	+ 20.87 (0.38)			
						SE	+ 1.21 (0.08)	+ 2.49 (0.20)	+ 1.18 (0.35)			
Black et al., 2015	49 older adults with moderate sleep disturbances	SOL	- 5.38 (0.29)	- 21.83* (1.30)	- 21.83* (1.30)	SOL	+ 1.06 (0.11)	- 4.77 (0.57)	ISI	- 5.88* (1.39) - 9.49* (2.65)		
		WASO	- 26.63* (0.89)	- 36.27* (1.41)	- 36.27* (1.41)	WASO	- 9.96* (0.29)	- 24.30* (0.85)	PSQI	- 1.54* (0.62) - 5.38* (2.53)		
		SE	+ 5.21* (0.62)	+ 12.02* (1.67)	+ 12.02* (1.67)	SE	+ 0.55* (0.09)	+ 0.89* (0.61)	DBAS	- 0.78* (0.61) - 2.49* (2.30)		
		TST (hr)	+ 0.18* (0.22)	+ 0.21* (0.30)	+ 0.21* (0.30)	TST (min)	+ 11.44* (0.26)	- 25.07* (0.67)				
		N/A				N/A				MAPs	SHE	<i>d</i> (between groups)
Zhang et al., 2015	60 older adults with chronic insomnia	N/A				N/A			PSQI	- 2.80	- 1.10	0.89*
									AIS	- 2.50	- 1.00	0.65*
									FSI-I	- 10.60	0.00	1.02*
								FSI-S	- 3.70	+ 0.24	0.20*	
Zhang et al., 2015	60 older adults with chronic insomnia	N/A				N/A				MBSR (<i>d</i>)		WLC (<i>d</i>)
									PSQI	- 3.33* (1.12)	+ 0.20 (0.06)	
								DD	- 0.50* (0.76)	+ 0.03 (0.04)		

Note. Outcomes were calculated for this manuscript as +/- changes in means from baseline to post-treatment. For Gross et al. (2011), mean scores were not calculated and change scores were used as reported in the original manuscript. For Black et al. (2015), Cohen's *d* is between-groups, Cohen's *d* was not reported in Britton et al. (2010, 2012). For all other studies, Cohen's *d* is reported as within-group effect sizes. Exact means, standard deviations, standard errors, and confidence intervals can be found in the original publications. *p<.05.

AIS – Athens Insomnia Scale; C – Comparison Condition; CBT-I – Cognitive Behavior Therapy for Insomnia; DBAS – Dysfunctional Beliefs and Attitudes about Sleep Scale; DD – PSQI Daytime Dysfunction Component; DSM-IV – Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; FSI-I – Fatigue Symptom Inventory - Interference; FSI-S – Fatigue Symptom Inventory - Severity; GSES - Glasgow Sleep Effort Scale; ISI – Insomnia Severity Index; MAPs – Mindfulness Awareness Practices; MBCT – Mindfulness-Based Cognitive Therapy; MBSR – Mindfulness-Based Stress Reduction; MBTI – Mindfulness-Based Treatment of Insomnia; MOS-SS – Medical Outcomes Study – Sleep Scale; NWAK – Number of Awakenings; PCT – Pharmacotherapy; PSG – Polysomnography; PSQI – Pittsburgh Sleep Quality Index; PSAS – Pre Sleep Arousal Scale; SD – Sleep diary; SE – Sleep Efficiency; SHE – Sleep Efficacy; SOL – Sleep Onset Latency; SQ – Sleep Quality; SSES – Sleep Self-Efficacy Scale; SWS – Slow wave sleep; TST – Total Sleep Time; TWT – Total Wake Time; TX – Treatment Condition; WASO – Wake After Sleep Onset; WLC – Wait-List Control