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Review article

Effects of mindfulness-based stress reduction on anxiety symptoms in young people: A systematic review and meta-analysis

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ABSTRACT

In this study, we evaluated the efficacy of mindfulness-based stress reduction (MBSR) for young people with anxiety symptoms. We used many databases, including PubMed, PsycINFO, Web of Science, EMBASE, CINAHL and Cochrane Library (from inception to May 2019). We included randomized controlled trials (RCTs) comparing MBSR with various control conditions, including didactic lecture course, health education, treatment as usual, didactic seminar and cognitive behavioral program in young people with anxiety symptoms. Finally, we selected fourteen studies comprising 1489 participants comparing with control conditions. The meta-analysis suggested that MBSR significantly reduced anxiety symptoms compared to control conditions at post-treatment (Standardized Mean Difference, SMD = –0.14, 95% CI –0.24 to –0.04). However, the effect of MBSR on anxiety symptoms in young people may be affected by different intervention duration, especially the significance in a short-term intervention (less than 8 weeks). In addition, the meta-analysis indicated publication bias for anxiety symptoms. Using the trim-and-fill method, we found the adjusted standardized mean difference, which indicated that MBSR was still significantly superior to the other control conditions. The sensitivity analysis showed that the result was reliable. Current evidence indicates MBSR has superior efficacy compared with control conditions in treating young people with anxiety symptoms. Based on this, we suggest there is a significant effect of MBSR on young people with anxiety symptoms, especially the effects of long-term intervention for future studies.

1. Introduction

Anxiety is one of the most prevalent and nationwide diagnosed psychiatric conditions in youth (Bear et al., 2019). According to the World Health Organization (WHO), the prevalence of anxiety disorders in adolescents is 10 to 19 percent (Bandelow and Michaelis, 2015). Left untreated, anxiety disorders tend to develop into a chronic that often continues into adulthood (Hill et al., 2016). Anxiety symptoms are associated with a range of physical and mental problems and other negative outcomes. Physical discomfort such as palpitations, dizziness, chest tightness, sleep disorders, and joint muscle tension (Rouillon, 1999; Woodward and Fergusson, 2001) is often prone to occur, while there is also an increased risk of illicit drug dependence seeking to relieve anxiety and stress (Woodward and Fergusson, 2001). In term of mental damage, anxiety is associated with low self-esteem, reduced well-being and other mental illnesses, especially depression (Woodward and Fergusson, 2001);anxiety disorder not only causes a huge economic burden and reduces the quality of life, but also becomes one of the main reasons of suicide among youths (Hoffman et al., 2008; Kim-Cohen et al., 2003; Windfuhr et al., 2008). A study has shown that anxiety disorder leads to lower educational attainment and adolescents with anxiety disorders have a higher risk of education failure than those without anxiety disorders (Woodward and David, 2001). However, less than 50% of young people with mental disorders receive specialized treatment services (Ye et al., 2014). Moreover, anxiety is hard to identify among young people as adolescents may not be as clear as adults (Hill et al., 2016). Therefore, timely identification and evidence-based treatment is urgently needed to ensure optimal outcomes.

The anxiety problem of adolescents has attracted the attention of practitioners and scholars. A growing empirical literature has studied

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the short-term efficacy and feasibility of both psychosocial (James et al., 2013) and psychopharmacological (Dieleman and Ferdinand, 2008) interventions for the treatment of anxiety disorders in youth. In terms of pharmacotherapy, the overall response rate of generalized anxiety symptoms (GAD) to current mainstream drugs is 44-81% (Borwin et al., 2013), mainly including selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), second-line drug buspirone, benzodiazepines, and tricyclic antidepressants, etc. (Borwin et al., 2013). However, due to many side effects of these drugs, long-term use of these drugs is likely to lead to the increase of total cholesterol, dyslipidemia, sexual dysfunction, and even high incidence of drug dependence (Baldwin and Polkinghorn, 2005; Beyazyuz et al., 2013; Lader, 2012; Mahe and Balogh, 2000). Therefore, the current strategy of drug treatment only is not satisfactory for the high incidence of anxiety disorder in young people. In the non-drug treatment situation, psychotherapy has been recommended as the main method for the treatment of anxiety by many countries' guidelines and clinical studies (Cuijpers et al., 2016; Hopkins et al., 2015; Malhi et al., 2015). Studies have shown that cognitive-behavioral therapy (CBT) (James et al., 2015; Zhou et al., 2015), reading therapy (Rapee et al., 2006), music therapy (Goldbeck and Ellerkamp, 2012), and mindfulness-based stress reduction (MBSR) (Hjeltnes et al., 2017; Shauna et al., 1998) have been widely used in relieving anxiety symptoms of teenagers. Cognitive-behavioral therapy (CBT) (James et al., 2015; Zhou et al., 2015) serves as beneficial interventions for the relief of adolescent anxiety symptoms, and is recommended as a first-line psychotherapy for anxiety disorders in the treatment guidelines (Health and Welfare, 2016). Although CBT has achieved positive results in previous RCTs, the response rate of it is not demonstrative, as about 40-50% of young people receiving treatment still have symptoms at the end of acute treatment (Silverman et al., 2008). A Child/Adolescent Anxiety Multimodal Study (CAMS) (Compton et al., 2010) found that the combination (COMB) of CBT, sertraline, and placebo) was superior to both CBT (59.7%) and sertraline (SRT) alone (54.9%), as well as pill placebo (23.7%). Therefore, for the anxiety symptoms of young people, we need to find new and effective psychological intervention methods, such as MBSR.

In the late 1970s, Dr. Kabat-zinn introduced mindfulness-based stress reduction into psychotherapy, helping patients cope with stress, relieve pain, improve mood and improve life comfort (Holzel et al., 2011; Kabat-Zinn, 1982). The original MBSR was designed only for individuals with illnesses, but currently MBSR has widely been used to relieve stress, anxiety, and depression in the general population (Virgili, 2015). Standard MBSR training consists of an 8-week course (Williams and Penman, 2011), including many parts such as body scans (a progressive movement of attention through the body from toes to head observing any sensations in the different regions of the body), sitting and breathing (involving awareness of body sensations, thoughts, and emotions while focusing on the breath), "Hatha Yoga" (which consists of stretches and postures designed to enhance greater awareness and to balance and strengthen the musculoskeletal system), walking meditation (observing the abdominal undulating movement caused by breathing, such as emotional observations). Mindfulness therapy helps individuals stop "action mode" (referring to the individual's automatic, unconscious, inner feelings, thoughts, and bodily sensations, and habitual reaction mode) in the presence of negative emotions (anxiety, depression, stress, fear, etc.) and stressful life events. Instead, it was replaced by the "existence mode" of thinking (that is, learning to accept and recognize all the objective experiences of the present, without reacting to such negative experiences) (Didonna, 2009). In the state of existence mode, individuals think out of the box, eliminates unnecessary worries, finding themselves in the real world (Didonna, 2009), thus changing their self-esteem, psychological resilience and life satisfaction (Bajaj et al., 2016; Zainal et al., 2013). In addition, MBSR has been shown to improve emotional disorders in people with a variety of diseases, such as pain, diabetes, asthma, and malignant tumors, etc. It has been used in the treatment of various physical and mental diseases (Hoffman et al., 2012; Pbert et al., 2012; van Son et al., 2013).

The impact of mindfulness-based stress reduction on young people's mood regulation has been widely accepted in treatment. It draws increasing attention. MBSR interventions for medical students and preschool students can effectively reduce self-reported status and trait anxiety and improve mental experience score assessed at the end of the intervention (Shapiro et al., 1998). In addition, MBSR has a significant effect on reducing symptoms such as depression, anxiety, paranoia, and sensory stress in adolescent outpatients (Diaz-Gonzalez et al., 2018). In addition to these clinical effects of coping with negative emotions, MBSR is highly recommended for non-clinical overweight or obese adolescents. The research found that it can decrease depressive symptoms more efficiently than cognitive and behavioral adolescents 6 months of treatment (Shomaker et al., 2017).

Previous meta-analyses (Bamber and Morpeth, 2019; Borquist-Conlon et al., 2019; Dunning et al., 2019; Halladay et al., 2019; Kallapiran et al., 2015a; Zoogman et al., 2015) have shown the effect of mindfulness training on anxiety and other psychological outcomes in children, adolescents and college students. First of all, some meta-analyses have included non-randomized controlled studies, such as Borquist (2017) and Zoogman (2015)'s study involving QED (quasi-experimental design) (Borquist-Conlon et al., 2019), Tx only (treatment only design), OCT (open-controlled trial (no randomization)) (Zoogman et al., 2015), and research on the pretest/posttest analysis of MBI (Bamber and Morpeth, 2019); second, some meta-analyses involve children and adolescents (under 18 years old) (Borquist-Conlon et al., 2019; Dunning et al., 2019; Kallapiran et al., 2015a; Zoogman et al., 2015), or college students and graduate (Bamber and Morpeth, 2019; Halladay et al., 2019) in the sample population; in the meanwhile, varied types of mindfulness practices (including MBCT, MBSR, ACT, Meditation, mindfulness martial arts and others) were blended by the studies (Bamber and Morpeth, 2019; Borquist-Conlon et al., 2019; Dunning et al., 2019; Halladay et al., 2019; Kallapiran et al., 2015; Zoogman et al., 2015), which masked the evidence of the specific treatment effect of MBSR on anxiety symptoms. It is necessary to explore the effects of single MBSR on young people's emotional symptoms in randomized controlled trials. Recently, a systematic review has demonstrated the role of single MBSR in improving related psychological symptoms, such as reducing depression symptoms in adolescents (Chi et al., 2018). Therefore, it is urgent to assess the impact of MBSR on adolescent anxiety symptoms. Moreover, more young adult data has been collected in the recent publications. So a well-designed new meta-analysis is urgently needed to resolve the limitations of the previous meta-analysis and update the findings with more recent studies. We aimed to explore the effect of MBSR on anxiety symptoms among adolescents and young adults by conducting a systematic review and meta-analysis of relevant RCTs.

2. Methods

2.1. Selection of studies

Literature was systematically and independently obtained by two authors (XZ and JYG) through PubMed, PsycINFO, Web of Science, EMBASE, The Cumulative Index to Nursing & Allied Health Literature (CINAHL), and the Cochrane Library (from inception to May 2019). The selection was using the following keywords: (mindfulness-based stress reduction OR MBSR) AND (anxiety OR anxiety symptom) AND (adolescent OR teen OR teenager OR student OR youth OR young people OR young adult). In order to extend the search scope to obtain more accurate high-quality literature, we also search for relating references for the systematic review articles.

2.2. Inclusion criteria

Studies were included in this Meta-analysis if:(1) randomized controlled trials that explored the effect of MBSR intervention on anxiety symptoms of adolescents and young adults. In this systematic review, we only included the English literature; (2) the systematic review included studies with adolescents and young adults aged from 12 to 25 years old. Participants who were clinically diagnosed as anxiety using any diagnostic criterion, such as the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 1980, 1987, 1994, 2000, 2013) and the International Classification of Diseases (World Health Organization, 1978, 1992); and the various types of anxiety disorders included in the DSM-5 (American Psychiatric Association, 2013). (3) the intervention group was designed to conduct MBSR or adapted the MBSR course according to the manual by Kabat-Zinn (1990). Control conditions include treatment as usual, a didactic lecture course, substance abuse class, didactic seminar, cognitive-behavioral program, health education, and no intervention (waitlist); (4) anxiety symptoms are the main outcome indicators, which are measured by anxiety-related scales.

2.3. Exclusion criteria

Studies were excluded if: (1) they are just meta-analyses or secondary analyses involving large, completed sample sizes; (2) joint studies (such as MBSR and drug combination) were also excluded because the specific effects of MBSR could not be assessed in these trials; (3) no post-intervention scale scores on anxiety were reported.

2.4. Data extraction

In this process, the authors (XZ, JYG and GLL) independently determine the outcome indicators for data analysis and extraction. These data included: the first author and the year of publication, research settings and implementer, demographic information of the study population (source, number of participants, and age), information related to intervention (measure and time), follow-up time, and variables related to results (dropout, anxiety and measurement tools). The differences in the data extraction process are discussed and determined by the three authors (XZ, ZXX, and CNZ) to ensure the accuracy of the data. In the case of missing data or vaguely reported in an article, an email was sent to the author requesting a detailed description.

2.5. Risk of bias assessment

We used the Cochrane Handbook for Systematic Reviews of Interventions Version 5.2.0 to estimate the risk of bias so as to assess the quality of each study. The tool includes assessing the risk of bias for each study in multiple areas including the high, low, or unclear levels of bias: randomization generation, allocation concealment, the blindness of participants and personnel, blindness of outcome assessment, incomplete outcome data, selective reporting, and other risks of bias. According to the above seven aspects, the results of bias risk assessment are summarized into RevMan 5.3, thus the deviation risk assessment summary table is generated. All differences are decided by the third and fourth authors (GLL and CRC).

2.6. Statistical analysis

We performed a statistical analysis by using Review Manager (RevMan) version 5.3 (The Nordic Cochrane Center, The Cochrane Collaboration, and Copenhagen). The chi-squared test and the I^2 statistic are used to exam the heterogeneity of the data. The I^2 statistic is an important indicator of heterogeneity, with values of 25%, 50%, and 75% representing low, medium, and high heterogeneity respectively (Higgins et al., 2003). For medium to high heterogeneity, we use a random-effects model for analysis; in addition, we use a fixed-effect model. For continuous results, the effect size of the continuous data was synthesized by using Cohen's *d* of standardized mean difference (SMD) with 95% confidence interval (CIs). A forest plot was generated as well. Finally, Funnel plot and the Egger regression asymmetry test (Egger et al., 1997) were applied to examine potential publication bias. In addition, the Trim and Fill method (Duval and Tweedie, 2000) was used in Stata version 14.0 to estimate the number of studies that would have to be removed from the funnel plot to make it symmetrical, and impute an estimated effect size that accounts for funnel plot asymmetry.

3. Results

3.1. Literature search and screening

A total of 237 records were obtained for the online database search, and two additional studies were generated by manually searching for published comments or meta-analysis. After the removal of duplicates, 107 studies remained, as 65 of them were excluded at the title and abstract screening stages. The remain 42 studies were then included in the full-text screening process. Finally 14 studies were remained after this process and put into the meta-analysis. Fourteen studies (RCTs) (Bergen-Cico et al., 2013; Biegel et al., 2009; Bluth et al., 2016; Diaz-Gonzalez et al., 2018; Dvořáková et al., 2017; Gouda et al., 2016; Hazlett-Stevens and Oren, 2017; Johnson et al., 2016; Kang et al., 2009; McIndoo et al., 2016; Rosenzweig et al., 2003; Shomaker et al., 2017; Sibinga et al., 2016; Song and Lindquist, 2015) with a total of 1489 participants were included in this meta-analysis. The process of literature screening was shown in Fig. 1.

3.2. Basic information in included studies

The characteristics of the 14 included studies are shown in Table 1. The years of publication range from 2003 to 2018. The design of studies was using randomized controlled trials. The samples mostly come from student groups, with one exception (Biegel et al., 2009) that used adolescent psychiatry outpatients. The minimum sample size is 24 (Bluth et al., 2016), and the maximum is 302 (Rosenzweig et al., 2003). One (Rosenzweig et al., 2003) of these studies did not report information about the age of the sample. The control group measures were not explicitly reported in seven studies (Dvořáková et al., 2017; Gouda et al., 2016; Hazlett-Stevens and Oren, 2017; Johnson et al., 2016; Kang et al., 2009; McIndoo et al., 2016; Song and Lindquist, 2015) and the adapted version of MBSR was used in four studies (Bluth et al., 2016; Dvořáková et al., 2017; Johnson et al., 2016; Shomaker et al., 2017). The MBSR intervention time in four studies was less than 8 weeks, for example, one (McIndoo et al., 2016) of which was 4 weeks, one (Bergen-Cico et al., 2013) was 5 weeks, and two (Dvořáková et al., 2017; Shomaker et al., 2017) were 6 weeks. In studies with an intervention time greater than 8 weeks, two of them were 10 weeks of intervention, one was 11 weeks and one was 12 weeks. In the 14 studies, four studies (Bergen-Cico et al., 2013; Diaz-Gonzalez et al., 2018; Gouda et al., 2016; Sibinga et al., 2016) did not report withdrawal from the experiments, more than half of the studies were not followed up, and only five studies (Biegel et al., 2009; Gouda et al., 2016; Johnson et al., 2016; McIndoo et al., 2016; Shomaker et al., 2017) reported the time of follow-up.

3.3. Risk of bias assessment

Fourteen studies were rated as “moderate risk of bias.” There was no study judged as “low risk of bias” and “high risk of bias.” The results of the risk of bias assessment are summarized in Fig. 2.

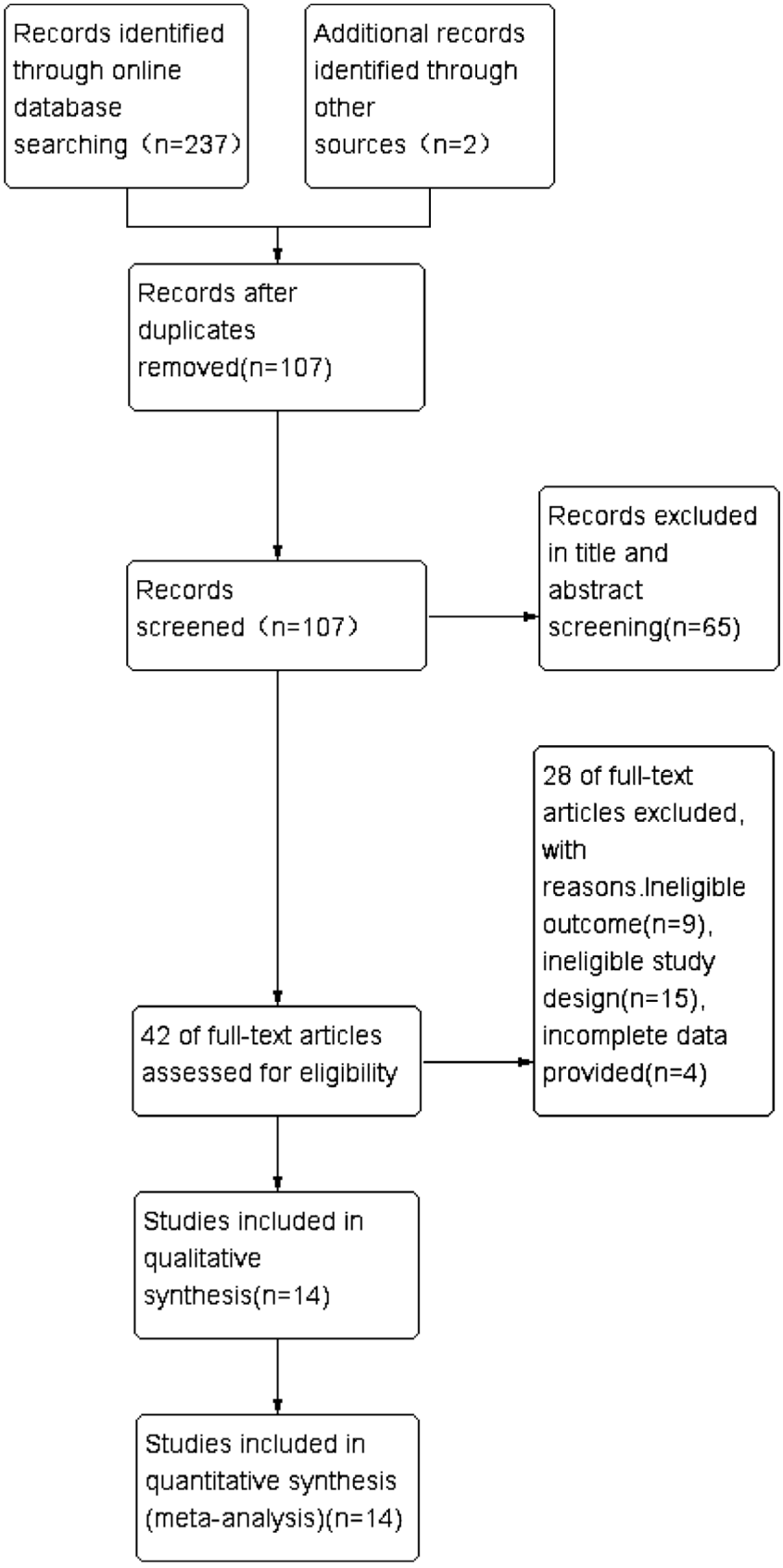

Fig. 1. Flow diagram showing the process of study selection.

Table 1
Main characteristics of included trials.

Study	Nation	Participants	Research settings	Implementer	Sample Size(n) (EG/CG)	Age, M(SD) or Range (EG/CG)	Intervention	Comparison	MBSR duration	Drop-out (%)	Follow-up time	Outcome measure
Bergen-Cico et al. (2013)	United States	Undergraduate students	School	A professor completed MBSR teacher training	119(72/47)	21.50 ± 1.00/21.10 ± 1.40	MBSR	a didactic lecture course	5-week	None	None	STAI
Biegel et al. (2009)	United States	Adolescent psychiatric outpatients	Hospital and home	Two master's- degree-level instructors trained in MBSR	102(50/52)	15.70 ± 1.13/15.00 ± 1.19	MBSR + TAU	TAU	8-week	16.70	3-month	SCL-90R
Bluth et al. (2016)	United States	Ethnically diverse at-risk adolescents	School mathematics classroom and gym	A mindfulness practitioner and a mindfulness instructor of 3 years	27(14/13)	16.80 ± 1.30/17.20 ± 1.10	Learning to BREATHE curriculum	Substance abuse class	11-week	14.80	None	STAI
Dvořáková et al. (2017)	United States	First-year college students	The freshman residential halls	Two trained facilitators	109(55/54)	18.20 ± 0.40/18.20 ± 0.40	Learning to BREATHE	None	6-week	3.67	None	GAD
Díaz-González et al. (2018)	Spain	Adolescents receiving mental health services	The group sessions and at home	Two instructors trained and experienced in delivering MBSR interventions	80(41/39)	14.61 ± 1.09/14.49 ± 1.12	MBSR + TAU	TAU	8-week	None	None	SCL-90R
Hazlett-Stevens et al. (2017)	United States	Undergraduate and graduate students	NA	A self-help format according to the workbook and would not involve access to a therapist for advice	92(47/45)	22.1 ± 4.70/22.1 ± 4.70	MBSR	None	10-week	26.10	None	DASS-21
Johnson et al. (2016)	Australia	Young adolescents	School and home	A mindfulness practitioner with ten years of personal practice	293(165/128)	13.63 ± 0.43/13.63 ± 0.43	Modified MBSR	None	8-week	8.19	3-month	DASS-21
Kang et al. (2009)	Korea	Nursing students	A quiet place after school hours	A researcher who had received professional training in mindfulness meditation	41(21/20)	22.69 ± 1.49/ 22.25 ± 0.86	MBSR	None	8-week	21.90	None	STAI
McIndoo et al. (2015)	United States	Depressed college students	A university	Three advanced clinical psychology (doctoral) students who have enrolled in the comprehensive 8-week MBSR program	34(20/14)	19.30 ± 1.90/19.00 ± 1.50	MBSR	None	4-week	11.70	1-month	BAI
Rosenzweig et al. (2003)	United States	2nd-year students of medical college	A medical college	NA	302(140/162)	NA	MBSR	Didactic seminar	10-week	8.20	None	POMS
Sarah et al. (2016)	Germany	The students of grade 11	On school premises	A certified mindfulness teacher and trained Psychiatrist with long-standing experience	29(15/14)	16.10 ± 0.51/16.40 ± 0.50	MBSR	None	8-week	None	4-month	HADS
Shomaker et al. (2017)	United States	Adolescent girls	Clinical Research Laboratory	A clinical psychologist and co-facilitated by one of two graduate students	33(17/16)	15.01 ± 1.68/14.97 ± 1.75	Learning to breathe	Cognitive behavioral program	6-week	15.10	6-month	STAI-C
Sibinga et al. (2016)	United States	Primary and middle school students	School	Two experienced MBSR instructors	300(159/141)	12.00/12.00	MBSR	Health education	12-week	None	None	anxiety: MASC
Song et al. (2015)	Korea	Nursing students	A university	A trained instructor with over 10 years of background experience in MBSR	50(25/25)	19.60 ± 1.70/19.50 ± 2.00	MBSR	None	8-week	12.00	None	anxiety: DASS-21

Note: Abbreviations: EG, Experimental Group; CG, Control Group; SD, standard deviation; NA, not available; MBSR, Mindfulness-based stress reduction; TAU, treatment as usual; GAD, the Generalized Anxiety Disorder Scale; STAI, Spielberger State-Trait Anxiety Inventory; SCL-90, Symptom Checklist-90-R; HADS, the Hospital Anxiety and Depression Scale; DASS21, the Depression Anxiety Stress Scales-21; BAI, Beck Anxiety Inventory; POMS, The Profile of Mood States; STAI-C, the State-Trait Anxiety Inventory for Children-Trait Version; MASC, Multidimensional Anxiety Scale for Children

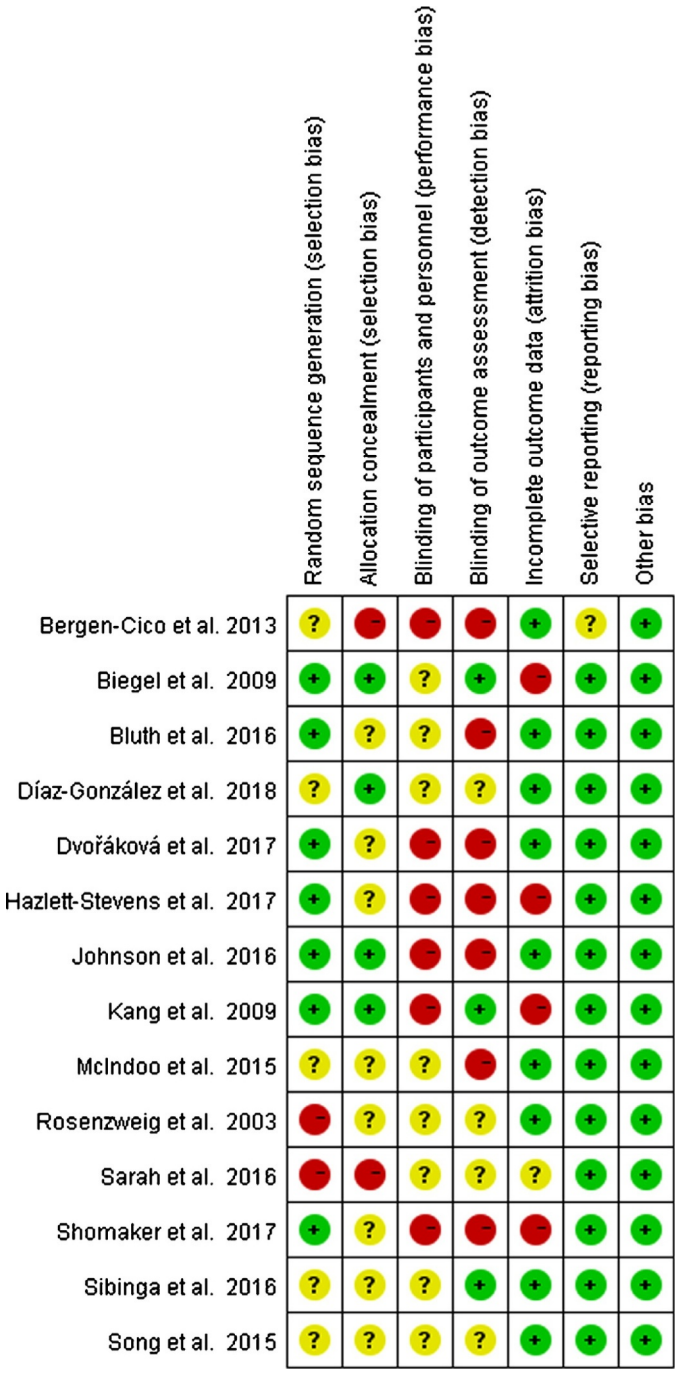

Fig. 2. Summary of risk of bias assessment.

3.4. Meta-analysis

14 studies involved 725 subjects in the MBSR intervention group and 764 subjects in the control group. Due to the relatively low heterogeneity among the included studies (I^2 = 6%; P = 0.38 for χ^2 test), a fixed-effect model was selected for quantitative synthesis. Overall, the meta-analysis revealed a significant difference between the MBSR intervention and control groups in alleviating anxiety (P = 0.007, SMD = –0.14, 95% CI: –0.24 to –0.04). The forest plot of the meta-analysis is shown in Fig. 3.

The difference between MBSR intervention and control in alleviating anxiety achieve statistical significance (P = 0.007), and the heterogeneity between the included studies was relatively low.

3.5. Subgroup analyses

We performed two different subgroup analyses with intervention time (≥ 8 weeks, < 8 weeks) and type of control condition (active control, inactive control). Moderator analysis showed no significant difference in the severity of anxiety symptoms between studies with intervention times (≥ 8 weeks) and studies with intervention times (< 8 weeks) (χ^2 = 0.90, P = 0.34). A fix effects model showed there was a post-intervention between-group difference in favor of MBSR with a medium effect size (SMD = −0.14, 95% CI: −0.24 to −0.04) (P = 0.007). We found that when the MBSR duration was ≥ 8 weeks, there was no significant difference between the intervention group and the control group (P = 0.05, SMD = −0.12, 95% CI: −0.23 to −0.00). However, when the MBSR duration was < 8 weeks, there was a significant difference between the MBSR group and the control group (P = 0.04, SMD = −0.24, 95% CI: −0.48 to −0.01) (as it was illustrated in Fig. 4A).

In terms of the type of control condition, Fig. 4B shows that there was no significant difference between studies with active and inactive control conditions (χ^2 = 0.07, P = 0.80). Inactive control group has a significant difference in alleviating anxiety symptoms (P = 0.04, SMD = −0.15, 95% CI: −0.30 to −0.01), whereas the active control group did not (P = 0.09, SMD = −0.13, 95% CI: −0.27 to 0.02) (Fig. 4B). This suggests that the effect of MBSR on anxiety varied, as a function of control condition with MBSR is more effective than inactive control conditions but less effective than active control conditions.

A, Forest plot of the SMD for changed scores in anxiety rating scales with MBSR. B, Forest plot of the SMD for changed scores in anxiety rating scales for active intervention measures in the control group.

3.6. Sensitivity analysis and publication bias assessment

Due to the low heterogeneity of the Meta-analysis (I^2 = 6%), we evaluated the publication bias by visual examination of the funnel plot and a quantitative assessment using Egger's test (Egger et al., 1997). The funnel plot of proximal SE between the MBSR intervention group and the control group was slightly asymmetric; and the Egger's test revealed that there may be publishing bias (t = −2.23, P = 0.046). When we quantified the potential effect of small study bias on the primary efficacy outcome by using the trim-and-fill method (Duval and Tweedie, 2000), four hypothetical missing studies were added, and the imputed SMD was −0.100 (95% CI: −0.199 to −0.002), indicating that MBSR was still significantly superior to the control (P < 0.05, Fig. 5). Sensitivity analyses were conducted by excluding studies that may have large effects on meta-analysis results (i.e., either outliers or having high or unclear risk of bias in multiple domains). The results demonstrated that there was no significant difference between the two groups (Fig. 6). Thus, a significant difference between the MBSR intervention group and control group in alleviating adolescent anxiety would be considered as a relatively reliable finding.

4. Discussion

4.1. Summary of main findings

In this study, we attempt to assess the effect of MBSR on anxiety symptoms of young people by a meta-analysis of randomized controlled trials. A total of 14 articles involving 1489 participants were obtained through literature retrieval and screening. The meta-analysis found that MBSR was significantly superior to other control conditions in reducing anxiety symptoms in young people. The results of our study showed that MBSR can effectively reduce young people's anxiety symptoms compared with conventional measures, such as treatment as usual (Biegel et al., 2009) and health education (Sibinga et al., 2016). Based on the intervention duration of MBSR and whether the control group was active, the subgroup analyses showed that there are no significant

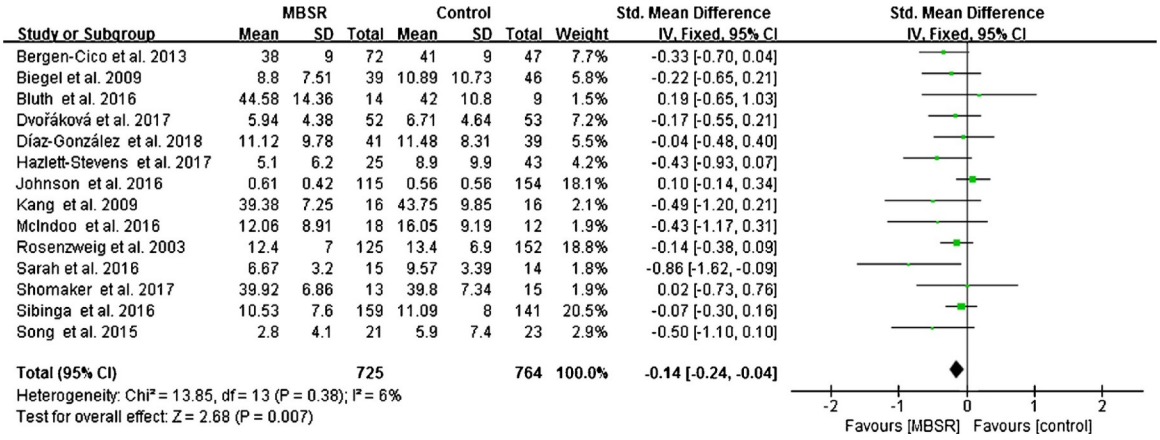

Fig 3. Forest plot of MBSR intervention versus conventional control in alleviating anxiety.

effects both in the intervention group (≥ 8 weeks) and the active control group. The intervention group (< 8 weeks) and the inactive control group had significant effects on alleviating anxiety symptoms. The trim-and-fill analysis results illustrated that the potential risk of publication bias was low. Furthermore, the reliability of the results was supported by the sensitivity analysis. Due to a small number of included studies used with clinical participants and lacked statistical power, we cannot draw a conclusion regarding the role of MBSR in relieving anxiety symptoms of clinical young people. Future trials are encouraged to recruit clinical participants to examine the effects of MBSR on anxiety symptoms in young people.

Our finding is different from a previously published meta-analysis (Strauss et al., 2014) assessing the effect of Mindfulness-Based Interventions (MBIs) on depression and anxiety. The meta-analysis (Strauss et al., 2014) found that MBI was effective in reducing depressive symptoms (Hedges g = −0.73, 95% CI: −0.09 to −1.36), but not anxiety symptom severity (Hedges g = −0.55, 95% CI: 0.09 to −1.18). The results were different from our study is because their meta-analysis (Strauss et al., 2014) included MBSR, and MBCT, and PBCT (Person-based Cognitive Therapy). In the form of a mindfulness intervention, Strauss et al synthesized 12 studies, including 5 MBSR studies, 6 MBCT studies, and 1 PBCT study, which may lead to inaccuracy of the analysis results. In addition, the heterogeneity of anxiety index analysis is high (I^2 = 89%), which might introduce significant bias to the results. In our study, the disadvantage (including different forms of a mindfulness intervention, such as MBSR, MBCT, and PBCT) of the previous research (Strauss et al., 2014) was avoided by evaluating the effect of MBSR on anxiety accurately, and by using “fixed-effect model” for data synthesis while the heterogeneity between included studies was low (I^2 = 6%).

4.2. Findings of subgroup analysis

Although our study demonstrated the positive impact of MBSR on young people with their anxiety symptoms, the subgroup analysis revealed the only significant significance of MBSR intervention within 8 weeks. But no significant difference was found in interventions over 8 weeks (including 8 weeks). This finding differs from a previous comprehensive meta-analysis (n = 182; β = 0.01, SE = 0.0015, P< 0.00001) (Khoury et al., 2013). The main reason for the discrepancy may arise from the differences in the population characteristics, mindfulness training practitioners, and research settings between the two studies, such as sample age. The conclusion of the study (Khoury et al., 2013) is based on the whole population and MBIs. However, our subjects are young people aged from 12 to 25 years old. Influenced by the social environment, family environment, and self-condition. Adolescents have unique psychological characteristics in personality, emotional regulation, and interpersonal communication, etc., which may be the important reason for the different results. What's more, that study confirmed a positive correlation between MBIs intervention time and individual benefit. Our study focused on the effect of MBSR on anxiety symptoms in young people. Furthermore, the practical diversity of MBSR cannot be ignored when interpreting the finding. It must be taken into account that although all the studies used MBSR, they are different in implementation, some used standard protocols, while others used a more brief or lightened version with fewer sessions. In addition, the studies targeted different populations, and used different scales to measure variables. This diversity in study designs and measuring tools may have been a large contributor to the observed differences in effect sizes. Therefore, we urgently need larger, high-quality randomized controlled trials in the future to validate this finding. Subgroup analysis of control condition type showed that MBSR had a significantly better effect on treating young people's anxiety symptoms than the inactive control group (such as treatment as usual). However, when MBSR was compared with the active control group, the significant effect disappeared. In the five studies that used an active control condition, two of them were using didactic lecture course or seminar (Bergen-Cico et al., 2013; Rosenzweig et al., 2003); one was using a substance abuse class (Bluth et al., 2016) and a cognitive-behavioral program (Shomaker et al., 2017), while the other was in health education (Sibinga et al., 2016). Therefore, the diversity of control types in the active control group may be an important reason for the lack of significant difference. At the same time, the age of the sample, the research settings, the implementer and time of the intervention cannot be ignored. However, these information do not affect the protruding nature of MBSR in relieving anxiety symptoms. In the non-active control group, MBSR significantly reduced the main symptoms compared with the control group (P = 0.04). This is similar to the finding of a previous study (Strauss et al., 2014), which divided 12 studies into groups and found that there was a significant difference (P = 0.001) in primary symptom severity between the MBIs group and inactive control group (including aerobic exercise, TAU and wait-list). For this reason, MBSR is worthy to be compared among the didactic lecture course, health education, didactic seminar, and cognitive behavioral program, in reducing the anxiety symptoms of young people. Therefore, this result should be interpreted carefully.

4.3. Future research

In view of our search strategy, some qualified studies published in other languages or in other databases may be inadvertently excluded, so more research in other languages and broader databases is needed in the future in order to better understand the specific role of MBSR intervention in adolescent anxiety. Compared with inactive controls of anxiety disorder, MBSR intervention is more effective in reduce anxiety

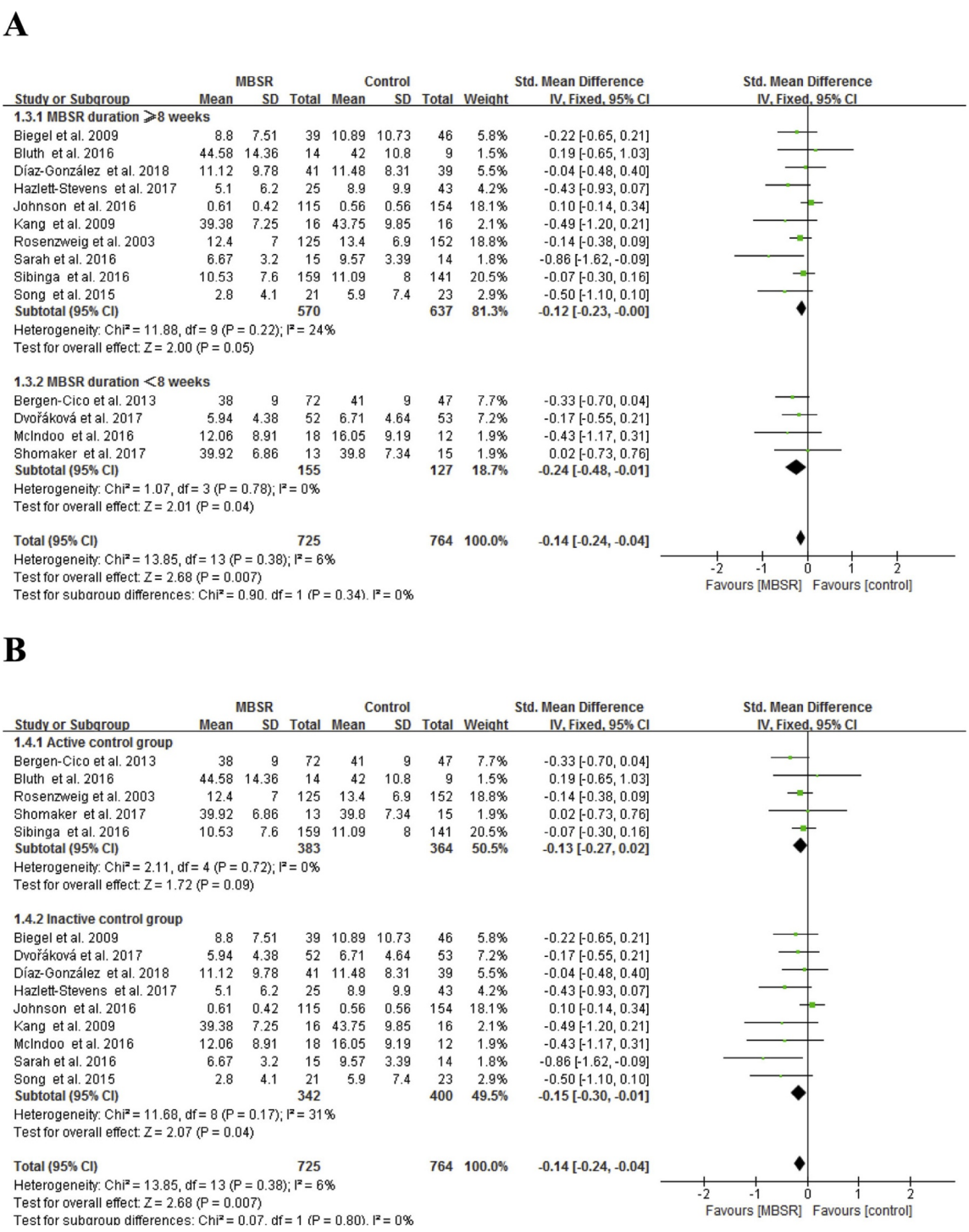

Fig 4. Subgroup analyses of anxiety outcome.

and other symptoms. It is possible that participant characteristics such as sex, educational level or cultural background may affect participant responses to MBSR. Researchers should conduct as many sample intervention studies as possible under the same cultural background to verify the impact of MBSR on anxiety in adolescent patients.

Despite the shortage of clinical cases (only one), this study failed to evaluate the effect of MBSR on clinical and non-clinical population. A meta-analysis found that it also has positive effects on anxiety and stress in non-clinical populations (Kallapiran et al., 2015). Meanwhile, Zoogman et al (Zoogman et al., 2015). found that the effect size of mindfulness interventions in clinical samples was larger than in non-clinical samples. Individuals who display elevated subclinical symptoms are more likely to develop clinically significant psychopathology (Ruscio et al., 2007); therefore, investigating the effects of MBSR among individuals with emerging signs and symptoms of an anxiety disorder is particularly important. This may provide some diverse directions for future research in the treatment of adolescents with anxiety, especially in the clinical area.

Many included studies have unclear deviation risks in the generation of random sequences, concealment and blindness. Although these bias risks are common in randomized controlled psychotherapy trials (Shean, 2014), we conducted a sensitivity analysis of the included

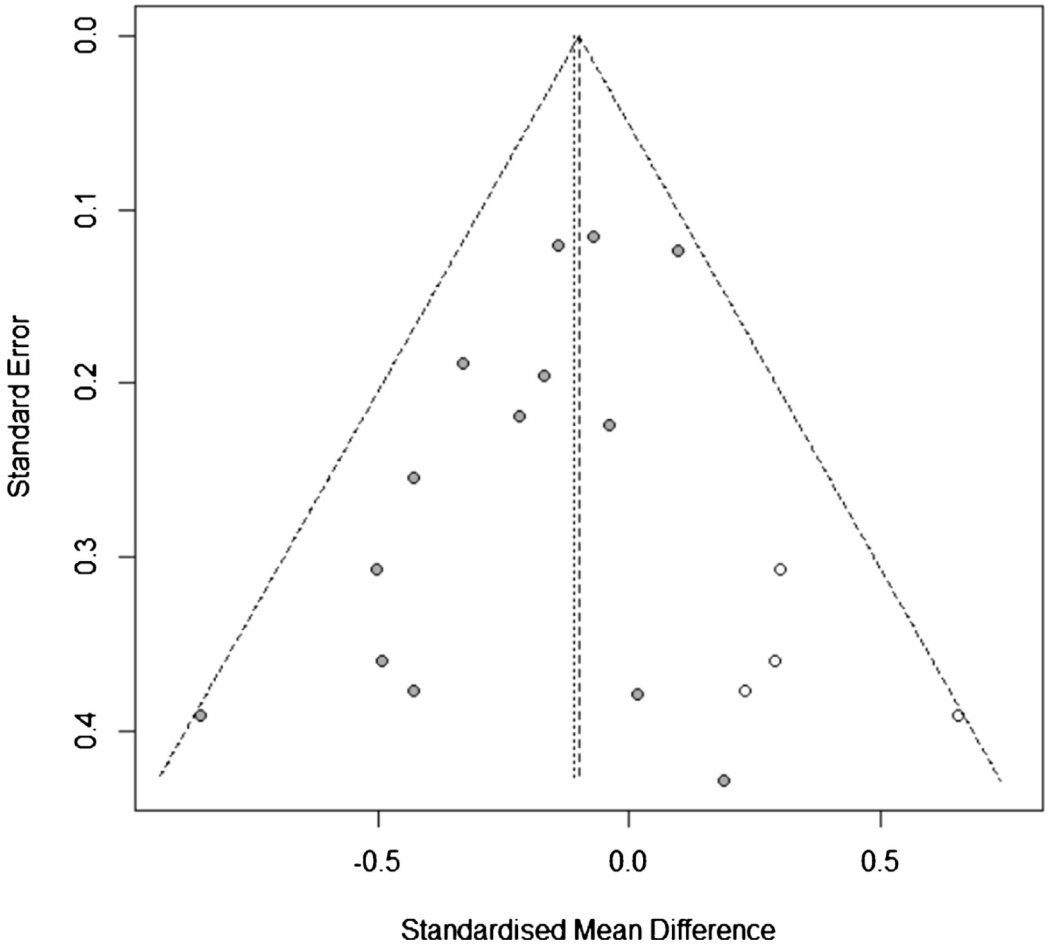

Fig 5. Funnel plot for the anxiety outcome. Not: Black circles: included studies. White circles: imputed studies using trim-and-fill methods.

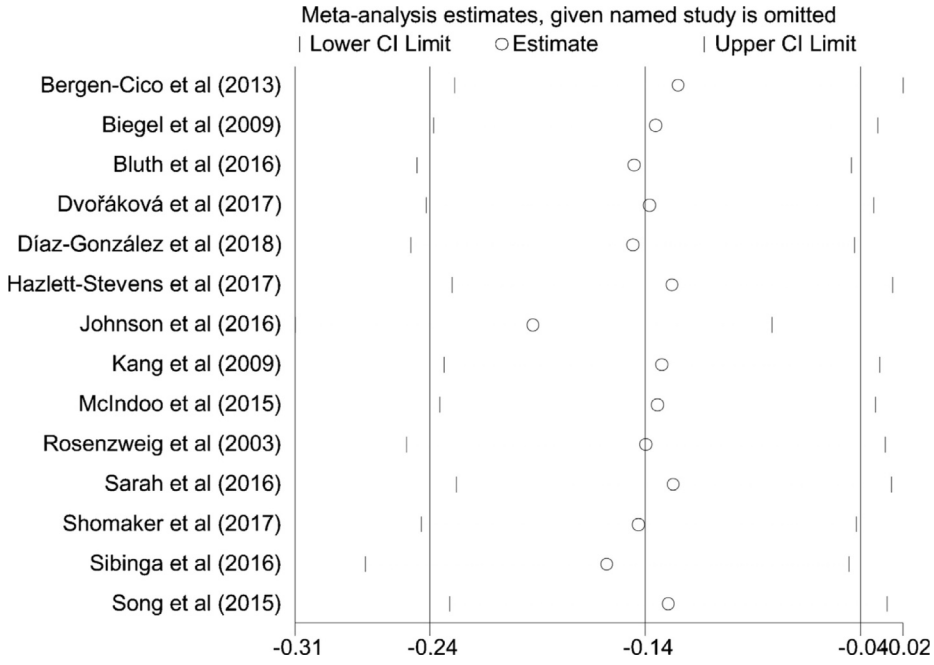

Fig 6. Sensitivity analysis included in the study.

literature to balance the potential risk of bias and the accuracy of meta-analysis. And more rigorously designed studies are needed to reduce the potential risk of bias in the future. The findings of the current study can help to reduce anxiety symptoms in young people and provide feasible support for short-term MBSR (< 8 weeks) interventions to improve the symptoms. However, due to the lack of follow-up evaluation and the difference of follow-up time, this study failed to point out the long-term follow-up effect of MBSR intervention, so the future meta-analyses need to be further explored.

5. Conclusion

To our knowledge, it is the first time that meta-analysis has been used to examine the efficacy of MBSR on anxiety symptoms of young people. Overall, the findings of this systematic review and meta-analysis suggest that mindfulness-based stress reduction (MBSR) may be helpful in alleviating anxiety symptoms in young people. MBSR, as a promising method, can be widely used in the treatment of anxiety symptoms. At the same time, MBSR in the youth population showed the outstanding effect of the short-term intervention, but no long-term effect, which may require a high-quality and randomized controlled trial to demonstrate. Furthermore, due to the non-significant difference of the active control group, the effect of MBSR intervention may be affected by the condition of the control group. In view of the increasing demand in the psychological counseling of young people, MBSR, which aims at positive mental health, could be widely carried out to promote the emotional health of adolescents.

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Declaration of Competing Interest

The authors declare no conflict of interest. Authors of this article have approved the submission of the manuscript to the journal and the data presented in the article is novel and has not yet been presented elsewhere.

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