Effects of mindfulness meditation on anxiety, depression, stress, and mindfulness in nursing students: a meta-analysis and trial sequential analysis of randomized controlled trials

Yu-Feng Li*, Wen-Xin Sun*, Xiu-Jie Sunb,*, Juan Sun*, Dong-Mei Yang*, Bei-Li Jia*, Bin Yuan*

*Department of Health Care Five, Qingdao Municipal Hospital, Qingdao, Shandong 266072, China
bDepartment of Nursing, Qingdao Municipal Hospital, Qingdao, Shandong 266072, China

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Abstract: Objective: The aim of this study was to assess the effectiveness of mindfulness meditation (MM) on anxiety, depression, stress and mindfulness in nursing students. Methods: A comprehensive search and screening procedures were conducted to locate all MM interventions implemented with nursing students. For randomized controlled trials (RCTs) in accordance with the inclusion criteria, a search was conducted in PubMed, Embase, Web of Science, Medline, PsycINFO, Cumulative Index to Nursing and Allied Health (CINAHL), Cochrane Central Register of Controlled Trials (CENTRAL), China Biology Medicine (CBM), Chinese National Knowledge Infrastructure (CNKI) and Wanfang. Databases were retrieved from inception through August 2018. Additional studies were identified through hand searches and Internet searches. Two reviewers collected relevant data of eligible articles according to the data extraction tables. Based on Cochrane Handbook, critical appraisal of the methodological quality was assessed by two other reviewers. An Excel form was used to extract main characteristics of included RCTs. Meta-analysis and trial sequential analysis (TSA) were carried out using software RevMan 5.3 and TSA 0.9. Results: Five RCTs with 257 nursing students were included. Only two studies were assessed as high quality and three studies were evaluated as moderate quality. Meta-analysis showed that, comparing with the control group, MM could significantly improve anxiety (SMD = −0.45, 95% CI −0.73 to −0.17, P = 0.001) and stress (SMD = −0.69, 95% CI −0.97 to −0.40, P < 0.001). TSA results confirmed that the outcome of the merger is credible. It could also significantly improve depression level of nursing students after 8 weeks intervention duration (SMD = −0.70, 95% CI −1.14 to −0.26, P = 0.002). However, there was no beneficial effect on depression level of nursing students with 1 week intervention duration (SMD = 0.09, 95% CI −0.42 to 0.59, P = 0.74) and its effects on mindfulness level of nursing students also did not show statistical significance (SMD = 0.37, 95% CI −0.04 to 0.77, P = 0.07). No definitive conclusions were drawn from the TSA. Conclusions: The results of this meta-analysis indicated that MM could effectively reduce the level of anxiety and stress of nursing students. TSA confirmed that the results of meta-analysis are credible. For depression, it could also significantly improve depression of nursing students with 8 weeks intervention, but there was no significant effect on nursing students with 1 week intervention duration. There was also no beneficial effect on mindfulness level of nursing students. However, TSA indicated that the accumulated evidence is still inconclusive. We suggest that more well-designed clinical trials with large sample and higher quality would be required in future to draw a definitive conclusion.

Keywords: mindfulness • meditation • anxiety • depression • stress • nursing students • meta-analysis • trial sequential analysis

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* Corresponding author.
E-mail: xsun5818@qq.com (X.-J. Sun).

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1. Introduction

Anxiety and depression are very common negative emotional experiences, prevalent in contemporary college students. Long-term anxiety and depression can lead to physical and mental damage, a decline in academic performance, quality of life, interpersonal tension, and other issues in college students. Nursing students, an important part of college students, must not only abide burdensome theoretical learning but also experience clinical practice. The clinical environment may cause them to experience stress and anxiety, and the initial clinical practice may be the most stressful period in students’ education.\(^1\)\(^-\)\(^2\) Nursing students may endure both the professional stress in clinical practice and personal stress, which can include personal relationships, sense of values, prospects, and future and academic problems, experienced by them during their college life.\(^3\) Reasons for the increased negative emotions and stress associated with this aspect of an educational program include lack of knowledge and experience, feeling unprepared for practice, problems related to death and dying, fear of making a mistake, witnessing pain and suffering, being observed and assessed, problematic interpersonal relationships with clinical teachers and nursing staff, and unfamiliar with the hospital environment.\(^4\)\(^-\)\(^7\) Anxiety and depression are regarded to be general factors for evaluating mental health status. Appropriate stress helps to maintain physical and mental health; however, too much stress can lead to negative impact, such as dissatisfaction with one’s self and a sense of failure, severe anxiety, frustration, and even depression.\(^8\)\(^-\)\(^9\) It can be internalized and has a negative impact on the health of the nursing students themselves, the overall patient care, and professionalism in nursing; if the stress of nursing students is not appropriately relieved, it can then become obstacles to optimal learning and nursing performance.\(^10\)\(^,\)\(^11\)

A large-scale study in China (\(n = 5245\)) showed that 11.7% of university students were depressive and 4.0% could be diagnosed as sufferers from major depressive disorder.\(^12\) However, some studies showed that the incidence of depressive mood among nursing students is as high as 50%, and most of them are in mild to moderate depression.\(^13\)\(^-\)\(^15\) Anxiety and depression are often experienced simultaneously. Depression affects about 67% of college students with anxiety, and anxiety was a major predictor of depression for nursing students.\(^16\)\(^,\)\(^17\) A good mental state is to improve the individual cognitive function, improve the mental movement, and behavior of the important guarantee. Anxiety and depression are important psychological changes in an individual, and their clinical manifestations will also be affected and even result in clinical errors. Nursing students have anxiety and depression, and this emotional distress makes them difficult to have a good learning state and master the clinical skills.

Mindfulness is regarded not as something to get or to acquire, but as an internal resource that already exists, patiently awaiting to be reawakened.\(^18\) The study had found that increased mindfulness can improve psychological functions, reduce in suffering, and has been proved to be an important predictor of depression in nursing students.\(^17\)\(^,\)\(^19\) Mindfulness meditation (MM) is originated from Vipassana meditation in Buddhism, which is defined as a process of focusing one’s mind in the present moment, maintaining a nonjudgmental attitude, and detaching from destructive thoughts and feelings.\(^20\) In the Buddhist tradition, the concept of the self is impermanent and considered to be harmful by producing thoughts of selfishness, attachment, and pain.\(^21\)\(^,\)\(^22\) Therefore, MM is a means of sensory detachment and reducing bias in one’s perception of the world.\(^23\) In recent years, variants of MM have been incorporated into Western psychology and have shown evidence of improving mental health.\(^24\)

Nurse educators may be aware that their students experience anxiety, depression, and stress during their professional education; however, they may not be conscious of the extent of the distress and the influence it has on students’ lives and learning. Moreover, although an increasing body of studies on anxiety, depression, stress on nursing students exists, transforming this knowledge into practice remains an ongoing issue that warrants further attention. Therefore, how to take simple and efficient intervention method to decrease their psychological distress (stress, anxiety, depression, etc.), has become the current nursing education workers to solve the important issues.

MM is a group of meditation practice centered on mindfulness techniques. Through relaxation and concentration exercises, people may improve consciousness in focusing on a particular object, exercising emotions, relaxing the role of the body.\(^25\) MM mainly includes meditation, mindfulness of decompression therapy, and mindfulness of cognitive therapy.\(^26\) It has a sufficient theoretical basis, has been widely used by foreign scholars to ease the pressure, emotional management, and clinical adaptation of the disease, and has achieved good results.\(^27\)\(^,\)\(^28\) The study reported that mindfulness might be beneficial to nursing students to handle stress since it was negatively related to anxiety, depression, and stress.\(^17\)\(^,\)\(^29\) However, the studies that MM is applied to nursing students are few, and the effects of MM on them are less well known.

In recent years, researchers have tried to introduce orthodox meditation in nursing education, and it
is expected that the implementation of this measure will have a good impact on nursing students, however, there is no systematic review regarding the effects of MM on nursing students. Therefore, while the results of this study were collected at home and abroad in comparison of meditation with the conventional method on the psychological state of the random control experiment, meta-analysis method was used to evaluate the effect of intervention, so as to provide a reliable basis for meditation in the psychological intervention effect of nursing students. It also examined the sufficiency and conclusiveness of currently available evidence.

2. Methods

2.1. Search strategies

We searched seven English databases and three Chinese databases, including PubMed, Embase, Web of Science, Medline, PsycINFO, Cumulative Index to Nursing and Allied Health (CINAHL), Cochrane Central Register of Controlled Trials (CENTRAL), China Biology Medicine (CBM), Chinese National Knowledge Infrastructure (CNKI), and Wanfang. Databases were searched among literature collected from inception through August 2018 for randomized controlled trials (RCTs) in accordance with inclusion criteria. We developed a search strategy by PubMed on the basis of medical subject heading (MeSH) terms and text words of key articles which we identified a priori. We used a similar strategy in the other electronic sources. Search terms were “mindfulness”, “meditation”, “mindfulness-based meditation”, “mind–body therapies”, “mindfulness-based stress reduction”, “MBSR”, “Vipassana”, “Zen”, “pupil nurs*”, “nursing student*”. Studies were restricted to English and Chinese languages. Two reviewers searched articles independently according to search strategy.

2.2. Inclusion and exclusion criteria

Inclusion criteria were (1) the studies had to relate to MM directed only on nursing students; their nationality and race were not limited; (2) to assess anxiety, depression, stress, or mindfulness as outcome; (3) study design was RCT; (4) comparative control group; and (5) the studies were written in English or Chinese languages.

Exclusion criteria were (1) articles were not acquired; (2) articles without complete data; (3) articles about clinical nurses, medical students, or nursing teachers; and (4) duplicate literature.

2.3. Study selection

Two reviewers screened titles and abstracts of relevant studies independently using search criteria. After full texts of these potentially included studies were obtained, two reviewers evaluated and selected them independently according to inclusion criteria. Disagreements between reviewers were resolved through discussions. The third reviewer was consulted for a final decision if consensus was not reached.

2.4. Quality critical appraisal

The methodological quality of the included RCTs was evaluated independently by two reviewers according to Cochrane Handbook for Systematic Reviews of Interventions. The methodological quality of the included study in terms of a random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, selective outcome reporting, and other bias exists. Each component was categorized as having a high, low, or unclear risk of bias. Disagreement was resolved by consultation with a third researcher.

2.5. Data extraction

Data were extracted using a standard data extraction form. Information such as study characteristics (e.g., first author and publication year), subjects characteristics (e.g., age and number of sample), study design, countries, method of intervention and control group, intervention duration, and outcome measures were obtained. Data were extracted by one reviewer and double-checked for accuracy by a second reviewer.

2.6. Statistical analysis

Meta-analysis was performed by RevMan 5.3 software (available from the website for free: http://ims.cochrane.org/revman). Standardized mean difference (SMD) was calculated for continuous outcomes with different measurements. We calculated SMD with 95% confidence intervals (CIs) for continuous outcomes. The heterogeneity was determined by chi-squared test and $\chi^2$ value ($\chi^2 > 50\%$ indicating high heterogeneity). A random effect model was used to estimate the overall effect when $\chi^2$ value ≥50%; otherwise, a fixed effect model was applied. Subgroup analyses used the random effect model. $P < 0.05$ was defined as significance level and $P$ values were two-sided. Sensitivity analysis was conducted by eliminating every single trial to confirm the stability and reliability of the meta-analysis result.
Due to the limited number of included studies, funnel plots were not conducted to assess publication bias.

Meta-analysis might result in type I errors due to an increased risk of random error when smaller numbers of RCTs and participants are involved. Thus, we undertook trial sequential analysis (TSA) to avoid random errors and examine the reliability and conclusiveness of the currently available evidence. If cumulative Z-curve was obtained across the monitoring boundaries, a sufficient level of evidence for the intervention effect may have been reached and no further studies were needed. To perform TSA, both types I and II errors were needed. In this review, the required information size (RIS) was estimated using $\alpha$ (type I error) of 5% two-sided and a $\beta$ of 20% (power = 80%). The TSA was performed using software TSA 0.9 (available from the website for free: http://www.ctu.dk/tsa).

3. Results

3.1. Search outcomes

A total of 720 articles, including 544 English and 176 Chinese articles and another 2 from citation reference lists, were obtained from all the databases in preliminary search. After removal of duplicates, 502 titles and abstracts were examined for inclusion, and 27 full-text papers were identified and retrieved for detailed evaluation. After screening, 22 papers were excluded because they did not meet the inclusion criteria and 5 RCTs were included in the meta-analysis. The process of literature screening is shown in a flow diagram (Figure 1).

![Flow diagram of inclusion and exclusion criteria.](http://www.ctu.dk/tsa)
3.2. Characteristics of included RCTs

The characteristics of the included RCTs are summarized in Table 1. Total of 5 RCTs involving 257 subjects were included and all reports were written in English language. The age of the participants was not recorded in one study. One study was conducted in the USA, two in Korea, one in Thai, and one in China. The sample of trials ranged from 41 to 60. The mode of intervention was face to face with the participants in three studies, a combination of voice-recorded files and face to face in one study, and online instruction in one study. The duration of intervention was 1 week with 7 sessions in one study, 4 weeks in two studies, and 8 weeks with 8 sessions in two studies. A total of four studies assessed anxiety. Anxiety was measured using the Self-Rating Anxiety Scale (SAS) in one study, the State Trait Anxiety Inventory (STAI) in two studies, the Depression, Anxiety and Stress Scale-Anxiety (DASS-A) in one study. Three studies assessed depression, one study used the Beck Depression Inventory, one used the Self-Rating Depression Scale (SDS), and the remaining one study used a Depression, Anxiety and Stress Scale-Depression (DASS-D). Four studies assessed stress, two studies used the Perceived Stress Scale (PSS), one used the Psychosocial Wellbeing Index-Short Form Questionnaire (PWI-SF), and one study used a Depression, Anxiety and Stress Scale-Stress (DASS-S). Two studies measured mindfulness by the Mindfulness Attention Awareness Scale (MAAS) and the Five-Facet Mindfulness Questionnaire (FFMQ), respectively, and two studies used PSS. All studies were published between 2009 and 2017.

3.3. Quality critical appraisal

Risk of bias assessment is presented in Figure 2. Of all included RCTs, two studies were grouped by computer-generated random number table and each participant drew a number, respectively, while remaining three failed to report details. Two trials reported low risk on allocation concealment. None of the included RCTs described blinding of the participants and personnel. The outcomes assessor was reported to be blinded.

### Table 1. Main characteristics of included RCTs

| Study                  | Design | Country | Subjects            | Sample (n) | age (year) (Mean ± SD) | Investigation | Study duration | Outcomes assessment |
|------------------------|--------|---------|---------------------|------------|------------------------|---------------|-----------------|---------------------|
| Burger et al.          | RCT    | USA     | Nursing students    | 28         | 24                     | MM            | 4 weeks, meditate 10 min/day and keeping a practice | PSS, FFMQ |
| Chen et al.            | RCT    | China   | Nursing students    | 30         | 30                     | MM            | 1 week, 7 sessions, each session lasted 30 min/day | SAS, SDS |
| Kang et al.            | RCT    | Korea   | Nursing students    | 21         | 20                     | SCBMM         | 8 weeks, 8 sessions, each session lasted 1.5-2 h/week | STAI, BDI, PWI-SF |
| Ratanasiripong et al.  | RCT    | Thai    | Nursing students    | 29         | 31                     | MM            | 4 weeks, 2 sessions, practicing 3 times/day | STAI, PSS |
| Song et al.            | RCT    | Korea   | Nursing students    | 21         | 23                     | MBSR          | 8 weeks, 8 sessions, each session lasted 2 h/week | DASS-A, DASS-D, DASS-S, MAAS |

Note: RCT, randomized controlled trial; E, experimental group; C, control group; MM, mindfulness meditation; SCBMM, Stress coping program-based mindfulness meditation; MBSR, mindfulness-based stress reduction; NI, no intervention; WL, Waiting list; SAS, Self-Rating Anxiety Scale; STAI, State Trait Anxiety Inventory; DASS-A, Depression, Anxiety and Stress Scale-Anxiety; SDS, Self-Rating Depression Scale; BDI, Beck Depression Inventory; DASS-D, Depression, Anxiety and Stress Scale-Depression; PSS, Perceived Stress Scale; PWI-SF, Psychological Wellbeing Index-Short Form Questionnaire; DASS-S, Depression, Anxiety and Stress Scale-Stress; FFMQ, Five-Facet Mindfulness Questionnaire; MAAS, Mindfulness Attention Awareness Scale.
3.4. Outcome pooled analysis

3.4.1. Anxiety

Four studies involving 205 participants evaluated the effects of MM on nursing students’ anxiety level.\textsuperscript{32-35} A fixed effect model was applied ($P = 0.99$, $I^2 = 0$).
The results demonstrated that, compared with control group, MM had a significant effect in improving anxiety level for nursing students (SMD = −0.45, 95% CI −0.73 to −0.17, \( P = 0.001 \)) (Figure 3A). We performed a TSA at the level of \( \alpha = 0.05 \) (two-sided), \( \beta = 0.20 \) (power 80%), and then the pooled result indicated a reliable finding that RIS = 151 was reached with Z-curve across conventional statistically significance test boundary and TSA-adjusted boundary (Figure 4A). Thus, the possibility of a false positive result due to small sample size is very small and a larger sample size is unlikely to alter the conclusions of our analysis significantly. So MM can improve anxiety of nursing students and it is worth using.

### 3.4.2 Depression

Three studies including 145 participants reported the effects of MM on nursing students’ depression level.\(^{32,33,35}\) A random effect model was applied (\( P = 0.07, I^2 = 62\% \)). A combined analysis results showed that, compared with control group, MM had no statistically significant effect in improving depression level for nursing students (SMD = −0.41, 95% CI −0.95 to 0.13, \( P = 0.14 \)) (Figure 3B). In subgroup analysis, according to intervention duration, one study of 1 week intervention duration showed no significant effect on depression level (SMD = 0.09, 95% CI −0.42 to 0.59, \( P = 0.74 \)). However, two studies of 8 weeks intervention duration showed a significant effect on depression level (SMD = −0.70, 95% CI −1.14 to −0.26, \( P = 0.002 \)). We did not perform TSA for depression level on nursing students due to no significant effect and substantial heterogeneity identified during meta-analysis.

### 3.4.3 Stress

Four studies involving 197 participants evaluated the effects of MM on nursing students’ stress level.\(^{31–34}\) A fixed effect model was applied (\( P = 0.69, I^2 = 0 \)). The results revealed that, compared with control group, MM had a large significant effect in reducing stress level.

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**Figure 3.** Effect of mindfulness meditation on anxiety, depression, stress and mindfulness. A. Anxiety B. Depression C. Stress D. Mindfulness
for nursing students (SMD = -0.69, 95% CI -0.97 to -0.40, $P < 0.00001$) (Figure 3C). TSA was performed, and RIS of 146 was computed on the basis of $\alpha = 0.05$ (two-sided), $\beta = 0.20$ (power 80%). The pooled result revealed reliability due to Z-curve across conventional statistically significant boundary, TSA-adjusted boundary and the cumulative number of participants reached RIS of 146 (Figure 4B). So MM has efficiency for stress on nursing students and it is worth using.

### 3.4.4. Mindfulness

Two studies involving 96 participants evaluated the effects of MM on nursing students’ mindfulness.\(^{31,33}\) A fixed effect model was applied ($P = 0.28$, $I^2 = 15\%)$. The results showed that, compared with control group, MM had no significant effect in increasing mindfulness level for nursing students (SMD = 0.37, 95% CI -0.04 to 0.77, $P = 0.07$) (Figure 3D). For this outcome, TSA revealed that the optimal sample size is 654 participants, which is larger than the current sample. Furthermore, the Z-curve did not cross conventional statistically significance test boundary, demonstrating that the cumulative evidence was too insufficient to draw firm conclusions and more studies were required to confirm this result (Figure 4C).

### 3.5. Sensitivity analysis

To evaluate the effect of an individual study on the results for the meta-analysis of anxiety, depression, stress, and mindfulness, sensitivity analysis was performed. Results of the effect on depression and mindfulness were changed when studies were eliminated. Excluding the study results by Chen and Song,\(^{33,35}\) respectively, results of the effect on the level of depression and mindfulness were changed, which means the conclusion is unreliable. More studies with a larger sample size will be needed for the results to be verified.

### 4. Discussion

#### 4.1. Main findings

An increasing body of evidence has demonstrated that MM can also significantly improve physical and mental symptoms for different groups of people, such as breast cancer survivors, elementary school teachers, chronic insomnia patients, and so on.\(^{36–38}\) The study showed that the psychological pain of the students was reduced and their quality of life was improved after attending MM training.\(^{39}\) Also, meditation training has a positive effect on the awareness and cognition of healthy people (perception, attention, memory, etc.) which can improve attention and cognitive flexibility.\(^{40}\)

This meta-analysis provided evidence supporting the effects of MM in nursing students. To achieve high quality rather than quantity, our meta-analysis included only five RCTs, all of which were published in recent 10 years. This reflects the growing interest for MM in the nursing education. We carried out TSA to determine the RIS and to evaluate whether the current evidence is sufficient. The study found that TSA could protect against spurious conclusions from meta-analysis, especially
from those that reported positive results based on only few studies and few events.\textsuperscript{41} Another study showed that TSA could prevent 93% of false-positive results.\textsuperscript{42}

The meta-analysis systematically reviewed currently available literature, including 5 RCTs with 257 participants to evaluate the effect of MM on anxiety, depression, stress, and mindfulness in nursing students. The pooled results of the involved RCTs revealed that MM significantly reduced the level of anxiety and stress and the results manifested reliability with current evidences according to TSA. We observed significant improvements in the control of anxiety, stress, and mindfulness which support implementing MM programs for nursing students.

In addition, the results of our subgroup analyses of the depression suggested that intervention duration of 8 weeks had positive effects but short intervention duration (1 week) had no significant effects. These results can be explained for several reasons. First, depression is due to long-term accumulation of psychological problems which needs to be improved by a step-by-step process. Only after a certain intervention time, its positive effect may be revealed.\textsuperscript{35} Second, included the number of studies is insufficient, there may be a publication bias.

However, there was no significant effect on increasing mindfulness level and we could not make definitive conclusions with current evidences according to TSA. Therefore, researchers should conduct a large number of high-quality RCTs in the future to explore the impact of meditation on the level of depression and mindfulness in nursing students in order to give full play to the positive role of evidence-based nursing theory.

### 4.2. Strengths and limitations

Some strengths of our study must be pointed out. First, we performed a comprehensive database search and identified all relevant RCTs as many as possible. Second, we conducted a rigorous quality assessment and most of the trials included are of moderate quality. Furthermore, although there are some methodological differences between the studies, most of the statistical heterogeneity was low or absent in the analyses. Finally, we also performed detailed analyses of the data and through TSA we could confirm a significant effect that MM can improve anxiety and stress for nursing students.

Some limitations of this meta-analysis must be acknowledged. First, the overall sample size was not large enough, so the result may be resulted in a certain bias. Second, included outcomes were measured using different self-reported scales, so selection bias may be caused. Further studies in this field should use the same assessment instruments, so that other researchers can conduct systematic reviews enrolled a larger sample size. Third, articles published only in English or Chinese languages were selected due to language constrains. This may cause a potential risk of publication bias.

### 4.3. Implications for practice and future research

The MM program, a non-pharmacological approach to ease bad mood, emphasized on self-care, compassion, and healing, makes it an effective intervention for stress management.\textsuperscript{43} Mindfulness is the same as the present consciousness, and seems to be positive psychology or spirit. This concept is similar to resilience, which is the ability to transform from a negative experience to a positive way in physiology and psychology.\textsuperscript{44} Since nursing students may experience high levels of stress in their educational environment which lead them to a state of anxiety or depression, it is critical for nurse educators that students’ health is regard as a priority. Educators can help students by integrating MM intervention programs into the educational curriculum which target management of anxiety, depression, and stress. Higher mindfulness scores of meditations may also have implications for safe nursing practice, as the mindfulness trait carries with it a heightened monitoring ability and meta cognitive skill.\textsuperscript{45} MM can provide nursing students with a simple, effective way to cope with anxiety, depression, and stress, increase mindfulness level, reduce bad emotion elicited physical arousal, and achieve mental well-being and professional growth in their future careers. So MM program is worthy of application among nursing students.

### 5. Conclusions

Taken together, our comprehensive meta-analysis suggested that MM program had valuable effects on anxiety and stress of nursing students. For depression, it could also significantly improve depression of nursing students with 8 weeks intervention, but there is no significant effect with 1 week intervention duration of nursing students. However, there was also no beneficial effect on increasing mindfulness of nursing students. We suggest that future more researches with large sample size and higher quality need to be done to further examine for MM practice can be maximized to generate positive effects and to improve psychological status.

### Ethics approval

Ethical issues are not involved in this paper.

### Conflicts of interest

All contributing authors declare no conflicts of interest.
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