

# The effects of mindfulness-based interventions on nursing students: A meta-analysis

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## ABSTRACT

**Background:** Recently, mindfulness interventions have been extensively applied in the field of nursing education. However, no consensus has been reached on whether these interventions can reduce anxiety and depression in nursing students.

**Objective:** This meta-analysis was designed to determine the effect of mindfulness interventions on levels of depression, anxiety, stress and mindfulness for nursing students.

**Design:** Meta-analysis of randomized controlled trials.

**Methods:** The following Chinese and English databases were searched for relevant articles: Pubmed, Embase, Cochrane library, Web of Science, CNKI (China National Knowledge Infrastructure) and Wanfang. The search encompassed the establishment of these databases up until January 2020. Two reviewers separately entered the data into Review Manager Software 5.3.

**Results:** A total of 10 randomized controlled trials (RCTs) were reviewed. It was found that mindfulness interventions significantly lowered levels of depression (SMD = -0.42, 95% CI: -0.56 to -0.28,  $P < 0.001$ ), anxiety (SMD = -0.32, 95% CI: -0.47 to -0.17,  $P < 0.001$ ) and stress (SMD = -0.50, 95% CI: -0.65 to -0.35,  $P < 0.001$ ) in nursing students. Furthermore, the interventions raised levels of mindfulness in this group (SMD = 0.54, 95% CI: 0.33-0.75,  $P < 0.001$ ).

**Conclusions:** Mindfulness interventions can significantly reduce nursing students' negative emotions, helping them to manage their stress and anxiety. College nursing educators should consider adopting mindfulness interventions in nursing education to promote the mental health of students.

## 1. Introduction

Authors of a systematic assessment and meta-analysis which included 8918 nursing students from 15 countries worldwide (Tung et al., 2018) found a 34% incidence of depression in the global nursing population, and further, depression was generally accompanied by other diagnoses such as anxiety (Chernomas and Shapiro, 2013; Song et al., 2014). These diagnoses adversely affected the academic performance, mental health, physical status and professional values of nursing students (Song et al., 2014).

In the face of a heavy workload, nursing students are vulnerable to anxiety and depression. Such an unhealthy psychological state will have a serious impact on their academic performance. The resulting problems include students' loss of love for nursing, burnout or a high attrition rate, which lead to instability of nursing teams (Guillaumie et al., 2017).

Therefore, nursing educators and nursing researchers have focused on reducing the anxiety, depression and stress of nursing students. Accordingly, there was a clear need for an in-depth systematic review focusing on effective intervention approaches for nursing students experiencing negative psychological outcomes such as depression and anxiety. Several authors have recently reported that mindfulness interventions could mitigate stress, anxiety and depression, as well as having good effects on mental illness and chronic diseases (Zhou et al., 2020; Van der Riet et al., 2018; Pathrose et al., 2020; Lengacher et al., 2016).

Mindfulness refers to an internal perception which aims to help individuals to concentrate on the present and their surroundings without being distracted by past or future events (Guillaumie et al., 2017). The concept originated from Buddhism and is inspired by zazen, meditation and other concepts (Ott, 2004). In the 1970s, American psychologist

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Kabat-Zinn developed mindful stress reduction therapy, inspired by Buddhist thoughts (Kabat-Zinn, 1982). He defined mindfulness as paying purposeful and conscious attention to the present without judging current concepts (Kabat-Zinn, 1982). Mindfulness interventions can increase attention to the current experience through a series of simple exercises, allowing participants to consciously open their minds and so achieve inner peace or harmony (Chen et al., 2012). These interventions consist of mindfulness meditation (MM), mindfulness yoga and mindfulness cognitive training. Mindfulness focused interventions help individuals respond to disease or adverse stimuli positively, and to enhance their coping ability. At present, the most developed and common mindfulness interventions include mindful stress reduction therapy (MBSR) (Keng et al., 2020), mindful cognitive therapy (MBCT) (Compen et al., 2018), acceptance and commitment therapy (ACT) (McCracken and Vowles, 2014), and dialectical behavior therapy (DBT) (Wang and Jiang, 2016). Mindfulness interventions have been used to reduce the anxiety, depression and stress levels of nursing students, as well as to improve their mindfulness (Yüksel and Bahadır, 2020; Wang and Chen, 2015).

Given the convenience, easy implementation and potential positive effects of mindfulness interventions, it is unsurprising that nursing educators from many countries have conducted numerous empirical studies on their effectiveness (Yüksel and Bahadır, 2020; Marthiensen et al., 2019; Zeng et al., 2017; Song et al., 2018). However, results have been not uniform. Some scholars found that adopting mindfulness interventions can significantly elevate levels of mindfulness and reduce the stress, anxiety and depression of nursing students (Fleming, 2019; Zeng et al., 2017; Song and Lindquist, 2015), whereas other scholars have reached no statistically significant results (Mathad et al., 2017; Chen et al., 2013; Kang et al., 2009). Therefore, it is evident that the analysis of the effectiveness of mindfulness interventions for reducing psychological distress and increasing mindfulness in nursing students remains inconsistent at the present time. Thus, the authors aimed to identify high-quality randomized controlled trials and conduct a meta-analysis to assess the effect of mindfulness interventions on college nursing education, as well as to comprehensively and concretely explore the impact of mindfulness interventions on the anxiety, depression, stress and mindfulness levels of nursing students. Based on reliable evidence and rigorous results, the authors attempted to provide a reliable empirical basis for the development of interventions for improving the psychological state of nursing students and to lay an effective theoretical foundation for the application of mindfulness interventions by nursing educators and researchers from different cultural backgrounds.

## 2. Methods

The studies included in this meta-analysis are all published articles, meaning no ethical issues were involved.

### 2.1. Inclusion criteria

The inclusion criteria for this meta-analysis were as follows: (1) P: All nursing students were included, regardless of grades or degrees. Nursing students in school and practice were both included; (2) I: Studies needed to be about interventions based on mindfulness, including mindfulness meditation, mindfulness yoga and mindfulness cognitive training, MBSR, MBCT, ACT, DBT, and so on. Intervention duration was unlimited; (3) O: Nursing students' depression, anxiety, stress or mindfulness levels were outcome indicators (that is, no specific measurement tool for the identified outcomes needed to be specified); (4) Studies needed to be randomized controlled trials; (5) Studies needed to be published in Chinese or English.

### 2.2. Exclusion criteria

Studies were excluded if: (1) Participants were non-nursing students;

(2) They were duplicated; (3) The full text was unavailable; (4) The study data was incomplete or unsuitable for meta-analysis; (5) Other types of intervention were used apart from mindfulness interventions.

### 2.3. Search strategy

The present meta-analysis was conducted according to the guidelines in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA; Moher et al., 2009). To achieve a more comprehensive search, the authors searched all published articles from the following Chinese and English databases: Pubmed, Embase, Cochrane library, Web of Science, CNKI (China National Knowledge Infrastructure) and Wanfang, from the establishment of the databases until January 2020. The retrieval strategy was determined based on Mesh terms in Pubmed and Embase and was combined with keywords in important articles in both Chinese and English. English search terms included: ("Mindfulness" [Mesh] or "Meditation" [Mesh] or "mindfulness" or "meditation" or "mindfulness-based intervention" or "MBSR" or "mindfulness-based stress reduction" or "mindfulness-based cognitive therapy" or "Vipassana") and ("nursing students" or "student nurses") and ("randomized controlled trial" or "randomized" or "randomly" or "trial" or "groups"). Chinese search terms were: (正念疗法 或 正念减压 或 正念认知 或 正念干预) and (护生 或 护理学生) and (随机对照 或 随机分组 或 随机).

Following the literature retrieval, two researchers independently scanned and analyzed the titles and abstracts of the articles and excluded those irrelevant to this meta-analysis. Full texts of the remaining articles were carefully read by the two independent researchers until all included articles were determined. Additionally, to ensure the comprehensiveness of the search, the authors further searched the available references for relevant reviews, meta-analyses or systematic reviews.

All retrieved records were imported into EndNote X9 software for classification. After scanning the titles and abstracts and reading the full texts of the remaining studies, the studies that met the inclusion criteria of this meta-analysis were selected. This process was carried out by two researchers independently. In the case of disagreement, a decision was made in consultation with a third researcher.

### 2.4. Data extraction and statistical analysis

Data extraction was conducted by two researchers independently, in accordance with a pre-designed Excel table. The following information was extracted: author, year, country, research design, sample size (experimental group/control group), participants, intervention, intervention period/week, outcomes and measurement scale. Any differences were addressed through consultation with a third researcher.

The statistical analyses were conducted under the guidance of one of the authors (Cui XS), a professor of statistics. Additionally, all authors were knowledgeable about the statistical analysis conducted. Data was entered into evaluation management software RevMan 5.3. Statistical heterogeneity of the included literature was analyzed by calculating  $I^2$  statistics and with a chi-square test (Higgins et al., 2003) before results were integrated. If  $I^2 < 50\%$ ,  $P > 0.10$ , this indicated low heterogeneity between included studies, then the fixed effect model was used. If  $I^2 > 50\%$ ,  $P < 0.10$ , this indicated high heterogeneity among included studies, then the random effects model was adopted to summarize the results. When using the fixed-effect models, it was assumed that the population effect sizes are the same for all studies (Cheung et al., 2012). In contrast, the use of the random-effects model was an attempt to generalize findings beyond the included studies by assuming that selected studies are random samples from a larger population (Lim et al., 2018). The continuous data were generated by standardized mean difference (SMD) as well as 95% confidence intervals (CI). A bilateral  $P < 0.05$  was considered statistically significant in the overall effect.

### 3. Results

#### 3.1. Literature search results

A total of 743 English and Chinese studies were preliminarily retrieved, 42 of which were duplicates. After reading the titles, 566 studies (case analysis = 3, meta-analysis = 12, irrelevant theme = 541) were excluded. After reading the abstracts, 122 studies (non-RCT = 14, non-trial = 46, review = 62) were excluded. Following a reading of the full text, 13 studies (incomplete data = 8, full-text unavailable = 5) were excluded. Therefore, 10 RCTs were involved in this meta-analysis. The literature screening process is illustrated in Fig. 1.

#### 3.2. General study features

Ten RCTs published between 2009 and 2018 were included. One study was from Jordan, two from the United States, two from China, one from Sweden, two from Korea, one from India and one from Thailand. One study was published in Chinese (Qiu et al., 2017), and the remaining nine studies were published in English. The sample sizes ranged from 32 to 488, and 1204 nursing students were recruited in all included studies, of which 604 participated in experimental groups, and

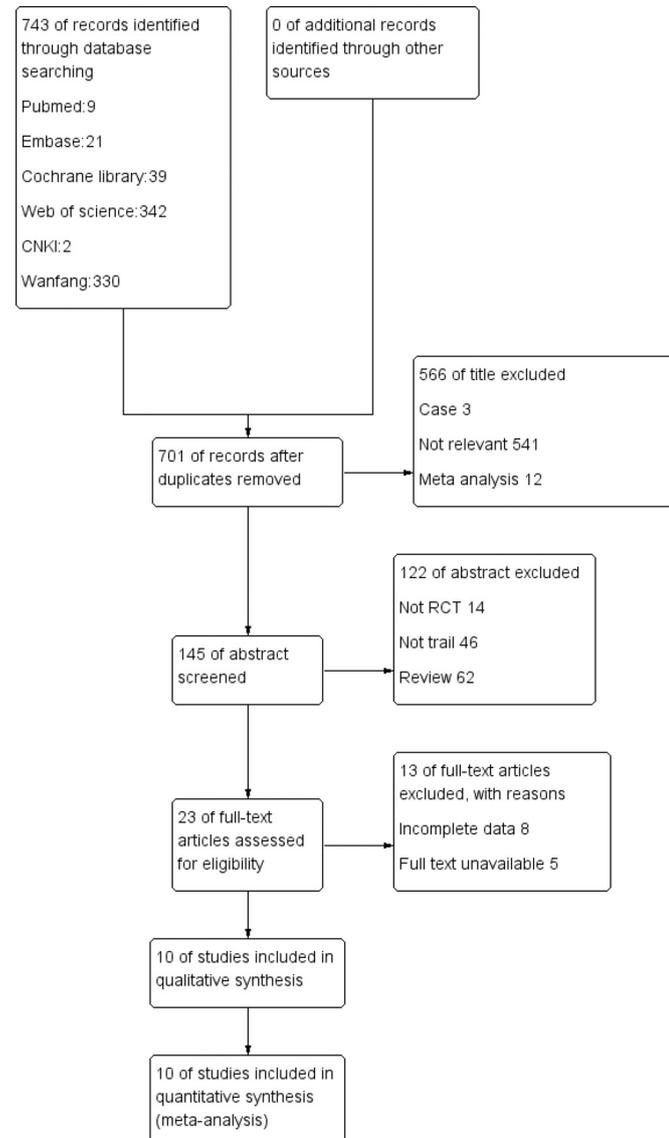


Fig. 1. Flow diagram of study selection.

600 in control groups. The research subjects were all nursing students, including undergraduate and master's students as well as nursing students in practice. All interventions were mindfulness-based, ranging from 1 to 20 weeks, with a duration of 1 to 5 h of intervention time per week. Outcome measured included depression, anxiety, stress and mindfulness levels. Table 1 lists the features of the included studies.

#### 3.3. Risk of bias in the included literature

The quality assessment of the included literature was conducted by two researchers, based on the Cochrane Handbook (5.1.0) quality assessment criteria. 'Low-risk bias', 'Unclear' and 'High-risk bias' were used to indicate the degree of bias risk. In case of uncertainty, when an author was uncertain about the ranking, a third researcher was consulted.

All included studies randomized study participants, but the specific randomization approach was only articulated in three of the studies (Alsaraireh and Aloush, 2017) used computer software for random grouping; Chen et al. (2013) completed the randomization process by means of random number table; and Kang et al. (2009) randomized groups using odd and even numbers known only to the participants themselves). Plummer et al. (2018) conducted a randomized blinded study, while in Frögéli et al. (2016)'s study, all surveys except for baseline measurements were sent to participants via email. The authors of seven articles described a loss of follow-up during the study (Alsaraireh and Aloush, 2017; Burger and Lockhart, 2017; Frögéli et al., 2016; Mathad et al., 2017; Kang et al., 2009; Plummer et al., 2018; Song and Lindquist, 2015). It is worth mentioning that in Frögéli et al. (2016)'s study, two sets of data were analyzed, that is, the total number of people who started the program as well as the number of people who completed. In nine of the studies, authors identified not statistical significant difference in baseline levels between the intervention and control groups. Additionally, in Frögéli et al. (2016)'s baseline measurements, a statistically significant difference was found in work-in-health care between the two groups, which will have an impact on the reliability of their research results. Specific information can be seen in Table 2, and the results of risk bias assessment are presented with a 'risk of bias summary' in Fig. 2.

#### 3.4. Meta-analysis results

##### 3.4.1. Depression scores

The authors of five existing studies (Alsaraireh and Aloush, 2017; Chen et al., 2013; Kang et al., 2009; Qiu et al., 2017; Song and Lindquist, 2015), recruited 805 nursing students (402 in the intervention group, 403 in the control group), and reported students' depression scores. In two of the studies (Chen et al., 2013; Kang et al., 2009), no statistically significant difference in depression scores between the intervention group and the control group ( $P > 0.05$ ) was identified, although the results from the other three studies (Alsaraireh and Aloush, 2017; Qiu et al., 2017; Song and Lindquist, 2015) differed significantly ( $P < 0.05$ ). Mindfulness interventions were found to significantly lower the depression scores of nursing students compared to the control group. Moreover, a low level of heterogeneity was found between the five studies ( $I^2 = 28\%$ ,  $P < 0.001$ ). Thus, the fixed effects model was applied, the results of which are shown in Fig. 3 (SMD =  $-0.42$ , 95% CI:  $-0.56$  to  $-0.28$ ,  $P < 0.001$ ). As suggested from the combined results of the random effects model (SMD =  $-0.42$ , 95% CI:  $-0.62$  to  $-0.22$ ,  $P < 0.001$ ), model changes had no significant effect on the results, suggesting that the results of this meta-analysis are robust.

##### 3.4.2. Anxiety scores

Authors of five studies (Chen et al., 2013; Kang et al., 2009; Qiu et al., 2017; Ratanasiripong et al., 2015; Song and Lindquist, 2015), including 684 nursing students (340 in the intervention group, 344 in the control group), reported anxiety scores. Scores between the

**Table 1**  
Characteristics of studies included in the meta-analysis.

Author (year)	Country	Design	Sample size	Participants	Intervention	Intervention period/week	Outcomes(scale)
			E/C		E/C		
Alsaraireh (2017)	Jordan	RCT	91/90	Undergraduate nursing students	MM/PE	10(3 h per week)	(CESD-R)
Burger (2017)	USA	RCT	28/24	Prelicensure nursing students	MM/WL	4(70 m per week)	③(PSS-10) ④(FFMQ)
Chen et al. (2013)	China	RCT	30/30	Undergraduate nursing students	MM/WL	1(3.5 h per week)	②(SAS) (SDS)
Frögéli-a (2016)	Sweden	RCT	69/44	Nursing students	ACT/WL	6(2 h per week)	④(MAAS) ③(PSS)
Frögéli-b (2016)	Sweden	RCT	29/44	Nursing students	ACT/WL	6(2 h per week)	④(MAAS) ③(PSS)
Frögéli-c (2016)	Sweden	RCT	69/44	Nursing students	ACT/WL	6(2 h per week)	④(MAAS) ③(PSS)
Frögéli-d (2016)	Sweden	RCT	29/44	Nursing students	ACT/WL	6(2 h per week)	④(MAAS) ③(PSS)
Kang (2009)	Korea	RCT	16/16	Nursing interns	MM/WL	8(1.5-2 h per week)	③(PWI-SF) ②(STAI) (BDI)
Mathad (2017)	India	RCT	40/40	Nursing students	Yoga/WL	8(5 h per week)	③(PSS) ④(FMI)
Paul et al. (2015)	Thailand	RCT	29/31	Nursing students	MM/WL	4(21 times per week)	③(PSS) ②(SAS)
Plummer (2018)	USA	RCT	36/58	Masters of nursing students	MBI/WL	20(1.5 h per week)	③(PSS) ④(CSMS-R)
Song (2015)	Korea	RCT	21/23	Undergraduate nursing students	MBSR/WL	8(2 h per week)	③(DASS-S) ②(DASS-A) (DASS-D)
Qiu (2017)	China	RCT	244/244	Nurse trainees with left-behind experience	MT/WL	5(2 h per week)	④(MAAS) ②(SCL-90) ④(FFMQ)

E: experimental group; C: control group; MM = mindfulness meditation; PE = physical exercise; WL = wait-list; ACT = acceptance and commitment training; MBI = mindfulness-based intervention; MBSR = mindfulness-based stress reduction; MT = mindfulness training.  
: depression; ②: anxiety; ③: stress; ④: mindfulness.

**Table 2**  
Literature quality assessment.

Author (year)	Random sequence generation	Allocation concealment	Blind method		Outcome data	Selective reporting	Other bias	Literature quality
			Participants and personnel	Outcome assessment				
Alsaraireh-2017	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	A
Burger-2017	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Chen-2013	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Frögéli-a-2016	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	High-risk bias	Low-risk bias	B
Frögéli-b-2016	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Frögéli-c-2016	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	High-risk bias	Low-risk bias	B
Frögéli-d-2016	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Kang-2009	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	B
Mathad-2017	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Paul-2015	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Plummer-2018	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	Low-risk bias	A
Song-2015	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B
Qiu-2017	Low-risk bias	Low-risk bias	Unclear	Unclear	Low-risk bias	Low-risk bias	Low-risk bias	B

mindfulness intervention group and the control group differed significantly ( $P < 0.05$ ), with the mindfulness intervention significantly reducing nursing students' anxiety levels. These five studies exhibited low heterogeneity ( $I^2 = 0\%$ ,  $P < 0.001$ ), meaning the fixed effects model

was applied to merge the results. As suggested from the combined results (SMD =  $-0.32$ , 95% CI:  $-0.47$  to  $-0.17$ ,  $P < 0.001$ ; see Fig. 4), the results remained unchanged after the random effects model was adopted to merge the results (SMD =  $-0.32$ , 95% CI:  $-0.47$  to  $-0.17$ ,  $P < 0.001$ ),

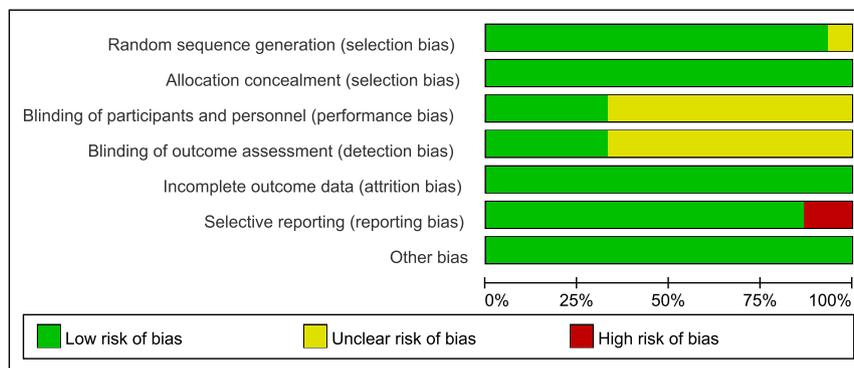


Fig. 2. Risk of bias summary.

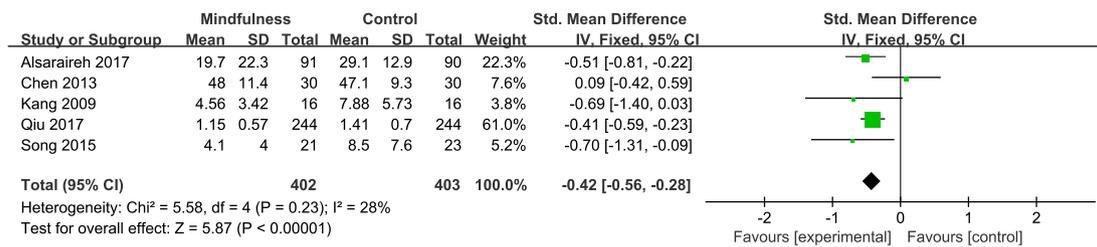


Fig. 3. Forest plot of the depression scores.

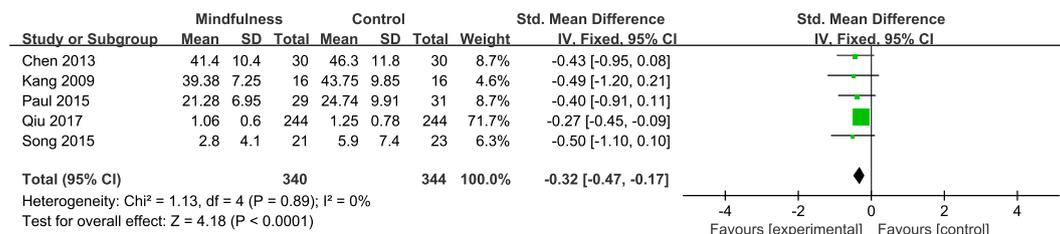


Fig. 4. Forest plot of the anxiety scores.

implying that the results of this meta-analysis are robust.

### 3.4.3. Stress scores

The authors of seven existing studies (Burger and Lockhart, 2017; Frögéli et al., 2016; Kang et al., 2009; Mathad et al., 2017; Plummer et al., 2018; Ratanasiripong et al., 2015; Song and Lindquist, 2015), which included 734 nursing students (366 in the intervention group, 368 in the control group), reported students' stress scores. In Frögéli et al.'s study, two sets of data were analyzed; that is, the total number of people who began studying and the total number who finished their

studies. Additionally, stress was measured at two time points: immediately after the intervention and three months later. Thus, four groups of data were included in the meta-analysis for comparison. Five group results (Frögéli-c et al., 2016; Frögéli-d et al., 2016; Mathad et al., 2017; Plummer et al., 2018; Ratanasiripong et al., 2015) had no significant differences in stress scores between the intervention and control groups (P > 0.05). However, it was found overall that mindfulness interventions could significantly alleviate nursing students' stress levels (SMD = -0.50, 95% CI: -0.65 to -0.35, P < 0.001; see Fig. 5). There was low heterogeneity among the seven included studies (I<sup>2</sup> = 26%, P < 0.001),

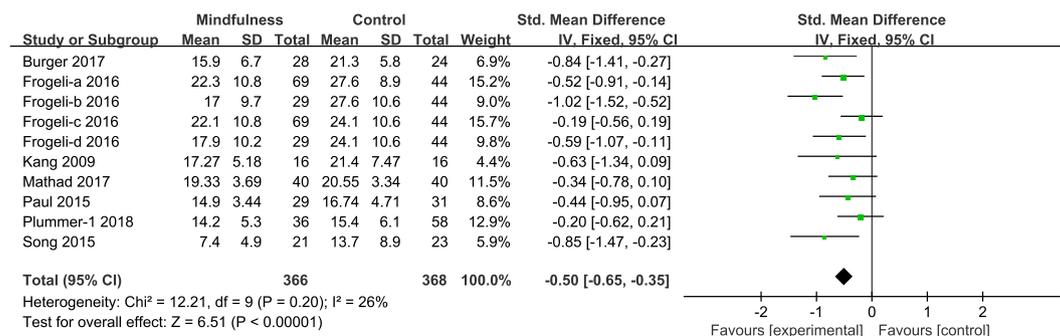


Fig. 5. Forest plot of the stress scores.

then the fixed effect model was applied to merge results. The results altered after the random effect model was applied (SMD = -0.51, 95% CI: -0.69 to -0.34,  $P < 0.001$ ), suggesting that the results of this meta-analysis are robust.

### 3.4.4. Mindfulness scores

Authors of six studies (Burger and Lockhart, 2017; Frögéli et al., 2016; Mathad et al., 2017; Plummer et al., 2018; Qiu et al., 2017; Song and Lindquist, 2015), which included 1318 nursing students (637 in the intervention group, 681 in the control group), reported students' mindfulness scores. In Plummer et al. (2018)'s study, levels of mindfulness, mindfulness awareness and mindfulness attention were determined. Thus, all three groups of data were included in this meta-analysis, and moderate heterogeneity was achieved ( $I^2 = 65%$ ,  $P < 0.001$ ). Therefore, the random effect model was applied for integration. It was found that mindfulness interventions could significantly enhance nursing students' mindfulness levels (SMD = 0.54, 95% CI: 0.33–0.75,  $P < 0.001$ ; Fig. 6). In one of the included studies (Mathad et al., 2017), no statistically significant results were reported, while the other five complied with the results of the meta-analysis. Following the integration of the fixed effect model, no significant changes were identified, demonstrating that the results of this meta-analysis are robust (SMD = 0.67, 95% CI: 0.56–0.79,  $P < 0.001$ ).

## 4. Discussion

### 4.1. Summary of major findings

In the present meta-analysis, relevant Chinese and English studies were comprehensively retrieved by combining MESH and free terms. Ten randomized controlled trials of high quality were obtained and included in the meta-analysis. In the included studies, 1204 nursing students from seven countries in Asia, the Americas and Europe were recruited. This geographical extensiveness enhanced the applicability.

It was found that mindfulness interventions could significantly reduce levels of depression, anxiety and stress in nursing students, as well as enhance their levels of mindfulness. The possible reasons for these findings may be that mindfulness originates from two words in Buddhism: 'Sati', indicating 'awareness', and 'Samprajanya', meaning 'clear comprehension' (Greucci et al., 2015). Mindfulness therapy aims to rid individuals of negative emotions and help them face life positively through simple training (Robins et al., 2014). It can arouse the attention of individuals to their physiology, thinking and emotions and teach self-care, self-nursing and self-regulation, leading to a peaceful state of mind and an optimistic attitude which can be maintained in work and study (Pang et al., 2010). From a neurobiological perspective, Davidson (2004) has reported that mindfulness interventions can decrease levels of cortisol, a stress hormone, thereby improving mood and overall individual happiness. These findings have been verified this research conducted by Dr. Davidson by other authors (Goldin and Gross, 2010;

Jindal et al., 2013). In terms of application, mindfulness-based interventions have been extensively used for disease treatment (Fang et al., 2010), pain management (Motaghedhi et al., 2016) and emotional problems (Sears et al., 2011). Scholars have suggested that mindfulness interventions can reduce anxiety and depression, lower blood pressure, reduce sensitivity to pain, and improve students' academic achievement (Wang and Chen, 2015).

Nursing students in all 10 of the included studies underwent the interventions at the beginning of their program. It is worth noting that all but two of the studies tested formal interventions. Frögéli et al. (2016) reported that six stages of intervention were conducted three times a week, with students being free to engage in the intervention when appropriate. In Qiu et al. (2017)'s intervention, a combination of formal training and informal self-practice was used; in addition to 2 h of intensive training per week for five weeks, students were required to do at least 30 min of self-practice every day, meaning that differences in intervention protocols may increase the heterogeneity of meta-analysis to some extent. It has been found that whether the intervention is formal or informal intervention has no significant impact on the results (Wu et al., 2013). In terms of heterogeneity, the meta-analysis was also affected by the large difference in sample size among the included studies (range: 32–488); there were also differences in the frequency and duration of intervention (range: 70–210 min and 1–20 weeks, respectively), and in the outcome indicators. Although the heterogeneity of the outcome indicators was relatively low, more high-quality studies with large sample sizes and multiple perspectives are needed to confirm these results.

Only one of the included articles included follow-up results; they were from three months after the end of the intervention (Frögéli et al., 2016). No statistically significant difference in stress scores between the intervention and control groups was reported at follow-up. Due to the lack of follow-up studies, this was not enough for meta-analysis, meaning this study was only included for descriptive analysis. More follow-up studies should be conducted in the future to explore the long-term effects of mindfulness interventions on various aspects of nursing students' lives.

### 4.2. Comparisons with other published reviews and suggestions for future research

In a review on the effectiveness of mindfulness interventions for nursing students and nurses, it was suggested that mindfulness meditation significantly impacted levels of stress, anxiety, depression and life satisfaction (Van der Riet et al., 2018). However, as the author stated in the limitation section of that paper, the study lacked a sample from Eastern countries. The authors of the current meta-analysis overcame this deficiency and drew the same conclusion based on Eastern and Western samples, providing more extensive support for the existing studies.

Additionally, the latest meta-analysis demonstrated that burnout is a

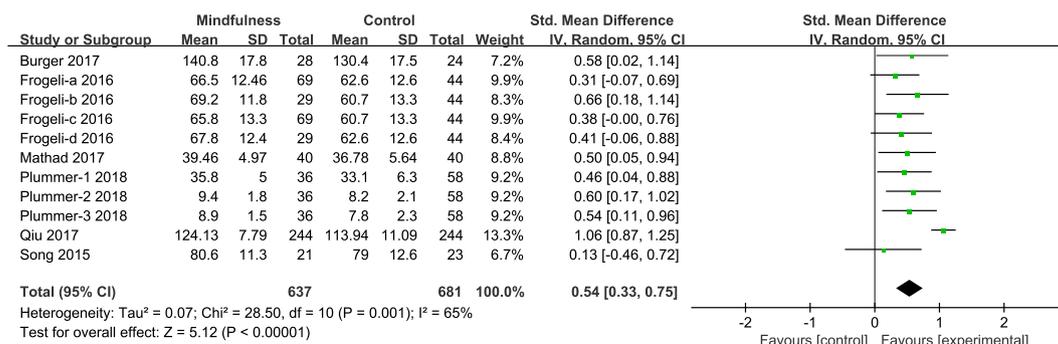


Fig. 6. Forest plot of the mindfulness scores.

problem that cannot be ignored among nurses worldwide (Woo et al., 2020). Nursing students will undoubtedly face this major problem during their future careers. Scholars have shown that stress and burnout can lead to health problems such as depression which can, in turn, affect future career development (Rudman and Gustavsson, 2011). Therefore, since mindfulness interventions were shown to significantly reduce the stress and depression of nursing students in this meta-analysis, the effects of interventions targeting burnout in nurses need further study. Furthermore, the results of this meta-analysis are based on the nursing student population. Future researchers could apply mindfulness interventions to a wider range of nurses, students and professionals from other health care disciplines to obtain more extensive findings.

#### 4.3. Limitations of this study

The authors of only three studies included in this meta-analysis described their method of randomization in detail. Others mentioned randomization but did not clearly explain the method used, which is a limitation for this meta-analysis to some extent. Second, there is no uniform measurement tool for the same outcome, which might increase the source of heterogeneity. In addition, the studies included in this meta-analysis included different types of mindfulness intervention protocols, which also increased the overall heterogeneity. Moreover, as shown in the follow-up results, whether and how long the positive effects of mindfulness interventions on nursing students can be sustained needs to be explored in more depth. Finally, only one study published in a language other than English (Chinese) was included in this meta-analysis, which may add to the selection bias.

#### 5. Conclusion

Relevant studies in Chinese and English were comprehensively retrieved, and randomized controlled trials published in different languages were included in this meta-analysis. It was found that mindfulness interventions could significantly decrease depression, anxiety and stress and enhance levels of mindfulness for nursing students. However, given the limited number of studies, long-term follow-up effects could not be assessed. Thus, more high-quality studies are needed to determine the long-term effect of mindfulness interventions for nursing students.

#### Design

A meta-analysis of randomized controlled trials.

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#### CRediT authorship contribution statement

Xue Chen: Responsible for the formulation of research ideas, the writing of papers and the overall direction of research, as well as the preliminary retrieval and selection of literature titles and abstracts. Bo Zhang: Provide help with language modification and polishing during major revision process, and work together to complete the content improvement of the article. Song-xian Jin: In the research process, she was responsible for assisting Xue Chen with literature search and selection of titles and abstracts. You-xi Quan: During the research, she was responsible for the full text reading with Xin-wei Zhang. Xin-wei Zhang: During the research, she was responsible for the full text reading with You-xi Quan. Xiang-shu Cui: Corresponding author of this article. She also supervised and guided the statistical methods used in this study, and handled the controversies encountered during article filtering if necessary.

#### Declaration of competing interest

The authors report no conflict of interests.

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