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The Effects of Mindfulness on Sleep Quality in Working Adults with Stress: A Systematic Review and Meta-analysis of Randomized Controlled Trials

Satita Laoveeratam[1,*], Pansak Sugkraroek[2], and Phawit Norchai[1]

[1]Department of Anti-Aging and Regenerative Medicine, College of Integrative, Dhurakij Pundit University, Bangkok 10210, Thailand

[2]Women's Center and VitalLife Scientific Wellness Center, Bumrungrad International Hospital, Bangkok 10110, Thailand

[*]Corresponding author; E-mail: 65130043@dpu.ac.th

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Abstract

This systematic review and meta-analysis evaluated the effects of mindfulness practices on sleep quality in working adults experiencing stress, a population often overlooked in clinical sleep research**.** A comprehensive search of six databases including PubMed, Scopus, ScienceDirect, Cochrane Library, ThaiJo, and Google Scholar were conducted for randomized controlled trials (RCTs) published before October 2024. Eight studies met inclusion criteria, with four comprising 195 participants included in the meta-analysis. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). Meta-analysis revealed that mindfulness significantly improved global sleep quality compared to controls (Mean Difference = -0.49; 95% CI: -0.82 to -0.16; $p = 0.003$; $I^2 = 0\%$). Subgroup analyses indicated improvements in sleep duration (MD = -0.18; $p < 0.001$) and reduced use of sleep medications (MD = -0.27; $p < 0.001$), with no significant changes observed in the other PSQI domains. These findings suggest that mindfulness may be a beneficial non-pharmacological approach for enhancing certain aspects of sleep in stressed working populations. However, the small sample size and modest effect size highlights the need for further high-quality studies with larger cohorts and longer follow-up periods.

Keywords**:** *mindfulness; MBIs; sleep quality; PSQI; stress workers*

1. Introduction

The working years are a lengthy and crucial period in an individual's life, marked by contributions to personal, familial, and societal well-being, while serving as the primary source of income for oneself, their family, and the nation. However, insomnia is a significant issue during this stage, increasingly affecting over 40% of adults in the U.S. and Thailand (Dopheide, 2020; Udomratn, 2008). Chronic insomnia profoundly impacts physical and mental health, elevating risks of high blood pressure, cardiovascular disease, stroke, diabetes, depression, and anxiety (Dopheide, 2020). It also reduces work performance, increases workplace injuries and road accidents, and raises healthcare costs (Reynolds et al., 2023; Shahly et al., 2012; Suni, & Rehman, 2023). These effects lead to a significant decline in quality of life and impose substantial economic burdens (Chalet et al., 2023, Shahly et al., 2012).

Sleep is a fundamental human function essential for physical and mental restoration. Adequate sleep strengthens the immune system, supports growth hormone secretion for tissue repair, and enhances cognitive functions such as focus, memory, and decision-making. It also helps regulate emotions and manage stress (American Psychological

Association, 2013; Bryan, & Peters, 2023). Sleep quality refers to the characteristics of an individual's sleep, which is the cumulative result of evaluating various aspects of sleep, including sleep duration each night, the time taken to fall asleep, the number of awakenings during the night, the duration of wakefulness after initially falling asleep, and the overall efficiency and effectiveness of sleep (National Sleep Foundation, 2024). These factors can be assessed using standardized tools such as the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), or objective assessments like Polysomnography (PSG) (Buysse et al., 1989, National Sleep Foundation, 2024; Morin et al., 2011).

Studies link insomnia to increased stress levels, effort-reward imbalance, heavy workloads, and poor physical health in the past month (Sanguankittiphan et al., 2024; Yang et al., 2018). Chronic stress disrupts sleep by activating the hypothalamic-pituitary-adrenal (HPA) axis, leading to elevated cortisol levels that reduce deep sleep and increase nighttime awakenings (McEwen, 1998; Meerlo et al., 2008). It also stimulates the sympathetic nervous system, causing heightened heart rate and blood pressure that hinder relaxation (Gerin et al., 2012; Selye, 1956; Meerlo et al., 2008). Stress suppresses melatonin production, further impairing circadian rhythm and sleep quality (Xia et al., 2023). Additionally, pre-sleep rumination and anxiety prevent mental and physical relaxation, creating a cycle where stress worsens sleep quality, and poor sleep amplifies stress sensitivity (American Psychological Association, 2013; Harvey, 2002; Gerin et al., 2012).

Although sleep recovery helps restore health, work obligations and family responsibilities prevent working adults from getting adequate rest. Research increasingly supports that mindfulness-based interventions (MBIs) help enhance and improve physical, mental, and emotional health. They also help reduce stress and enhance overall well-being, as well as improve sleep quality (Zhang et al., 2021; Rusch et al., 2019).

In Buddhism, "mindfulness" (or "sati") refers to the ability to remain aware, attentive, and conscious without becoming distracted or losing awareness (Phutthakohachat, 2023). The Buddha's teachings explain mindfulness through the "Four Foundations of Mindfulness," as outlined in the Mahasatipatthana Sutta. This practice involves clearly understanding the true nature of all things, free from the influence of defilements, allowing one to perceive reality as it truly is specifically, the cycle of Dependent Origination. Through this insight, practitioners come to recognize the three universal characteristics: Anicca (impermanence), Dukkha (suffering), and Anatta (non-self). Ultimately, mindfulness leads to the release of attachment and defilements, guiding practitioners along the path to enlightenment and Nirvana (Wikipedia, 2024a, 2024c).

The Four Foundations of Mindfulness involve contemplation of the body, feelings, mind and dhamma. By cultivating this constant awareness, practitioners deepen their understanding of the three characteristics, Anicca (impermanence), Dukkha (difficulty in maintaining the original condition), Anatta (non-self) (Dhamma-Sutta, 2024; Dhamma Study and Support Foundation, 2024; Wikipedia, 2024b). While rooted in Buddhist traditions, mindfulness practices such as meditation, breathing exercises, and body scans have been (Zhang et al., 2021). Programs like Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) have been widely implemented in healthcare settings and are increasingly studied for their role in managing stress and improving sleep quality.

In Western psychology, mindfulness is defined as moment-to-moment awareness of thoughts, emotions, bodily sensations, and surroundings, characterized by openness, non-judgment, curiosity, acceptance, and compassion (Kabat-Zinn, 1990). Mindfulness practices aim to cultivate a mindful state through formal techniques like mindful breathing, sitting meditation, and body scanning, or informally in daily life (Kabat-Zinn, 2003; Zhang et al., 2021). While rooted in Buddhist traditions, mindfulness practices such as meditation, breathing exercises, and body scans have gained significant popularity in the Western world (Nunez, 2021). Programs like Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) have been widely implemented in healthcare settings and are increasingly studied for their role in managing stress and improving sleep quality (Grossman et al., 2004; Hofmann et al., 2010; Kabat-Zinn, 2003; Segal et al., 2002). Other structured programs include the Mindful Self-Compassion (MSC) program, which integrates mindfulness with self-compassion practices to help individuals cultivate self-kindness, embrace personal imperfections, and reduce self-criticism (Neff, & Germer, 2013). Additionally, Mindfulness-Based Movement (MBM) approaches combine mindfulness with physical activities such as yoga, Tai Chi, and Qigong to enhance both physical and mental well-being (Yang et al., 2022).

Mindfulness practice, particularly through Mindfulness-Based Stress Reduction (MBSR), has been shown to induce both structural and functional changes in the brain. These include increased activity

and connectivity in the prefrontal cortex, cingulate cortex, insula, and hippocampus, along with reduced reactivity of the amygdala. Such neurobiological adaptations are associated with enhanced emotional regulation and greater resilience to stress (Gotink et al., 2016; Hölzel et al., 2011). Furthermore, mindfulness facilitates stress management by reducing excessive emotional reactivity and lowering cortisol levels, a key biomarker of stress (Carlson et al., 2007; Creswell, & Lindsay, 2014). It also promotes relaxation of the autonomic nervous system, disrupts maladaptive cycles of rumination and worry, facilitates faster sleep onset, reduces nocturnal awakenings, improves overall sleep quality, and supports sustained, uninterrupted rest (Gross et al., 2011; Lundh, 2005).

Despite growing evidence supporting the effectiveness of mindfulness interventions in improving sleep quality, most prior studies and meta-analyses have focused on clinical populations, such as individuals with chronic illnesses, psychiatric conditions, or specific sleep disorders. Few systematic reviews or meta-analyses have examined the effects of mindfulness specifically in working adults experiencing stress but without underlying medical conditions. Given the high prevalence of stress-related insomnia in the working-age population, and the unique occupational and psychosocial stressors they face, this represents a significant gap in literature. Addressing this gap can offer valuable insights into non-clinical preventive interventions and workplace mental health strategies. This study aims to fill this void by systematically reviewing and quantitatively synthesizing evidence on the impact of mindfulness practices on sleep quality in stressed, otherwise healthy working adults.

2. Objectives

To evaluate the effects of mindfulness practices on sleep quality in stressed working adults through a systematic review and meta-analysis of randomized controlled trials that used the Pittsburgh Sleep Quality Index (PSQI) as the primary outcome measure.

3. Materials and Methods

3.1 Search Strategies

A comprehensive systematic literature search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The search targeted studies published prior to October 2024 and was carried out across six databases: PubMed, Scopus, ScienceDirect, ThaiJo, Cochrane Library, and Google Scholar. The search strategy employed a combination of controlled vocabulary, MeSH terms, and phrases, including (“Mindfulness” OR “Vipassana”) AND “Stress” AND “Worker” AND “Sleep Quality.”

For the ThaiJo database, searches were conducted in both English and Thai languages. The English-language search strategy included the terms: ("Mindfulness" OR "Vipassana") AND "Stress" AND ("Sleep Quality" OR "Sleep" OR "Insomnia") AND/OR "Worker". The Thai-language search employed equivalent terms: ("สติ" OR "วิปัสสนา") AND "เครียด" AND ("คุณภาพการนอน" OR "นอน").

In Google Scholar, a simplified search strategy was used, and results were limited to the first 1,000 entries. A parallel search in the Thai language was also performed using the terms "สติ," "คุณภาพการนอนหลับ," and "ความเครียด," restricted to the first 200 results to ensure feasibility.

The review protocol was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO) under the ID: CRD42024619831.

3.2 Study Selection

We included only randomized controlled trials (RCTs) based on the following PICO framework:

Population (P): Working adults (≥18 years) experiencing stress. Stress had to be identified using standardized assessment tools (e.g., validated questionnaires or cortisol level measurements) or clearly described in study contexts, such as work-related stress, pandemic-related stress (e.g., during COVID-19), or other stressors documented in the research.

Intervention (I): Mindfulness-based or Vipassana practices, with no restrictions on format, duration, or delivery method. Eligible interventions included onsite programs, online sessions, computer-based applications, or hybrid approaches.

Comparison (C): Other interventions, such as sleep hygiene education, standard treatments, or wait-list control groups.

Outcome (O): Sleep quality measured using standardized tools, such as validated self-report questionnaires, actigraphy, or polysomnography.

Exclusion criteria included studies focusing on specific patient populations (e.g., those with psychiatric disorders, neurological conditions, cancer, chronic pain, or pregnancy), as well as studies where mindfulness was not a clearly defined component of the intervention or was offered only as an optional element.

Two reviewers (SL and PN) independently conducted the literature search, screened titles and abstracts, and assessed full-text articles for eligibility. Disagreements were resolved by consultation with a third reviewer (PS), who made the final decision.

3.3 Data Extraction

The following data were extracted from each included study: population characteristics, sample size, mean participant age, method of stress assessment (measured or identified), intervention details, duration and frequency of the intervention, sleep quality outcomes, and reported conclusions for both the intervention and comparison groups. Data extraction was performed independently by two researchers (SL and PN). Any discrepancies were resolved through discussion, and if consensus was not reached, a third researcher (PS) was consulted to make the final decision.

3.4 Risk of Bias Assessment

Two authors (SL and PN) independently assessed the methodological quality of the included studies using the Cochrane Risk of Bias 2 (RoB 2) tool for randomized trials (Sterne et al., 2019), in accordance with Version 6.3 of the Cochrane Handbook for Systematic Reviews of Interventions. The assessment covered five domains: (1) bias arising from the randomization process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in the measurement of outcomes, and (5) bias in the selection of the reported results. Each domain was rated as having a low risk of bias, some concerns, or high risk of bias, following Cochrane guidelines.

3.5 Data Analysis and Statistical Methods

A meta-analysis was performed using continuous outcome data by comparing means and standard deviations between groups. The analysis was conducted using Review Manager (RevMan) Software, Version 5.4.1. Treatment effects were assessed using mean differences (MD) to evaluate changes in sleep quality among stressed working adults, comparing the mindfulness intervention group with the control group. Statistical significance was set at $p < 0.05$. Forest plots were used to visually present the results. Heterogeneity among studies was assessed using Chi-squared test, with a p-value < 0.1 indicating statistical significance. The magnitude of heterogeneity was quantified using the I^2 statistic, with thresholds interpreted as follows: 0-40% (negligible), 30-60% (moderate), 50-90% (substantial), and 75-100% (considerable) heterogeneity. Subgroup analyses were conducted where applicable, particularly in areas contributing to heterogeneity, provided a sufficient number of studies were available. Publication bias was evaluated through visual inspection of funnel plots and statistical tests, including Egger's test and Begg's test, to assess the robustness of the results.

4. Results

4.1 Search Results and Study Characteristics

A comprehensive search across six databases identified a total of 1,835 articles: 51 from PubMed, 22 from Scopus, 561 from ScienceDirect, 10 from The Cochrane Library, 11 from ThaiJO, and 1,180 from Google Scholar. After removing duplicates and excluding studies that were non-primary research, unrelated to mindfulness interventions, not focused on working adults with stress, or did not assess sleep quality, 25 articles remained. One of these could not be accessed to full text, leaving 24 articles for full evaluation.

Of these, 14 studies were excluded for not being randomized controlled trials (RCTs), and 2 were excluded for not using standardized sleep quality measures. As a result, 8 studies met the inclusion criteria for the systematic review, and 4 were eligible for inclusion in the meta-analysis. The study selection process is illustrated in Figure 1.

The four studies included in the meta-analysis, conducted by Nam et al., (2024), Purdie et al., (2023), Klatt et al. (2009), and Klatt et al. (2017) were all RCTs with experimental and control groups. The studies were conducted between 2009 and 2024 and are summarized in Table 1.

Participants in these studies were adults aged 18–60 years, with inclusion criteria varying across studies. Most participants were working adults experiencing stress, with stress operationalized differently commonly through self-reported measures such as perceived stress scales or by occupation-related stress exposure (e.g., healthcare workers during the COVID-19 pandemic). The primary outcome was sleep quality, assessed in all four studies using the Pittsburgh Sleep Quality Index (PSQI). Mindfulness interventions differed in delivery format, including onsite (in-person) training, remote/online formats, and hybrid approaches. Most programs integrated multiple mindfulness practices. The session duration ranged from 20 minutes to 2 hours, the frequency of practice varied from daily to weekly, and the total intervention duration spanned 6 to 8 weeks (detailed in Table 2).

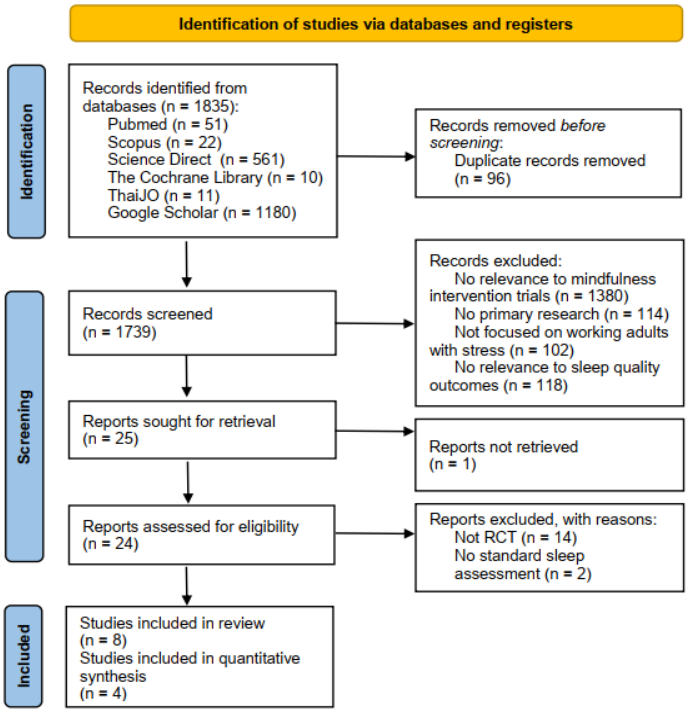

Figure 1 PRISMA flow diagram of selected studies.

Table 1 Characteristics of included studies

Authors, Year published, Country	Population, characteristics, stress (measured or identified)	Intervention group and comparison group (Sample size, Characteristics, mean age in years)	Sleep quality Measurement	Conclusion
Nam S, et al., (2024), US	- Black women often face significant psychological stress stemming from racial and gender-based discrimination. - Everyday Discrimination Scale - PSS	G1 = MBT-I via Zoom (n = 21, mean age = 35.43) G2 = Lifestyle health education (HE) (n = 9, mean age = 36.33)	ISI, PSQI, Actinography	Both groups showed significant improvements in sleep quality and insomnia severity.
Purdie et al., (2023), US	- Pediatric residents and physicians are experiencing epidemic levels of work-related stress and burnout.. - PSS	G1 = Mindfulness meditation delivered as a hybrid (in-person and digital) (MAPs) (n = 27, mean age = 26) G2 = Wait-list control (n = 39, mean age = 37)	PSQI	MAPs participants showed no differences in PSQI compared to controls.
Klatt et al., (2017), Denmark	- Workers who miss work due to an inability to perform normal activities or want to work but are not as effective as they could be. - PSS	G1 = Mindfulness in Motion (MIM) (n = 27, mean age = 43.8) G2 = waitlist control (n = 30, mean age = 42.0)	PSQI	The MIM group improved in quality of sleep scores as compared to the wait-list control group.
Klatt et al., (2009), US	- Full-time faculty and staff employed at a large Midwestern university - Salivary cortisol - PSS	G1 = low-dose Mindfulness-based stress reduction (MBSR-ld program) (n = 24, mean age = 43.41) G2 = wait-list control group (n = 24, mean age = 46.50)	PSQI	Both the MBSR-ld group and the control group showed significant improvements in their PSQI scores.

Table 2 Characteristics of included studies

Authors, Year published	Intervention Details	Details	Format	Duration
Nam S, et al., (2024)	Mindfulness-Based Therapy for Insomnia (MBT-I)	Combines mindfulness meditation with behavioral sleep strategies (e.g., sleep hygiene, stimulus control). Tailored for Black women, focusing on self-compassion and intersectionality.	Weekly, 1.5-hour sessions via Zoom.	8 weeks
Purdie et al., (2023)	Mindful Awareness Practices (MAPs)	Group-based exercises, including mindful breathing, eating, loving-kindness meditation. Self-study supported by a mobile app.	Weekly, 2-hour sessions with app support.	8 weeks
Klatt et al., (2017)	Mindfulness in Motion (MIM)	Integrates mindfulness, yoga, music, and reflective writing. Sessions include yoga, meditation, and relaxation techniques.	Weekly, 1-hour sessions.	8 weeks
Klatt et al., (2009)	Low-dose Mindfulness-Based Stress Reduction (MBSR-ld)	Focuses on workplace stress using relaxation, body scans, and yoga. Includes 20-min daily individual meditation with guided audio.	Weekly, 1-hour group sessions.	6 weeks

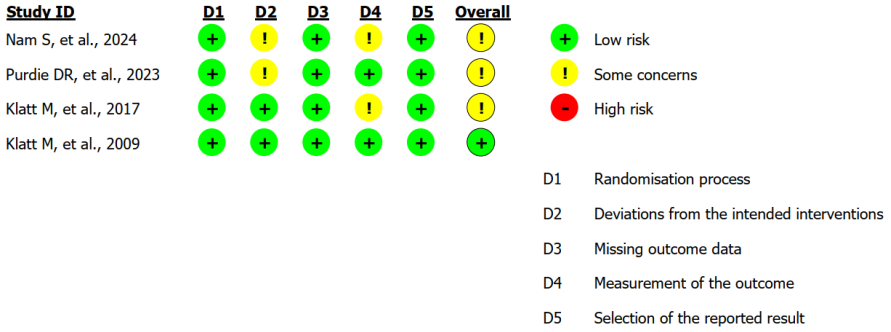

Figure 2 Quality assessment showed risk of bias in each included study

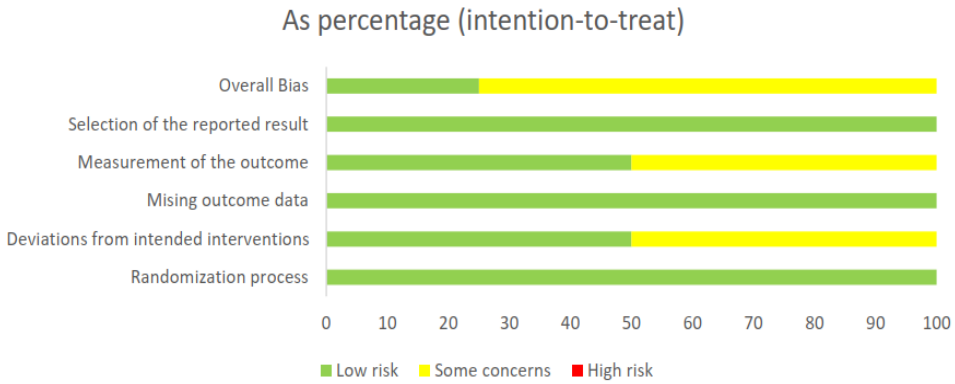

Figure 3 Quality assessment summary showed the risk of bias of all included studies

4.2 Quality of Included Studies

All included studies demonstrated a low risk of bias related to randomization and missing outcome data. However, 50% of the studies raised some concerns regarding bias due to deviations from intended interventions and outcome measurement, primarily because some assessors were aware of the intervention allocation. Despite these concerns, there was no conclusive evidence suggesting that such deviations or assessor awareness significantly influenced the outcomes. Nonetheless, potential bias remains a consideration across the included studies. A summary of the risk of bias assessments is presented in Figures 2 and 3.

4.3 Sleep Quality Outcomes

The effect of mindfulness on sleep quality was evaluated through a meta-analysis of four studies involving a total of 195 participants, using the Pittsburgh Sleep Quality Index (PSQI) as the primary outcome measure. The analysis indicated a significant improvement in global PSQI scores among participants in the mindfulness group compared to controls (Mean Difference [MD] = -0.49, 95% Confidence Interval [CI]: -0.82 to -0.16; p = 0.003; I^2 = 0%), suggesting a consistent effect across studies.

A subgroup analysis focusing on specific PSQI domains was conducted using data from two studies (Nam et al., 2024; Klatt et al., 2009), with a combined sample of 72 participants. The results revealed that mindfulness interventions led to significant improvements in sleep duration (MD = -0.18, 95% CI: -0.28 to -0.08; p < 0.001) and reduced use of sleep medications (MD = -0.27, 95% CI: -0.38 to -0.16; p < 0.001). No significant differences were observed in other PSQI domains, including subjective sleep quality, sleep latency, habitual sleep efficiency, and sleep disturbances.

The meta- analytic results are presented in Figures 4 and 5.

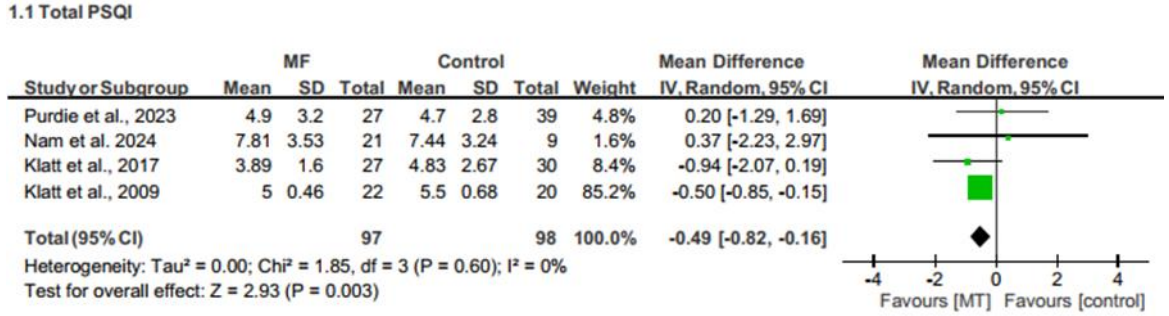

Figure 4 Forest plot of the meta-analysis showing the Mean Difference (MD) of the global PSQI scores between the Mindfulness group and the control group

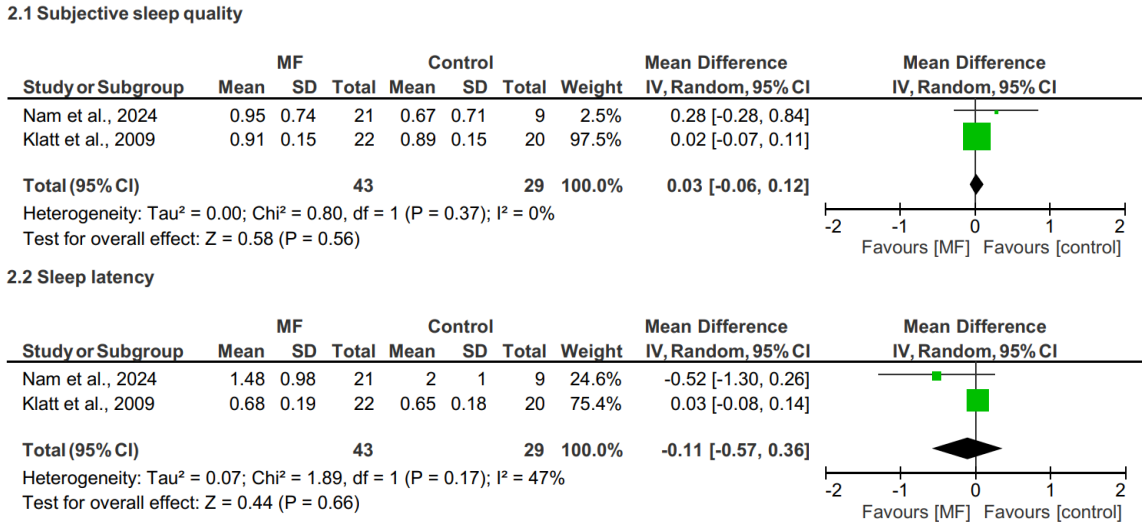

Figure 5 Forest plot of the meta-analysis showing the Mean Difference (MD) of PSQI scores in the subdomains between the Mindfulness group and the control group

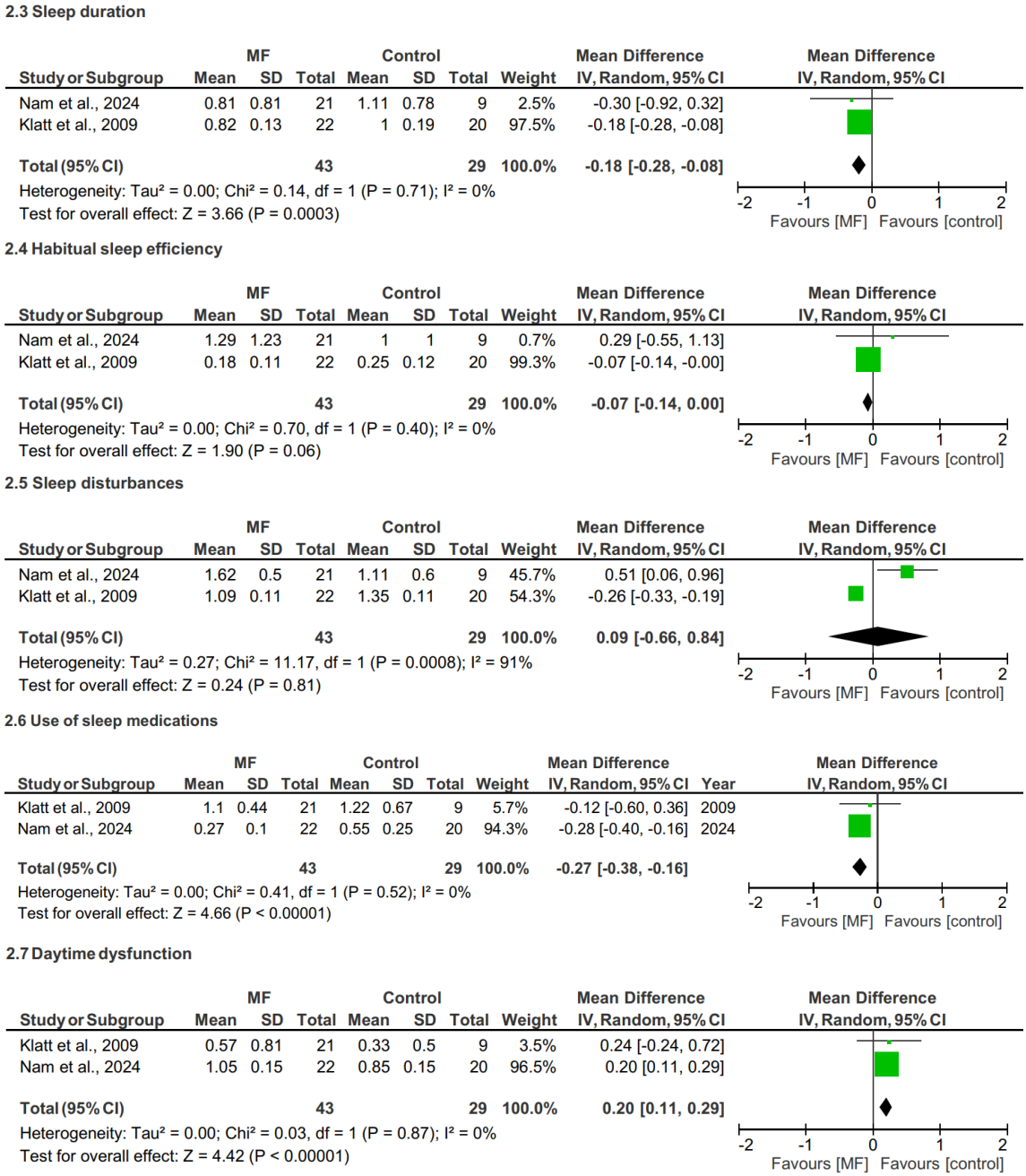

Figure 5 Cont.

5. Discussion

This systematic review synthesized evidence from eight randomized controlled trials (RCTs) examining the effects of mindfulness on sleep quality in stressed working adults. Four of these trials (N = 195) were eligible for meta-analysis and used the Pittsburgh Sleep Quality Index (PSQI) as a standardized outcome measure. The findings demonstrated that mindfulness interventions produced statistically significant improvements in global sleep quality compared to control conditions (MD = -0.49, 95% CI: -0.82 to -0.16; p = 0.003), with no statistical heterogeneity (I^2 = 0%), indicating consistent effects across studies.

As shown in Table 1, participants were working adults aged 18–60, but the operationalization of stress varied (e.g., pandemic-related stress, job strain), reflecting both the flexibility and variability of mindfulness interventions in occupational settings.

Table 2 further showed that intervention formats varied in session length (20 minutes to 2 hours), frequency (daily to weekly), and total duration (6 to 8 weeks). Despite these differences, mindfulness consistently improved sleep outcomes, suggesting that delivery mode (in-person, online, hybrid) did not affect efficacy.

The subgroup analysis (Figure 5) revealed specific improvements in sleep duration (MD = -0.18, $p < 0.001$) and reduced use of sleep medications (MD = -0.27, $p < 0.001$), based on two studies (Nam et al., 2024; Klatt et al., 2009). These findings suggest that mindfulness may influence both behavioral and physiological components of sleep, potentially via mechanisms related to autonomic nervous system regulation, parasympathetic activation, and stress-response dampening, consistent with earlier studies (Gotink et al., 2016; Hölzel et al., 2011; Carlson et al., 2007).

However, improvements were not observed in subjective sleep quality, latency, efficiency, or disturbances, which may point to the selective effects of mindfulness on stress-related arousal and sleep behaviors, rather than on sleep architecture or perception. This aligns with the notion that mindfulness supports behavioral routine regulation and present-moment awareness rather than directly modifying structural sleep parameters.

It is also important to note that while all four included studies reported statistically significant differences in global PSQI scores, the effect size was modest, and the minimal clinically important difference (MCID) for PSQI (often estimated at a 3-point change) may not have been reached. This raises questions about the clinical relevance of the findings and supports caution in generalizing mindfulness as a standalone treatment. This observation mirrors broader meta-analyses that emphasize mindfulness as a complementary, not substitutive, strategy to pharmacologic or cognitive-behavioral therapies (Rusch et al., 2019; Purdie et al., 2023).

Compared to previous reviews including diverse or clinical populations (e.g., fibromyalgia, anxiety, cancer) (de Entrambasaguas et al., 2023; Rusch et al., 2019), this study uniquely targets healthy working adults, enhancing the interpretation of mindfulness as a preventive intervention in workplace mental health strategies rather than clinical treatment.

The methodological strength of this review lies in its uniformity of outcome measures (PSQI across all studies), similarity in control conditions (waitlists or health education), and low heterogeneity ($I^2 = 0\%$). These aspects improve internal validity. Nonetheless, limitations include the small number of studies and participants, and the fact that subgroup analyses were based on only two trials, which limits confidence in domain-specific outcomes.

6. Conclusion

This systematic review and meta-analysis of randomized controlled trials provides evidence that mindfulness interventions can improve overall sleep quality in stressed working adults, particularly by enhancing sleep duration and reducing reliance on sleep medications. These findings underscore the potential of mindfulness as a non-pharmacological and accessible approach to mitigating sleep disturbances associated with occupational stress. However, the effects were not uniform across all sleep domains, and while statistically significant, the observed improvements were modest in magnitude and may not meet the threshold for clinical significance. Limitations such as the small number of eligible studies, variation in intervention formats, and short follow-up durations suggest that these results should be interpreted with caution.

Future research should prioritize larger, rigorously designed trials with standardized mindfulness protocols and extended follow-up. Incorporating objective sleep measures and stratified analyses by occupational setting and stress severity may further clarify the contexts in which mindfulness is most effective. Mindfulness should be considered a promising adjunct within a broader, multimodal strategy for promoting stress resilience and sleep health in working populations.

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