

# *A Meta-analysis of Mindfulness and Sleep Quality*

Junfeng Tang<sup>1, a, \*</sup>

<sup>1</sup>*School of Education, Hebei Normal University, Shijiazhuang City, Hebei Province, 050000, China  
a. 3180205291@caa.edu.cn*

*\* corresponding author*

**Abstract:** Mindfulness-based Therapies are an umbrella terminology for a group of interventions that is significantly efficient and effective in treating sleep disorders. To find out further research path of mindfulness-based stress reduction and mindfulness-based therapy for insomnia, a meta-analysis is conducted. Ten articles were included. The standardized mean difference is used as a measure to calculate this meta-analysis. Data in the analysis were processed using the random-effects model. The model's effect size hedges'  $g = -0.98$  (95% CI: -1.69 to -0.27). Thus, significant difference from zero ( $z = -2.70$ ,  $p = 0.007$ ) was found in the average outcome. After subgroup analysis, when language served as moderator did the Q test results appeared to be homogeneous ( $Q(8) = 43.08$ ,  $p < 0.001$ ,  $\tau^2 = 0.30$ ,  $I^2 = 86.20\%$ ). This study guides a) Chinese researchers to dig more into the applications as well as mechanisms and differences between Chinese and western participants, especially more creatively and innovatively, b) Researching in online MBSR and MBT-I might lead another path towards refined and enhanced application in the future and c) more detailed control information or factors should be reported or controlled.

**Keywords:** Mindfulness, Sleep Quality, Random Controlled Trial, Meta-analysis

## 1. Introduction

### 1.1. What Is Mindfulness?

Mindfulness is a concept that originated from Buddhism more than 2600 years ago, serving as a core of Zen introduced by Buddha. This Buddhist thought quickly spread in Asia, especially in the southeastern part. In the 20th century, mindfulness had drawn a great deal of attention in the field of psychology, among the psychologists Jon Kabat-Zinn who is one of the greatest and most influential scientists had developed and integrated mindfulness into modern psychological therapies and did several magnificent research on it to prove its validity and effectiveness. Contemporarily, scientific studies and the attendant media coverage have stoked interest in mindfulness therapies by highlighting the potential advantages for a variety of outcomes, including those related to mental health and physical well-being as well as cognitive, and interpersonal outcomes.

There have been many dialogues about the definition of mindfulness. One of the most used working definitions is a method or process of freely and mindfully attention to one's current experience. The act of concentrating on experiencing the present moment is in contrast with our everyday life experiences such as unintentionally wandering minds or suppression of unwanted

experiences. It is worth noting that a person's capacity of being mindful is associated with higher well-being [1].

## **1.2. Mindfulness-based Therapy (MBT)**

MBTs are an umbrella terminology for a group of interventions that is significantly efficient and effective in treating depression, anxiety, chronic pain, and of course sleep disorders. Mindfulness-based stress reduction (MBSR) intervention is probably the most famous and famed MBT, established at the University of Massachusetts by Jon Kabat-Zinn. This intervention is a programme that lasts for 8 weeks with weekly classes by a qualified therapist and homework with audio guides, which were originally used to treat chronic pain. With the research and development of MBTs, other branches aiming to cope with specific problems and disorders had been proposed. Mindfulness-based cognitive therapy (MBCT) is one of the most researched that focusing on dealing with depression, mindfulness-based relapse prevention (MBRP) is a therapy for drug addiction, and more effects of these MBTs are being discovered and researched such as dealing with eating disorders or enhance relationships.

In this research, the author will discuss two specific interventions, MBSR and Mindfulness-based Therapy for Insomnia (MBT-I). Ong et al found that MBSR and MBT-I have no significant difference in the treatment for total wake time (TWT) recorded in sleep diaries and the pre-sleep arousal scale (PSAS) [2].

## **1.3. Effectiveness of MBTs in Sleep Disorders.**

There has been much research on the effectiveness of MBTs, among which the form and participants of MBTs varied. There are randomized controlled trials (RCTs) giving evidence of the effectiveness of sleep quality improvement [3]. It was hypothesized by Ma et al that combining mindfulness exercises with outdoor nature walks will enhance university students' moods and sleep. [4]. Huberty et al researched meditation apps, showing a result of improved depression as well as anxiety outcomes in the population of sleep disturbance [5]. Suh et al and Yang et al made a meta-analysis on a specific population, indicating that MBTs help cancer survivors as well as hospitalized ones by alleviating sleep disturbance and improving sleep quality [6].

## **1.4. Neurobiological Mechanisms of Mindfulness**

The brain undoubtedly plays a role in mediating the benefits of a mindfulness intervention on outcomes, and some early MBT studies used functional and structural neuroimaging to assess the neural and biological mechanisms involved. The putamen, insula, postcentral gyrus, anterior cingulate cortex, as well as regions of the prefrontal cortex have all been found to be activated by formal mindfulness meditation techniques (such as mindful awareness of breathing) [7]. Even though MBT studies that are well controlled are scarce, some preliminary data suggest that mindfulness practices may physiologically affect the brain, in which the gray matter in the hippocampus is increased [8]. The neurological processes connecting mindfulness interventions with the outcome are still poorly understood, despite recent advancements. According to the theory of mindfulness, as a stress reducer put forth by some researchers, MBTs boost prefrontal cortical activity and functional connectivity, which is crucial for top-down stress regulation, while decreasing activity and functional connectivity in neural regions that are crucial for triggering the fight-or-flight response.

## **1.5. Questions**

Since plenty of research has been done previously, this meta-analysis will particularly be interested in the effectiveness of this relatively new trend for psychological therapy, especially in the following

aspects. First, do these different kinds of the population significantly impact MBSR intervention? Second, will nationality influence MBSR effects? Third, do studies differ significantly between English and Chinese publications?

## **2. Methods**

### **2.1. Search Strategy**

English content as well as Chinese content are presented. English literature data are collected from 3 digital databases—MEDLINE, Psycinfo, Elsevier, and Chinese literature search were done in CNKI, WanFang Data, and Weipu. All the research's published dates were restricted to later than January 1st, 2012.

Terms for searching contents were constructed to 3 main keywords: a) mindfulness or meditation, b) sleep quality or sleep disturbance, and c) RCTs. These keywords were used in both English and Chinese literature search.

### **2.2. Trial Selection**

To conduct a better and more favourable meta-analysis, and to enhance the reliability and liability in this research, several restrictions are applied.

- (1) Average age of the population must be adults older than 18.
- (2) All the experiments must be conducted in RCTs.
- (3) MBSR as well as MBT-I are delivered as the main techniques.
- (4) Measurement for sleep quality must use PSQI.
- (5) The trials must include pretest and posttest.
- (6) Repeated data should be excluded.

### **2.3. Data Extraction**

Details were extracted in a standardized form—the author and year of the published report, the language used, methods (MBSR or MBT-I), and participants' characteristics (gender, population, nationality). Arranged in a separate table.

### **2.4. Analytic Method**

The outcome measure applied in the data was the standardized mean difference. To fit the data, the model of random-effects was used. The degree of heterogeneity was determined using the restricted maximum-likelihood estimator. The  $I^2$  statistic and the Q-test for heterogeneity are also presented along with the estimate of  $\tau^2$ . A prediction interval for the actual results is also given if any degree of heterogeneity is found. Examining whether research may be anomalous and/or significant within the model's framework requires the use of studentized residuals and Cook's distances. For each of the research featured in the meta-analysis, studies that have a studentized residual are used to determine if it is unduly influential by utilizing a Bonferroni adjustment with a two-sided alpha of 0.05. For those studies having a Cook's distance greater than the median plus, six times the range of Cook's distance in quartiles is regarded as being overly influential. The regression test and rank correlation test are utilized to look for asymmetry in the funnel plot, utilizing the observed findings' standard error as a predictive factor.

### 3. Results

#### 3.1. Included Articles

After searching carefully, a total of 1699 articles were generated in three English electronic databases and 522 articles were found in Chinese electronic databases. From a brief reading of the titles and abstracts, 14 articles were included (8 in English and 6 in Chinese). Others that did not meet the criteria were excluded. One article was excluded because measures are not favourable and 3 articles were excluded due to inappropriate methods from English literature. Eventually, 10 articles were included [9-18].

#### 3.2. Coding

What is surprising is that all research that meet the criteria are traditional intervention and used a MBSR, online interventions are still under developed in an standard form. Eventually, information of included studies was coded in the following table (see Table 1).

Table 1: Coding.

| AUTHOR                | YEAR | LANGUAGE | N   | MALE/FEMALE  | POPULATION              | NATIONALITY |
|-----------------------|------|----------|-----|--------------|-------------------------|-------------|
| Barrett et al [9]     | 2020 | English  | 413 | Not reported | Healthy adults          | American    |
| Zhang et al [10]      | 2015 | English  | 60  | 35/25        | Chronic insomnia        | Chinese     |
| Horenstein et al [11] | 2019 | English  | 146 | Not reported | Social anxiety disorder | American    |
| Lengacher et al [12]  | 2014 | English  | 79  | All female   | Breast cancer survivors | American    |
| He et al [13]         | 2022 | Chinese  | 50  | 28/22        | Radiation dermatitis    | Chinese     |
| Li & Tu [14]          | 2019 | Chinese  | 80  | 54/26        | Liver cancer            | Chinese     |
| Liang et al [15]      | 2018 | Chinese  | 110 | All female   | Breast cancer           | Chinese     |
| Zhang [16]            | 2017 | Chinese  | 80  | All female   | Breast cancer           | Chinese     |
| Wei et al [17]        | 2017 | Chinese  | 160 | 69/91        | Insomnia patients       | Chinese     |
| Gu et al [18]         | 2021 | Chinese  | 106 | 51/54        | Moyamoya disease        | Chinese     |

#### 3.3. Statistical Analysis

##### 3.3.1. Mean Difference

The analysis comprised a maximum of 10 studies. Most estimations were negative, with the observed standardized mean differences ranging from -3.09 to 8.22. (70%). Using the random effects model as a base, the predicted average standardized mean difference was -0.11. (95% CI: -1.96 to 1.75). As a result, there was no discernible difference between the average result and zero ( $z = -0.11$ ,  $p = 0.91$ ). The Q-test indicates that the true outcomes are heterogeneous ( $Q(9) = 335.48$ ,  $p < 0.001$ ,  $\tau^2 = 8.87$ ,  $I^2 = 99.44\%$ ). Thus, the real outcome in certain research may thus be favorable even though the average outcome is assessed to be negative. One research (Zhang) with a value greater than 2.81 was identified as a possible anomaly in this model's case by examining the studentized residuals. The Cook's distances indicate that Zhang's study may have an excessive amount of influence. The rank correlation test did not reveal asymmetry of funnel plot ( $p = 0.73$ ), nevertheless the regression test did ( $p = 0.0003$ ).

### 3.3.2.Sensitivity Analysis

Since Q-test in the analysis is significant and Zhang's study is overly influential, a sensitivity analysis was applied to find out which study affects the overall model. After excluding Zhang's study from the research, the model's effect size hedges'  $g = -0.98$  (95% CI: -1.69 to -0.27) (see Figure 1). Thus, a significant difference from zero was found in the average outcome ( $z = -2.7$ ,  $p = 0.007$ ). However, the results Q test is still heterogeneous ( $Q(8) = 169.97$ ,  $p < 0.001$ ,  $\tau^2 = 1.13$ ,  $I^2 = 96.18\%$ ), therefore a subgroup analysis is applied.

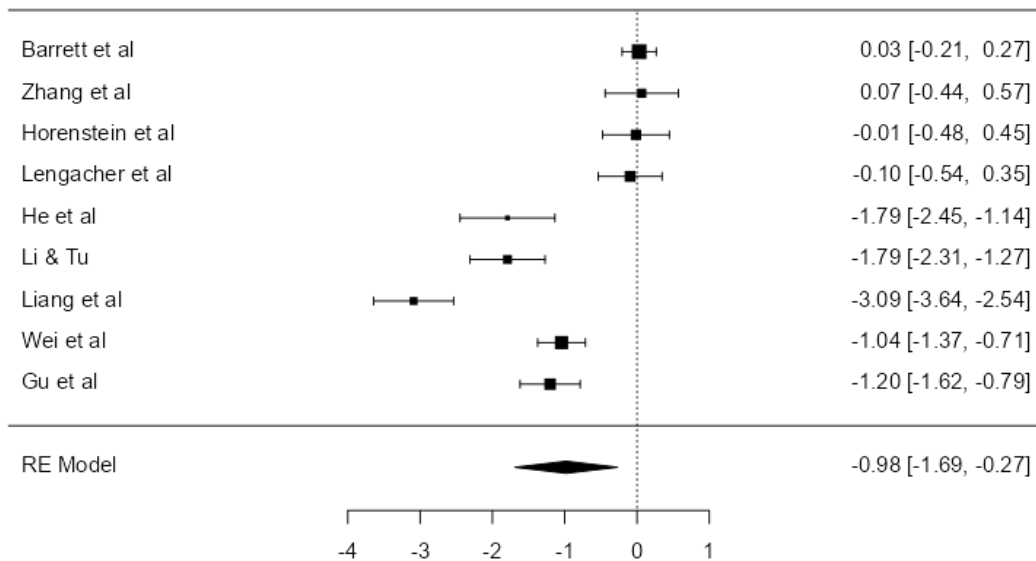


Figure 1: Forst Plot.

### 3.3.3.Subgroup Analysis

According to the coding conducted by the author, nationality, population and language were tested. Among them only when language served as moderator did the Q test results appeared to be homogeneous ( $Q(8) = 43.08$ ,  $p < 0.001$ ,  $\tau^2 = 0.30$ ,  $I^2 = 86.20\%$ ). After moderation, the forest plot was ranked by its hedges'  $g$  value (see Figure 2).

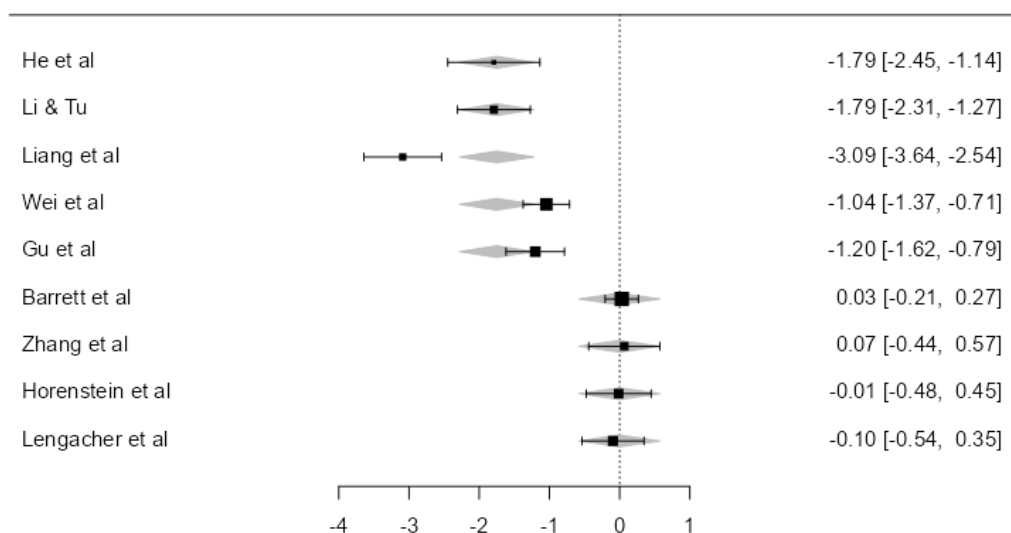


Figure 2: Moderated Forest Plot

### 3.3.4. Publication Bias Assessment

Publication bias assessment used Fail-Safe N (FSN) to conduct, and the result shows no bias ( $p < .001$ ). The funnel plot shows the comparatively equal distribution, which indicates no publication bias as well (see Figure 3).

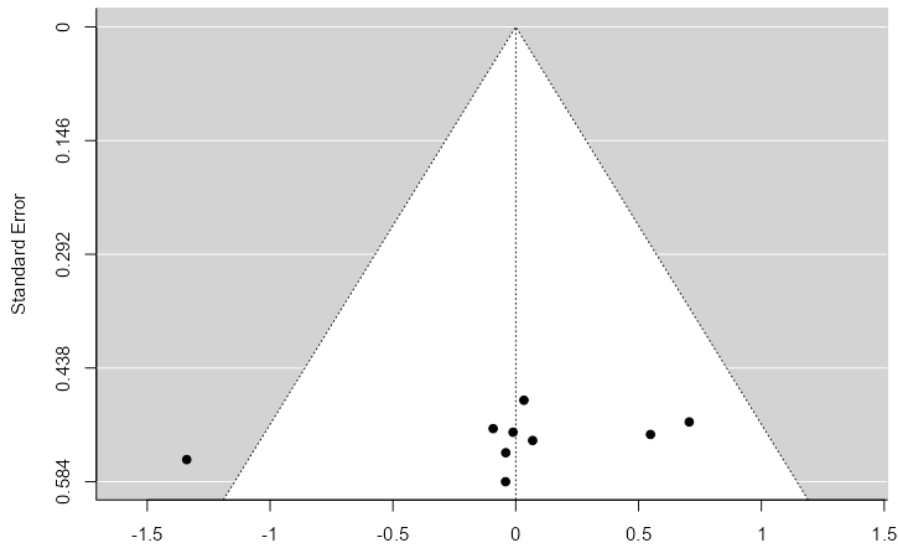


Figure 3: Funnel Plot

## 4. Discussion

From the meta-analysis and review of the articles, the population covers a great range of different groups of people, however, after the exclusion, no online MBSR or MBT-I study is conducted in RCT, which indicates further explorations on more scientific studies of these two interventions. It is especially important under the circumstances of the COVID-19 pandemic, for its effectiveness is related to the well-being of both the participants and therapists.

After subgroup analysis, the data showed a significant difference between English literature and Chinese literature, which means the effect and impact of English literature are more advanced than Chinese literature, what is more, it also indicates that China in the study of MBSR and MBT-I is underdeveloped. The research on mindfulness in China first started in 1999, which is later than that in western, besides, the overall number of research on the topic of mindfulness also sharply differed [19]. Further research on it in Chinese literature is needed to tighten the foundation of mindfulness study.

## 5. Conclusion

A systematic review of the articles reported on the MBSR or MBT-I for the improvement of sleep quality in adults yielded 13 trials published since 2012, after the careful exclusion, 10 articles were included. The overall quality of studies is relatively impressive, in which the population, gender, age, and nationality are diverse. This meta-analysis also includes Chinese literature and uses the published language as a moderator in the analysis, which yielded a discovery indicating potential weakness in China's study on mindfulness. This guides Chinese researchers to dig more into the applications as well as mechanisms and differences between Chinese and western participants, especially more creatively and innovatively. What is more, the author found a lack of studies on online MBSR and MBT-I interventions, researching it might lead to another path towards refined and enhanced application in the future. In the end, more detailed control information or factors should be reported



or controlled, since when the population and nationality moderate the model, there is still a heterogeneous result. If more studies could dig more into this issue, researchers could find a more precise way to practice MBSR and MBT-I, and make customized, personalized interventions when different individuals need to take this therapy, thus it could enhance the overall satisfaction and well-being of patients.

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