

# BMJ Open Efficacy of mindfulness-based intervention ('mindfulness-based joyful sleep') in young and middle-aged individuals with insomnia using a biomarker of inflammatory responses: a prospective protocol of a randomised controlled trial in China

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## ABSTRACT

**Introduction** Insomnia is a prevalent and significant public health concern. Insomnia can lead to increased inflammatory markers associated with chronic diseases such as cardiovascular disease, diabetes and cancer. Studies suggest that mindfulness-based interventions (MBIs) are more easily delivered within the community than cognitive behavioural therapy for insomnia (CBT-I) which was recommended as the preferred non-pharmacological treatment by the American Academy of Sleep Medicine, are effective in insomnia treatment and can reduce inflammatory markers level in older individuals with insomnia. This study aims to compare the effectiveness of an MBI to CBT-I in young and middle-aged individuals with insomnia disorder and explore its effect on nuclear factor kappa B (NF- $\kappa$ B), a transcription factor that controls the expression of genes involved in inflammation. **Methods and analysis** This report describes a protocol for a randomised controlled trial. Seventy eligible participants will be assigned to mindfulness-based joyful sleep or CBT-I for 2-hour sessions weekly for 8 weeks. The primary outcome is sleep quality assessed by the Pittsburgh Sleep Quality Index, severity of insomnia symptoms assessed by the Insomnia Severity Index and sleep parameters recorded using sleep diary and polysomnography. Secondary outcomes include perceived stress, anxiety and depression. The exploratory outcome is serum level of NF- $\kappa$ B. Outcomes will be evaluated at baseline, the end of the intervention period and at a 3 month follow-up. Data will be analysed using general linear models, specifically analysis of covariance and analysis of variance will be used. **Ethics and dissemination** Full ethical approval for this study has been obtained from the Ethics Committee of the Third Xiangya Hospital, Central South University, Changsha, China (2018-S236). If Mindfulness-Based Joyful Sleep is proven effective, its dissemination will help bridge the gap between the unmet need and the demand for insomnia interventions in China.

## Strengths and limitations of this study

- To our knowledge, this is the first randomised controlled trial exploring the benefits of a mindfulness-based intervention (mindfulness-based joyful sleep) for insomnia disorder in young and middle-aged individuals in China.
- Participants will be screened for sleep disorders at baseline by an experienced psychiatrist who is qualified to make a diagnosis of insomnia.
- An objective measure of sleep quantity, polysomnography, in addition to participant self-report measures will be used to assess outcomes.
- An objective biological measure, nuclear factor kappa B, will be assessed as a preliminary exploration of the anti-inflammatory effects of the mindfulness-based joyful sleep intervention.
- This study is limited as it will not include an untreated control group.

**Trial registration number** NCT03268629; Pre-results.

## INTRODUCTION

Insomnia has become a prevalent and significant public health concern.<sup>1</sup> An estimated 33% of the general population have insomnia symptoms, and 6%–10% meet the diagnostic criteria for insomnia.<sup>2</sup> A meta-analysis (n=17 studies; 115988 participants) revealed that the prevalence of insomnia in China was 15%; specifically, the prevalence of insomnia in individuals with a mean age  $\geq 43.7$  years was significantly lower than in individuals with a mean age  $< 43.7$  years.<sup>3</sup> An epidemiological survey evaluating sleep quality and insomnia

(n=26851 participants) showed that 26.6% of urban and rural residents in Hunan Province, China suffered from insomnia in 2017.<sup>4</sup> These findings indicate there is an unmet need for an effective therapy for insomnia.

The American College of Physicians suggested that adult patients are recommended to receive cognitive behavioural therapy for insomnia (CBT-I), in particular as its initial treatment for chronic insomnia disorder.<sup>5</sup> Evidence from meta-analysis of randomised controlled trials (RCT) showed that CBT-I is an effective treatment for insomnia delivered either individually or in small group format and is as effective as prescription medication for short-term treatment of chronic insomnia.<sup>6</sup> The American College of Physicians also indicated that a shared decision-making approach conducted by clinicians to determine whether pharmacological therapy should be employed in adults with chronic insomnia disorder, given that cognitive behavioural therapy was proven to be unsuccessful.<sup>5</sup> However, pharmacological treatments for insomnia are associated with residual effects on awakening and during the daytime, tolerance and dependence.<sup>7 8</sup> At the same time, CBT-I must be implemented by an experienced psychiatrist/psychologist with appropriate training.<sup>9</sup> China has a large population, a high prevalence of insomnia and few qualified CBT-I psychiatrists/psychologists. Therefore, there is the need for an effective and economic group-based psychological intervention for insomnia that can be easily mastered by healthcare professionals in China.

Mindfulness involves bringing attention to current experiences, including thoughts, feelings and physical sensations, with openness, curiosity and acceptance.<sup>10</sup> Jon Kabat-Zinn suggested that mindfulness is the essence of meditation.<sup>11</sup> In the 1970s, mindfulness, which was originally a Buddhist concept, became integrated into Western psychology. A series of psychological interventions based on mindfulness, known as mindfulness-based interventions (MBIs), were developed.<sup>11 12</sup> MBIs, including mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), dialectal behaviour therapy (DBT) and acceptance and commitment therapy (ACT) are aimed at relieving stress and mental and physical health concerns.<sup>11 12</sup> MBSR is a group-based programme and one of the most studied MBIs where grouping is an essential impact factor. Studies showed that group membership has a significant influence on alleviation of psychological symptoms.<sup>13</sup> The essence of MBIs is standardised, formalised mindfulness practice.<sup>11</sup> Mindfulness practices include formal practices (eg, sitting meditation, Tai Chi and yoga) and informal practices (bringing mindfulness to daily life, eg, mindfulness eating).<sup>14 15</sup> Mindfulness practices are easily learnt and can be conveniently performed at any place and time.<sup>16</sup> These characteristics are beneficial to the application and popularisation of mindfulness practices. Empirically supported benefits of mindfulness practices include development of emotional regulation, decreased reactivity and increased response flexibility, enhanced interpersonal relationships,

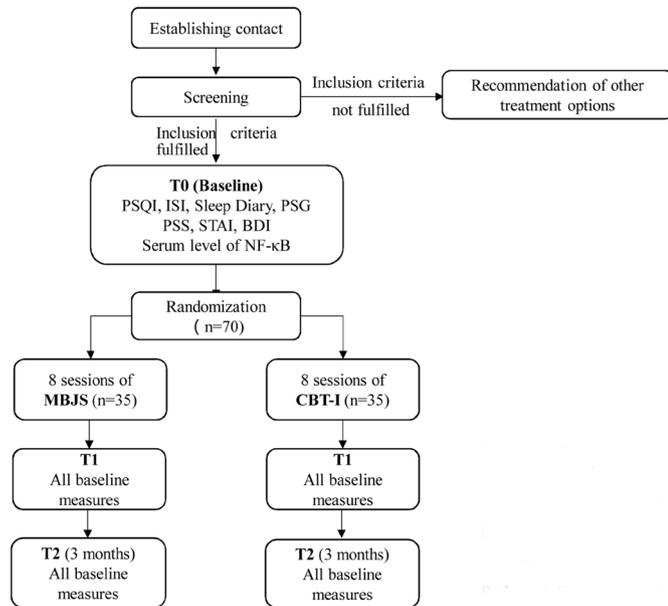
improved functioning related to the middle part of the brain's prefrontal lobe, enhanced immune functioning, improved well-being and reduced psychological distress.<sup>17</sup>

Some studies suggest that mindfulness practices can improve sleep quality and quantity in individuals with insomnia. Findings showed that mindfulness meditation can significantly reduce the severity of insomnia, sleep latency, arousal level before sleep and waking times; prolong total sleep time and improve sleep efficiency and quality in individuals with chronic insomnia.<sup>16 18–22</sup> Mindfulness meditation can ameliorate insomnia in individuals with cancer, depression, anxiety and obesity.<sup>23–27</sup> Tai Chi can improve sleep quality in individuals with chronic insomnia.<sup>28–30</sup> Yoga can ameliorate insomnia and improve sleep quality in individuals with insomnia.<sup>31–33</sup> Our previous study compared the effect of MBIs with CBT-I on insomnia and showed that MBIs produced similar effects as CBT-I.<sup>34</sup> However, many of these studies were associated with methodological limitations including (1) underpowered sample sizes, (2) insomnia was secondary to physical or mental disorders and (3) outcomes were based on participant self-report rather than objective evaluations such as biological indicators. Therefore, there is potential for more rigorous research on the effectiveness of mindfulness practices for insomnia.

Studies show that insomnia can alter inflammatory processes.<sup>35–37</sup> Inflammatory biomarkers may increase in response to insomnia and contribute to the aetiology of physical and mental disorders, including cardiovascular disease, diabetes, cancer and depression.<sup>37–40</sup> Nuclear factor kappa B (NF- $\kappa$ B) plays a key role in activation of inflammation in chronic insomnia.<sup>41</sup> Interventions that improve sleep and reduce inflammation may have positive effects on the health of the general population.<sup>9</sup>

Recently, the mechanism of mindfulness practices has been explored by monitoring gene expression.<sup>42</sup> In mindfulness practices, the most researched transcription factors are those related to stress and inflammation, where NF- $\kappa$ B plays a pivotal role. A meta-analysis conducted in 2017 reported that mindfulness practices, including meditation, Tai Chi, yoga and qigong were associated with a downregulation of the NF- $\kappa$ B pathway, potentially influencing the outcomes of chronic stress and inflammation-related diseases.<sup>42</sup> The effect of mindfulness practices on gene expression and inflammation has become a burgeoning area of research worldwide. However, studies investigating the application of mindfulness practices for inflammatory-based outcomes in insomnia are scarce. Some reports implied that mindfulness meditation and Tai Chi can reduce NF- $\kappa$ B expression in older adults or breast cancer survivors with insomnia.<sup>20 43 44</sup> However, to the author's knowledge, there are no published studies investigating the inflammation-related mechanisms underlying the beneficial effects of mindfulness practices in young and middle-aged individuals with primary insomnia.

To address the shortage of accessible interventions for insomnia in China, the proposed study was designed to



**Figure 1** Study design (randomised controlled trials) and assessment time points (consort chart). BDI, Beck Depression Inventory; CBT-I, cognitive behavioral therapy for insomnia; ISI, Insomnia Severity Index; MBJS, mindfulness-based joyful sleep; NF-κB, Nuclear factor kappa B; PSQI, Pittsburg Sleep Quality Index; PSG, polysomnography; PSS, Perceived Stress Scale; STAI, State Trait Anxiety Inventory.

explore the efficacy of an MBI (mindfulness-based joyful sleep (MBJS) intervention) for young and middle-aged individuals with insomnia in China. Outcomes will be assessed at three time points using self-reported measures, a sleep diary, polysomnography (PSG) and serum levels of NF-κB. This study has important public health implications, providing an option to bridge the gap between the unmet need and demand for support for individuals with insomnia in China.

## METHODS

### Patient and public involvement

Patients and public were not involved in the development of the research question or in the design of the study. Dissemination of the general results (no personal data) would be made on demand.

### Study design

The study design of the RCT is shown in [figure 1](#). This single-centre, assessor-blind, active-controlled, parallel group RCT will evaluate the efficacy of an MBI for insomnia (MBJS). The RCT will enrol 70 participants that will be randomised in a 1:1 ratio to the intervention group (MBJS intervention) or a control group (CBT-I). The trial consists of a screening visit, a 1-week washout period and an 8-week intervention period. The MBJS intervention or CBT-I will be administered once a week during the intervention period. Participants will be evaluated at baseline (1 week before the intervention period), at the end

of the intervention period and at a 3-month follow-up. Participants will have the right to withdraw their consent and discontinue participation at any time if they experience discomfort or a change in their condition. Plans for important protocol modifications will be communicated to trial registration. Trial results will be disseminated on trial registration (clinicaltrials.gov) or publication.

### Study objectives

- ▶ The primary study objective is to determine the efficacy of the MBJS intervention for insomnia.
- ▶ The secondary study objective is to determine the effects of the MBJS intervention on stress, anxiety and depression in individuals with insomnia.
- ▶ The exploratory objective is to determine the effects of the MBJS intervention on the inflammatory response in individuals with insomnia.

### Setting

The trial will be performed at the Department of Clinical Psychology, the Third Xiangya Hospital of Central South University in Changsha, China. The principal investigator (PI) will organise relevant training pertaining to research ethics and methods that will be attended by all research staff.

### Sample size

A priori power analysis conducted in Gpower using a two-tailed test, a 5% significance level and accounting for 20% attrition demonstrated that 35 participants in each group will be required to detect moderate to large treatment effects within the intervention group (effect size=0.68).<sup>24</sup> With a 1:1 allocation to each group, a total of 70 participants will be recruited.

### Recruitment

Participants will be recruited through advertisements posted in hospitals and Internet bulletin boards and by doctor referral from outpatient clinics. Interested participants will be invited to attend a screening visit at the Third Xiangya Hospital of Central South University, which will be conducted by an experienced psychiatrist. Participants meeting the inclusion criteria will be fully informed of their responsibilities and of all the procedures involved in the trial and will be asked to sign the written informed consent form before any protocol-directed procedures are performed. [Table 1](#) shows schedule of enrolment, interventions and assessments.

### Eligibility criteria

#### Inclusion criteria

1. Aged between 18 and 59 years.
2. Diagnosis of insomnia disorder according to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition.
3. Fully conscious.
4. Junior high school or higher education degree.
5. No language impairment or communication disorders.
6. Willing to participate in the study.

**Table 1** Schedule of enrolment, interventions and assessments

Time point	Study period				Close-out <b>t<sub>3</sub> follow-up assessment</b>
	Enrollment <b>t<sub>1</sub></b>	Allocation <b>t<sub>0</sub></b>	Postallocation <b>t<sub>1</sub></b> <small>intervention period</small>	<b>t<sub>2</sub></b> <small>postassessment</small>	
Enrolment:					
Eligibility screen	X				
Informed consent	X				
Allocation		X			
Interventions:					
MBJS intervention group			X		
CBT-I intervention group			X		
Assessments:					
Primary outcome measures					
PSQI	X			X	X
ISI	X			X	X
Sleep diary	X			X	X
PSG	X			X	X
Secondary outcome measures					
PSS	X			X	X
STAI	X			X	X
BDI	X			X	X
NF-κB	X			X	X

BDI, Beck Depression Inventory; CBT-I, cognitive behavioural therapy for insomnia; ISI, Insomnia Severity Index; MBJS, mindfulness-based joyful sleep; NF-κB, Nuclear factor kappa B; PSG, polysomnography; PSQI, Pittsburgh Sleep Quality Index; PSS, Perceived Stress Scale; STAI, State-Trait Anxiety Inventory.

### Exclusion criteria

1. Cognitive impairment.
2. Somatic disorders, including but not limited to cardiovascular disease, cerebrovascular diseases, endocrine diseases, autoimmune diseases and tumours.
3. Mental disorders, including but not limited to schizophrenia, mood disorders, anxiety disorders, trauma and stress related disorders, substance related disorders.
4. Pregnant or lactating women.
5. Currently taking any prescribed medication.
6. Currently participating in any mindfulness practice for 15 min per day (eg, yoga, Tai Chi, qigong, meditation).

### Randomisation and blinding

Simple randomisation will be used to assign participants to study groups. Seventy eligible participants will be randomised 1:1 into two groups using a random number table generated by a researcher using SPSS V.22.0. A researcher will create random allocation cards and seal them in sequentially numbered opaque envelopes. Another researcher will be responsible for group allocation. The trial will be assessor blinded as all researchers including the outcome assessors, statisticians and data analysts will be blinded to the group assignments;

providers of the intervention/control will necessarily be informed of the group assignments. Before the trial, researchers will be trained in the randomisation procedure and made aware of their individual responsibilities. The successful implementation and maintenance of the randomisation and blinding method will be validated.

### Intervention

#### Intervention group (MBJS intervention)

Participants in the intervention group will receive the MBJS intervention. The MBJS intervention was developed by the PI who has completed the Training of Mindfulness Facilitation (TMF) programme at the UCLA Mindful Awareness Research Center. The MBJS intervention adopts some elements from MBSR and mindful awareness practices (MAPs), which include mindfulness meditation and Tai Chi as core components. MBSR is a group-based intensive training in mindfulness meditation conducted in 8 weekly sessions, 2.5 hours per session, created by Kabat-Zinn at the University of Massachusetts Medical Center.<sup>45</sup> MAPs are learnt through a group-based manualised course in mindfulness meditation conducted in 6 weekly sessions, 2 hours per session, developed by the UCLA Mindful Awareness Research Center.<sup>20</sup> Preliminary

evidence suggests that MBSR, MAPs and Tai Chi have beneficial effects on insomnia.<sup>18–22 24 28–30 43 44</sup>

The proposed MBJS intervention will involve group-based mindfulness training conducted in 8 weekly sessions, 2 hours per session. Mindfulness practices embedded in the programme will include mindful breathing meditation, mindful body scan, mindful walking meditation, Tai Chi and daily life meditation. The participants will also receive sleep hygiene education. Proposed modules include:

1. Sleep and mindfulness: (i) why are we living with insomnia; (ii) why do we need mindfulness; (iii) mindful eating practice; (iv) how can we incorporate mindfulness into daily life?
2. Mindful awareness of stress: (i) stress and sleep; (ii) sleep hygiene education; (iii) mindful body scan practice; (iv) how can a body scan be used to explore stress?
3. Mindful awareness of breath: (i) seven attitudes of practising mindfulness; (ii) mindful breathing meditation practice; (iii) 3 min breathing space practice; (iv) how to use breath to relax the body and mind.
4. Mindfully working with thought and emotion: (i) sitting meditation; (ii) how can we acknowledge negative thoughts and emotions during sleep?; (iii) using the 'STOP' principle to acknowledge thoughts and emotions; (iv) using the 'RAIN' principle to acknowledge thoughts and emotions.
5. Mindful interactions: (i) sitting meditation; (ii) mindful listening practice; (iii) how can we listen and talk in a mindful way; (iv) mindful walking practice.
6. Moving mindfulness meditation: (i) introduction to Tai Chi; (ii) Tai Chi-based stress reduction movement; (iii) how to accept insomnia and break the circle of insomnia.
7. Moving mindfulness meditation: (i) Tai Chi-based stress reduction movement; (ii) how to incorporate Tai Chi into daily life and relax the mind and body.
8. Review of the mindfulness practices included in the programme; discussion about how to use mindfulness to deal with future challenges and wrap-up.

Each session of the MBJS intervention will include: 25 min instruction on mindfulness, 50 min practising mindfulness meditation, 40 min sharing experiences and discussing and 5 min providing direction on homework. Participants will be required to perform formal mindfulness practice at home for 5 min daily initially, advancing to 20 min daily at the end of the intervention period.

Each session of the MBJS intervention will be conducted in a private conference room at the Third Xiangya Hospital of Central South University. The room will be comfortable, with water and minimal chance of interruption. The MBJS intervention will be presented by the PI who has been trained and certificated in mindfulness meditation at the UCLA Mindful Awareness Research Center and has many years of experience practicing Tai Chi.

### Control group (CBT-I)

Participants in the control group will receive CBT-I, which includes four central components: stimulus control, sleep restriction, relaxation training and cognitive therapy. The aim of CBT-I is to reduce sleep-related physiological and cognitive arousal so that restorative sleep function can be re-established.<sup>24</sup> CBT-I will be a group-based programme conducted in 8 weekly sessions, 2 hours per session. Proposed modules include: (1) understanding sleep, sleep hygiene education, stimulus control and sleep restriction; (2) understanding your thoughts; (3) understanding and evaluating your emotions; (4) situation, thoughts, emotions, behaviours and physiological reaction; (5) automatic thoughts and core beliefs, finding new balance thoughts and beliefs; (6) Socratic questions, finding supportive or unsupportive proofs; (7) Relaxation training for sleep; (8) review of the cognitive and behaviour techniques included in the programme; discussion about how to use cognitive and behaviour techniques to deal with future challenges and wrap-up.

Each session of the CBT-I intervention will include: 25 min instruction on cognitive or behavioural techniques, 50 min practising cognitive or behavioural regulation techniques, 40 min sharing experiences and discussing and 5 min providing direction on homework. Participants will be required to complete different situations/thoughts/emotions/behaviours record sheets at home for 5–20 min daily.

Each CBT-I session will be conducted in a private conference room at the Third Xiangya Hospital of Central South University. The room will be comfortable, with water and minimal chance of interruption. CBT-I will be presented by an experienced psychiatrist/psychologist who has been specially trained in CBT.

### Measures

#### Compliance

Participants will be informed of the importance of attending each MBJS intervention/CBT-I session and completing homework, as the effect of the MBJS intervention/CBT-I on insomnia is dependent on compliance. Participants will be provided written literature and audio materials related to the MBJS intervention/CBT-I to promote their adherence to daily practice. Compliance with the interventions will be measured by attendance rates. The attendance of participants at each session of the MBJS intervention/CBT-I will be recorded on an attendance sheet by a research assistant.

### Outcome measurements

**Primary outcome: sleep quality, severity of insomnia symptoms, sleep parameters**

#### *Pittsburgh Sleep Quality Index*

Sleep quality will be measured subjectively with the Pittsburgh Sleep Quality Index (PSQI), which assesses sleep disturbances during the past month. The PSQI comprises 19 self-rated items and five items rated by a roommate. The 19 self-rated items are combined to

form 7 component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of medication and daytime dysfunction, each rated on a scale of 0–3. A global PSQI score (0–21) is derived from the sum of the component scores. A lower global PSQI score indicates better sleep quality. The five items rated by a roommate are used for clinical information.<sup>9</sup> The Chinese version of the PSQI (C-PSQI) includes 19 self-rated items and five items rated by a roommate. The C-PSQI has shown good reliability and validity (Cronbach's  $\alpha=0.84$ ).<sup>46</sup>

#### *Insomnia Severity Index*

The current severity of insomnia symptoms, sleep dissatisfaction, daytime impacts and distress concerning difficulties with sleep will be measured with the Insomnia Severity Index (ISI). The ISI comprises seven items, which are each rated on a five-point scale. Total scores range from 0 to 28. ISI clinical cut points are categorised as: no insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21) and severe insomnia (22–28). Response to treatment on the ISI has been defined as a change of  $\geq 7$  points from baseline and remission as reduction to a score  $< 8$ .<sup>22</sup>

#### *Sleep diary*

Sleep quantity will be measured subjectively with sleep parameters derived from participants' sleep diaries, including sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST) and time in bed (TIB).<sup>22</sup>

#### *Polysomnography*

PSG, with a minimum of electroencephalogram, electrooculogram and submental electromyogram recordings, will be used to objectively characterise sleep quantity.<sup>47</sup> PSG is currently the gold standard for sleep disorder diagnosis. Changes in sleep parameters including SOL, WASO, TST and TIB will be assessed.

#### *Secondary outcomes: stress, anxiety and depression*

##### *Perceived stress*

Perceived stress will be assessed using the Perceived Stress Scale (PSS). The PSS assesses all thoughts, feelings and stressful situations experienced during the past month.<sup>48</sup> Items are rated on a 5-point Likert-type scale, with higher total scores indicating higher perceived stress (0–13, low perceived stress; 14–26, moderate perceived stress; 27–40, high perceived stress). The PSS has shown good validity and reliability in several studies (Cronbach's  $\alpha=0.78$ – $0.91$ ).<sup>49</sup> The Chinese version of the PSS was developed by translation and back-translation of the original 14-item PSS and has shown adequate reliability and validity (Cronbach's  $\alpha=0.78$ ).<sup>49</sup>

##### *Anxiety*

Anxiety will be assessed using the State-Trait Anxiety Inventory (STAI). The STAI has 20 items for assessing trait anxiety (TAI) and 20 items for assessing state anxiety (SAI). All items are rated on a 4-point scale, with higher

total scores indicate greater anxiety. The STAI has good reliability (Cronbach's  $\alpha=0.86$ – $0.95$ ).<sup>50</sup> The Chinese version of the STAI (C-STAI) has 20 items for assessing trait anxiety and 20 items for assessing state anxiety and has shown good reliability and validity (test-retest reliability of the C-SAI is 0.88 and C-TAI is 0.90).<sup>51</sup>

##### *Depression*

Depression will be assessed using the Beck Depression Inventory (BDI). The BDI measures characteristic attitudes and symptoms of depression.<sup>52</sup> The BDI consists of 21 items. All items are rated on a 4-point scale, with higher total scores indicating more severe depression (31–40 indicates severe depressive symptoms and scores  $> 40$  indicate extreme depressive symptoms). The Beck Depression Inventory (BDI) demonstrates high internal consistency, with Cronbach's  $\alpha$  of 0.86 and 0.81 for psychiatric and non-psychiatric populations, respectively.<sup>53</sup> The Chinese version of the BDI is a 21-item, self-report inventory that has shown good reliability and validity (Cronbach's  $\alpha=0.89$ ).<sup>54</sup>

##### *Exploratory outcomes: NF- $\kappa$ B*

Serum level of NF- $\kappa$ B: peripheral blood will be collected using a blood collection tube containing sodium citrate as an anticoagulant. Within 2 hours, peripheral blood mononuclear cells (PBMCs) will be isolated. Nuclear extracts will be prepared from 10 000 to 40 000 PBMCs. The protein concentration of the nuclear extracts will be determined using the BCA (Bicinchoninic acid) assay. The concentration of activated NF- $\kappa$ B p65 in nuclear extracts will be determined using the Abcam NF- $\kappa$ B p65 ELISA Kit.

##### *Data collection and management*

Data will be collected at preintervention (1 week before the first session), postintervention (1 week after the last session) and at 3 months of follow-up. Each visit will comprise three assessments: (1) participants will complete self-administered questionnaires independently in a private conference room at the Third Xiangya Hospital, Central South University. Completion of the questionnaires will require approximately 45 min; during this time, outcomes assessors will be available to answer questions; (2) participants will complete a sleep diary at home under the guidance of outcome assessors; (3) participants will undergo PSG and NF- $\kappa$ B testing under the supervision of outcome assessors.

Outcome assessors will be trained to collect good quality data, promote participant retention and complete follow-up. Data analysts will be trained on data entry, coding, security and storage. Statisticians in the research team will provide training on data assessment and analysis.

Maintenance of participant confidentiality will involve: (1) asking participants just share personal and study-related information during the MBJS intervention/CBT-I sessions; (2) storing data in password-protected files on a designated computer with restricted access and (3)

ensuring only the research team have access to personal identifiable information and coding, all of which will be destroyed once the study is completed.

### Data monitoring

The data monitoring committee will include the PI, statisticians, outcome assessors and data analysts. The data monitoring committee will be independent from the sponsor and competing interests. Only the PI and data analysts will have the access to the final trial dataset.

Researchers will encourage participants to report any adverse event (described as unfavourable or unintended signs, symptoms or diseases occurring during the trial) that occur during the MBSJ intervention/CBT-I. Psychiatrists, other than the PI, in the research team will assess if the adverse event is related to the MBSJ intervention/CBT-I. If there is no association and participants' psychosomatic status is suitable for continuing the MBSJ intervention/CBT-I sessions, participants will be invited to stay in the study. If there is any association or participants' psychosomatic status is not suitable for continuing the MBSJ intervention/CBT-I sessions, the research team will recommend the participants to seek other therapy.

### Statistical analysis

SPSS V.22.0 will be used for data processing and analysis. All statistical tests will be two sided, with  $p < 0.05$  considered statistically significant. Between-group differences in numeric sociodemographic data and other measures at pretreatment will be assessed with the independent t-test and  $\chi^2$  test. Variables that are significantly different between groups will be treated as covariant(s) in analyses of treatment effects. Significant differences on multivariate analysis of variance (MANOVA) will be assessed with repeated-measures ANOVA to compare patient outcomes (PSQI, ISI, sleep diary, PSG, PSS, STAI, BDI and NF-kB).

## DISCUSSION

Insomnia is a prevalent sleep disorder, affecting a large proportion of the population.<sup>1</sup> Insomnia can lead to daytime functional impairment, causing occupational and social dysfunction and increase the risk of accidental injury (eg, traffic and work-related accidents).<sup>2</sup> Insomnia disorder is a common comorbidity of depressive disorder, bipolar disorder, anxiety disorder, diabetes mellitus, coronary heart disease, chronic obstructive pulmonary disease, arthritis, fibromyalgia and other chronic pain disorders.<sup>2</sup> Insomnia is a substantial economic burden to society.<sup>55</sup> The high prevalence of sleep disorders in the general population, the severe health-related consequences of insomnia and high costs have highlighted the need for effective interventions aimed at improving sleep.<sup>9</sup>

Previous studies show that mindfulness practices can improve sleep in individuals with insomnia.<sup>16–18–33</sup> In addition to some initial promising results, these reports emphasise evidence gaps and the need for further studies. Even though a high prevalence of insomnia has been

reported in the Chinese population,<sup>3</sup> the impact of mindfulness practices on insomnia in young and middle-aged individuals in China has not been explored in well-designed studies.

On the other hand, Garland *et al* suggested that MBIs have level II evidence, in so far as research is emerging on this relatively new treatment, and at this point in time CBT-I remains the gold standard of treatment.<sup>56</sup> Accordingly, it was well demonstrated that patients with chronic insomnia, combined treatment of medication with CBT led to enhanced benefits during acute therapy, however, long-term outcome was apparently optimised when discontinued medication was applied, in consideration of the period of maintenance CBT.<sup>57</sup> One study developed mindfulness-based therapy for insomnia (MBT-I), which shares the behavioural strategies of CBT-I and substitutes the cognitive components of CBT-I with mindfulness practices and discussion. MBT-I was found to be effective in insomnia treatment, however, this study did not compare MBT-I to standard CBT-I, it was not possible to determine the additive benefit of mindfulness training above the behavioural interventions provided in MBT-I.<sup>56</sup> More intriguingly, whether sequential combinations of MBIs besides for behavioural techniques have profound impact on the efficacy outcome is largely unknown, and hence further investigation is absolutely necessary.

This article describes the design and methodology of a parallel group RCT, which aims to test differences in sleep between individuals receiving the MBSJ intervention and CBT-I. The expected benefits of this research project are numerous, as it will provide a group-based, interactive and comprehensive mindfulness intervention to treat insomnia and promote healthy sleep in young and middle-aged individuals with insomnia in China.

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**Contributors** CP took primary responsibility in the design of the MBSJ Intervention and developing the initial draft of this manuscript. QT provided guidance in the design of the project and revised this manuscript. XW, YD and LD commented on this manuscript. PL contributed to the statistical methods. XM and YL contributed to the design of the MBSJ Intervention. G-PY commented on the design of the bioindicator assessment.

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