Clinical Psychology Review 76 (2020) 101814

Contents lists available at ScienceDirect

Clinical Psychology Review

journal homepage: www.elsevier.com/locate/clinpsychrev

Review

The effect of four Immeasurables meditations on depressive symptoms: A systematic review and meta-analysis

Jing Lv[a], Qiuling Liu[b], Xianglong Zeng[b,*], Tian P.S. Oei[c], Yidan Liu[b], Kexin Xu[b], Wenxiang Sun[d], Hanchao Hou[e], Jing Liu[f]

[a] Faculty of Education, East China Normal University, Shanghai, PR China
[b] Beijing Key Laboratory of Applied Experimental Psychology, National Demonstration Center for Experimental Psychology, Faculty of Psychology, Beijing Normal University, Beijing, PR China
[c] School of Psychology, The University of Queensland, Australia
[d] Faculty of Education, Beijing Normal University, PR China
[e] Centre for Positive Psychology, Melbourne Graduate School of Education, The University of Melbourne, Australia
[f] The National Clinical Research Center for Mental Disorders & Beijing Key Laboratory of Mental Disorders, Beijing Anding Hospital, Capital Medical University, Beijing, China

HIGHLIGHTS

- Four Immeasurables Meditation reduces depressive symptoms in various populations.
- Large effect sizes were observed in samples with depressive disorders.
- Effects differ across Four Immeasurables Meditation protocols.
- Meditation practice and effect are not directly associated.
- Mindfulness and self-compassion are important mechanisms of change.

ARTICLE INFO

Keywords:
Loving-kindness
Compassion
Depression
Dose-effect
Buddhist
Mindfulness

ABSTRACT

The Four Immeasurables Meditations (FIM) intervention have been shown as a promising intervention for reducing depressive symptoms. The current study is a systematic review of FIM intervention effects on depressive symptoms. Among 192 empirical research articles on FIM published before May 2019, 40 independent trials from 35 records measured depressive symptoms. The meta-analysis included 21 randomized controlled trials (RCT; $n = 1468$) and 16 uncontrolled trials ($n = 376$). The results supported overall effectiveness of FIM on depressive symptoms ($d = 0.38$ for RCT and $d = 0.87$ for uncontrolled trials). Moderator analysis indicated the effects differed across protocols, and effects were smaller in RCT using active control groups. No significant differences were observed for participant type, measures, intervention length, or intervention components. Individual studies found no direct association between meditation practice time and effects, and mindfulness and self-compassion were widely supported as mechanisms of change. Current evidence supports FIM as an effective intervention for reducing depressive symptoms, but additional studies with more rigorous designs using active control groups are needed. Further investigation should be encouraged regarding specific protocols and participants, the contribution of meditation practice, and other mechanisms such as positive emotions.

1. Introduction

According to the world health organization, depression is one of the most prevalence mental health problems in the 21st century. Depressive symptoms take various forms, such as feeling sadness, lack of interest or pleasure, change in appetite or sleep, feeling worthless, and thoughts of suicide (World Health Organization, 2017). People with a depressive disorder diagnosis experience these symptoms more frequently, and experience higher rates of reduced function. Depressive symptoms are also widely experienced by people with other mental or physical disorders and even those without serious health problems (Schweizer, Kievit, Emery, & Henson, 2018). In recent years, mindfulness-based

* Corresponding author at: Room 1515, Houzhulou, No. 19 Xinjiekouwai St. (Beijing Normal University), Haidian District, Beijing 100875, China.
E-mail address: xzeng@bnu.edu.cn (X. Zeng).

https://doi.org/10.1016/j.cpr.2020.101814
Received 25 July 2019; Received in revised form 9 December 2019; Accepted 3 January 2020
Available online 08 January 2020
0272-7358/

interventions have been considered effective for reducing depressive symptoms (Goldberg et al., 2018). For example, a recent meta-analysis supported that mindfulness-based cognitive therapy can effectively treat major depressive disorder and prevent recurrent depression (Tickell et al., 2019). With further development of mindfulness-based interventions, other Buddhist meditations received more attention (Hofmann, Grossman, & Hinton, 2011; Rosenzweig, 2013). Among them, the Four Immeasurables Meditations (FIM) have been considered promising interventions for effectively reducing depressive symptoms (Hofmann et al., 2015).

As the name indicates, FIM aim to cultivate four prosocial attitudes or *four immeasurables*: loving kindness (friendliness), compassion (willing the suffering of others to cease), appreciative joy (happiness regarding others' successes), and equanimity (a calm attitude toward others' fate based on wisdom; Zeng, Chiu, Wang, Oei, & Leung, 2015). Usually, FIM practitioners silently repeat blessings for an imagined person, and the details are adjusted to cultivate different attitudes: loving-kindness meditation blesses a person with phrases like "may you be happy," compassion meditation blesses a person in suffering with phrases like "may you be free from suffering," appreciative joy meditation blesses a person in success or happiness with phrases like "may you not lose what you gain," equanimity meditation imagines various fates of others and repeats sentences like "he or she is the bearer of his or her fate" (Sujiva, 2007). It is notable that FIM is also referred like 'loving-kindness and compassion meditation' (Hofmann et al., 2011). One reason of this is because loving-kindness meditation and compassion meditation are widely used, whereas studies focused on appreciative joy meditation just emerged in very recent years (Zeng, Chan, Liu, Oei, & Leung, 2017). To be consistent with Buddhist theory, as well as avoiding confusion between general references for all subtypes and references for a specific subtype, the term FIM (Zeng, Chan, et al., 2017) was used in the current study. Additionally, the targeted person in FIM progresses from easy to difficult, that is, starting with oneself or friends, then to neutral persons, and finally to disliked people or all-beings (Zeng et al., 2015).

Empirical studies on FIM have grown rapidly in recent years (Galante, Galante, Bekkers, & Gallacher, 2014), with two kinds of beneficial effects commonly investigated. First, a series of studies showed that FIM practices could generate immediate positive emotions, and multi-week FIM interventions enhanced positive emotions in daily life (see Zeng et al., 2015 for review). Second, many studies showed that FIM interventions could cultivate positive attitudes and decrease negative attitudes toward oneself and others (Kang, Gray, & Dovidio, 2015). These two types of beneficial effects directly countered symptoms such as lack of pleasure and negative attitudes toward self, which suggests that FIM are promising for reducing depressive symptoms. Some research groups have tested FIM interventions for treatment of clinical depressive disorders (Hofmann et al., 2015; Schuling et al., 2018), but these studies had small sample sizes and required statistical summaries across studies to draw stable conclusions. Furthermore, many studies measured depressive symptoms as secondary outcomes among many other outcome variables (e.g., Finlay-Jones, Xie, Huang, Ma, & Guo, 2018), which required a systematic summary of the results that were dispersed in reports. Additionally, although some scholars suggested that FIM interventions were promising for reducing depressive symptoms (Hofmann et al., 2015; Shahar et al., 2015), the findings were not consistent across studies and null results or even increased depressive symptoms were reported in many studies (e.g., Mascaro, 2012), requiring meta-analysis to evaluate the results and identify the potential factors that led to discrepancies. At present, there have been no systematic reviews or meta-analyses of FIM intervention effects on depressive symptoms. Two previous reviews summarized the effectiveness of FIM for treatment of various clinical disorders or subclinical mental problems (Graser & Stangier, 2018; Shonin, Van Gordon, Compare, Zangeneh, & Griffiths, 2014), but they did not include depressive symptoms in the non-clinical samples. Additionally, these reviews covered many outcome variables, and only provided a basic narrative summary on whether depressive symptoms were significantly changed. That is, they lacked a statistical summary of the findings and did not provide in-depth explorations of factors influencing the effects on depressive symptoms. In sum, the current status of FIM interventions for treatment of depressive symptoms is still unclear and a review of the published evidence in the literature is needed.

Thus, the current study intended to provide a comprehensive review of FIM intervention effects on depressive symptoms. Whenever appropriate, meta-analyses were conducted to provide a more objective evaluation of the effects across studies and narrative summaries were included to capture the information that could not be evaluated by meta-analyses. In addition to overall effectiveness, the current review focused on the following issues: First, previous studies found that emotion regulation effects differ between clinical and non-clinical samples (Garnefski et al., 2002), and between adults and adolescents (Zimmermann & Iwanski, 2014). Thus, the current review compared the effects of FIM across different samples. Second, previous reviews on the effects of positive emotions did not find evidence that FIM intervention length influenced the results (Zeng et al., 2015), and also found that the amount of meditation practice in FIM interventions had limited associations with outcomes (Zeng, Chio, Oei, Leung, & Liu, 2017). Furthermore, recent laboratory studies showed that subtypes of FIM (appreciative joy meditation versus compassion meditation) had different effects on positive emotions (Zeng, Chan, et al., 2017). Therefore, the current review illustrated how these structural and component variations of FIM interventions influenced the effectiveness of FIM interventions on depressive symptoms. Third, we investigated the underlying mechanism of FIM intervention effects on reducing depressive symptoms.

2. Method

2.1. Literature search

The literature search first identified all the FIM studies published in English before May 1st 2019, then investigated the effectiveness of FIM depressive symptoms. *Cochrane Central Register of Controlled Trials*, *ISI Core Collection*, *Medline*, *ProQuest Dissertations & Theses*, and *PsycInfo* databases were used to identify FIM studies. The search query used across title, keywords, and abstracts were "immeasurable OR kindness OR compassion OR ((Appreciative OR Sympathetic) AND Joy) OR equanimity OR metta OR mudita OR karuna OR upekkha" combined with "Meditat*", adjusted for different databases. After excluding duplicates, all studies that might fit the systematic review were obtained.

2.2. Selection of studies

The inclusion criteria were (a) English language articles published in academic journals or dissertations; (b) empirical studies that focused on multi-week FIM interventions; and (c) studies with quantitative measurements of depressive symptoms. The exclusion criteria were opposite to the inclusion criteria without additional limitation, except for two situations: (1) interventions where FIM accounted for $< 50\%$ of the major practices were not considered FIM interventions (e.g., Graser, Höfling, Weßlau, Mendes, & Stangier, 2016); and (2) practices that induced love or compassion through imaging the receipt of love or compassion from others (e.g., compassion focused imaging; Judge, Cleghorn, McEwan, & Gilbert, 2012) were not considered FIM (according to Shonin et al., 2014; Zeng et al., 2015).

Two authors independently reviewed the titles and abstracts to identify potential empirical FIM articles, then each full article was independently reviewed by two authors to identify whether it was an empirical FIM study. The reference lists of identified empirical studies and previous FIM reviews were checked for missing studies. Finally, the empirical FIM studies were screened by two authors to identify those

that met the criteria for the current review. Any discrepancies were discussed until a consensus was reached with help from a third author. Article authors were contacted for missing data, although not all authors replied or provided useful information.

2.3. Data extraction and coding

The d_{ppc} (standardized mean difference for a pre-post-control design) served as the effect size for RCT, and Cohen's *d* (the standardized mean difference for a pre-post design) served as the effect size for uncontrolled trials. If d_{ppc} or Cohen's *d* were not reported directly, effect sizes were computed as follows: (1) transforming the explained proportion of total variance in an analysis of variance (η^2) into d_{ppc}, (2) transforming *F* values into d_{ppc} according to Thalheimer and Cook (2002), or (3) calculating effect sizes with means and standard deviations according to Morris (2008). The missing correlation value between pre- and post-intervention was imputed as 0.5 (Follmann, Elliott, Suh, & Cutler, 1992).

The studies were coded for participant type (adults, adolescents; healthy people, people with depressive disorders, people with other clinical conditions), study design (iRCT, uncontrolled) and control conditions (wait list control, active control), protocol, intervention length, intervention components (e.g., FIM subtypes, focusing on self or others), depressive symptoms measures, long-term effects, mediator, moderator, and meditation practice. Additionally, the quality of each study was evaluated according to the Cochrane assessment for risk of biases. For inconsistent coding, objective information (e.g., intervention length) was checked according to the article, while subjective judgments (e.g., intervention components) were discussed by the two coders. All coding discrepancies were resolved through these processes.

2.4. Strategy of meta-analyses

The meta-analyses were conducted using R, version 3.5.1. The random-effects model was chosen as the theoretical approach for meta-analysis (Hedges & Vevea, 1998). The inverse of total variance (Hartung, Knapp, & Sinha, 2008) was used to weight each study and compute the average effect size. For both types of standardized mean difference (SMD; d_{ppc} and Cohen's *d*), a value < 0.2 indicated a small effect size, a value between 0.2 and 0.8 indicated a medium effect size, and a value larger than 0.8 indicated a large effect size (Cohen, 1988). Funnel plots were used to investigate publication bias. The Trim and Fill test (Duval, 2005) and Orwin's Failsafe *N* (Orwin, 1983) were applied to explore publication bias.

Heterogeneity was tested with the *Q* test (Hedges & Olkin, 1985), I^2 statistic, and τ^2 value (Higgins, Thompson, Deeks, & Altman, 2003). Moderator analyses were conducted to examine whether specific characteristics could explain heterogeneity. To develop statistically meaningful moderator analyses, the moderators were finally coded as follows: (1) participant type included: (a) healthy adults, (b) adults with clinical conditions, and (c) adolescents. Adults with clinical conditions were further divided as (b1) depressive disorders and (b2) other conditions. (2) Control conditions for RCT included (a) waitlist control group and (b) active control group. (3) Measures included coded levels for measures that were used in more than one trial, and revisions or short forms of the same instrument were coded as one instrument. For example, Beck Depression Inventory (BDI) and BDI-II were coded together, and the 21-item and 42-item versions of the Depression Anxiety and Stress Scale (DASS) were also coded together. (4) Intervention length included (a) high-intensity interventions, conducted over consecutive days and (b) low-intensity interventions, which were multi-week interventions with one or two sessions per week. The low-intensity interventions were further coded according to the length of the entire intervention. (5) Intervention components were coded in three types: (a) self-compassion interventions, which emphasized self-compassion and the meditation blessings for oneself accounted for at least half of the total meditation practice; (b) other-compassion interventions, which clearly emphasized compassion and meditation blessings for oneself accounted for less than half of the total meditation practice; (c) other interventions, which did not focus on self-compassion or compassion for others, or did not clarify components. (6) Special protocols included protocols that were applied in more than one trial.

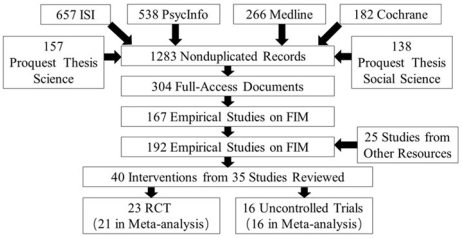

Fig. 1. Flowchart of studies selection.

3. Results

3.1. Search results and characteristic of studies

The literature search flowchart is shown in Fig. 1. The initial literature search collected 1283 non-duplicated records, and 304 full documents were accessed based on their title and abstract. A total of 135 journal articles and 32 master/doctoral dissertations were identified as empirical FIM research, and additional 24 journal articles and one dissertation were added from other resources (e.g., citations in articles). Therefore, there were 192 records that included empirical FIM research; 113 (i.e., 59%) were published on 2015 or later. A list of the 192 records of FIM research and reasons for exclusion of other fully-accessed documents are available upon request. A total of 40 interventions from 35 records met criteria for the current review.

Among the 40 interventions, 23 interventions were RCT studies, 15 were single group studies that compared pre- and post-interventions, and the remaining two interventions were quasi-RCT studies that compared FIM with other conditions in a non-randomized design. The intervention group in Wong (2011) was extracted and analyzed as an uncontrolled pre-post comparison, while the intervention by Brito-Pons, Campos and Cebolla (2018, Study 2) was removed because the intervention group came from an included RCT study (Brito-Pons et al., 2018, Study 1). Overall, these included 40% high risk, 12% low risk and 48% unclear risk across all studies and risk categories. The evaluation of each study is shown in Table A.1 in the Appendices.

3.2. Meta-analyses for randomized controlled trials

3.2.1. Handling of effect sizes

Among 23 RCTs, two studies lacked critical data for meta-analysis (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Shapira, 2012). The remaining 21 studies in the meta-analyses included 1468 participants. Three studies compared one FIM intervention with two control conditions, and the weighted average effect sizes were used for the final effect sizes (Desbordes et al., 2012; Mongrain, Barnes, Barnhart, & Zalan, 2018; Weytens, Luminet, Verhofstadt, & Mikolajczak, 2014). One study compared three types of FIM interventions with one control condition, and thus the three effect sizes were independent (Baltman, 2017). Another study computed two effect sizes with the same group of participants, and the effect size with the larger samples was used (Gonzalez-Hernandez et al., 2018). Thus, the RCT meta-analysis included 23 independent effect sizes. The information used for the meta-analyses are shown in Table 1, and additional information (demographic information, long-term effects, and contribution of meditation practice) is shown in Table A.2 in the Appendices.

Table 1
Summary of studies included in RCT meta-analysis.

Study	Participants	Participant Type	Comparison	Control Conditions	Protocol	Intervention Components	Length (weeks)	Measure	*n* FIM	*n* Ctrl	*d*
Arimitsu (2016)	low self-compassion community adults	Adults Healthy	Waitlist	WaitList	ESP	Others	7	BDI-II	16	12	0.66
Baltman (2017) 1	university students	Adults Healthy	Quiet Sitting	ActiveCtrl	Unamed	Others	2	CES-D	37	32	0.21
Baltman (2017) 2	university students	Adults Healthy	Quiet Sitting	ActiveCtrl	Unamed	Others	2	CES-D	30	32	0.33
Baltman (2017) 3	university students	Adults Healthy	Quiet Sitting	ActiveCtrl	Unamed	Others	2	CES-D	32	32	0.35
Bluth et al. (2016)	adolescents	Adolescents	Waitlist	WaitList	MFY	Self-Compassion	6	SMFQ	16	18	0.53
Brito-Pons et al. (2018)	community adults	Adults Healthy	Waitlist	WaitList	CCT	Other-Compassion	9	BDI-II	26	24	0.99
Desbordes et al. (2012)	healthy adults	Adults Healthy	Mindful Attention Training, Health Discussion Group	ActiveCtrl	CBCT	Other-Compassion	8	BDI-II	17	13,11	0.56
Dodds et al. (2015)	breast cancer survivors	Adults Clinical	Waitlist	WaitList	CBCT	Other-Compassion	8	CES-D-10	12	16	0.73
Dundas et al. (2017)	people at universities	Adults Healthy	Waitlist	Waitlist	Unamed	Self-compassion	2	MDI	53	64	0.45
Friis, Johnson, Cutfield, and Consedine (2016)	patients with diabetes	Adults Clinical	Treatment As Usual	WaitList	MSC	Self-Compassion	8	PHQ-9	32	31	0.41
Galante, Bekkers, Mitchell, and Gallacher (2016)	general public	Adults Healthy	Light Exercise	ActiveCtrl	Unamed	Others	4	IDAS	71	72	0.04
Gonzalez-Hernandez et al. (2018)	breast cancer survivors	Adults Clinical	Waitlist	Waitlist	CBCT	Other-Compassion	8	BSI	28	25	0.29
Haukaas et al. (2018)	university students	Adults Healthy	Attention Training Technique	ActiveCtrl	Unamed	Self-Compassion	2	PHQ-9	41	40	0.02
Johnson et al. (2018)	low-income suicide attempters	Adults Clinical	Support Group	ActiveCtrl	CAMP	Other-Compassion	6	BDI-II	35	24	0.35
Lang et al. (2019)	veterans with PTSD	Adults Clinical	Veteran.calm intervention	ActiveCtrl	CBCT	Other-Compassion	10	PHQ-9	14	14	0.41
LoParo et al. (2018)	suicide attempters	Adults Clinical	Support Group	ActiveCtrl	CBCT	Other-Compassion	6	BDI-II	52	30	0.16
Mascaro (2012)	university students and general public	Adults Healthy	Health Discussion Group	ActiveCtrl	CBCT	Other-Compassion	8	DASS-42	13	8	−0.45
Mascaro et al. (2018)	university students from medical school	Adults Healthy	Waitlist	WaitList	CBCT	Other-Compassion	10	DASS-42	21	11	0.45
Mongrain et al. (2018)	low agreeableness adults	Adults Healthy	Acts of kindness, Interpersonal Reflection	ActiveCtrl	Unamed	Other	3	CES-D	71	64, 61	0.1
Neff and Germer (2013)	community adults	Adults Healthy	Waitlist	WaitList	MSC	Self-Compassion	8	BDI	24	27	0.92
Reddy et al. (2013)	at risk adolescents	Adolescents	Waitlist	WaitList	CBCT	Other-Compassion	6	QIDS	29	26	0.02
Shahar et al. (2015)	high self-criticism adults	Adults Healthy	Waitlist	WaitList	Unamed	Others	7	DASS-21	14	18	0.66
Weytens et al. (2014)	university students	Adults Healthy	Positive Emotion Regulation, Waitlist	NA	Unamed	Others	6	BDI	16	28, 35	0.34

Note. ESP = Enhancing Self-Compassion; MFY = Making Friends with Yourself; CBCT = Cognitive Based Compassion Training; MSC = Mindful Self-Compassion; CAMP = Grady Compassion and Meditation Program. BDI = Beck Depression Inventory; CES-D = Centre for Epidemiological Studies Depression Scale; SMFQ = Short Mood and Feelings Questionnaire; MDI = Major Depression Inventory; PHQ = Patient Health Questionnaire; IDAS = Irritability, Depression and Anxiety scale; BSI = Brief Symptom Inventory; DASS = Depression Anxiety and Stress Scale; QIDS = Quick Inventory of Depressive Symptomatology–Self Report. "Ctrl" indicates control condition.

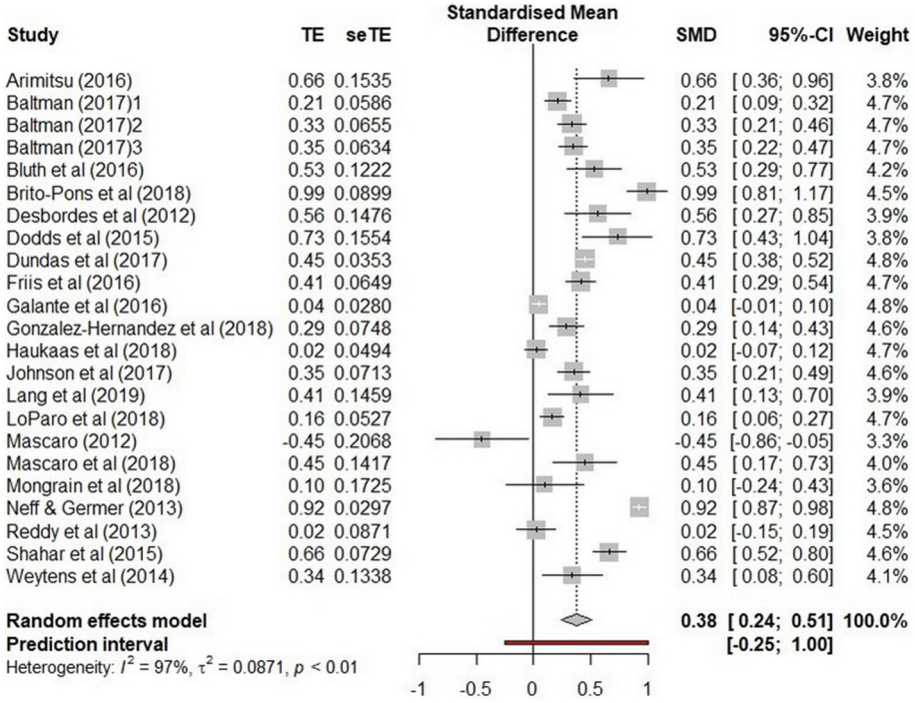

Fig. 2. Forest plot for meta-analysis for RCT studies.

3.2.2. Overall effects

The weighted average effect size across 23 independent effect sizes was d_{ppc} = 0.38 (95% CI = [0.24, 0.51]), indicating a medium effect of FIM intervention in reducing depressive symptoms across designs. Fig. 2 shows the forest plot, indicating large variation among the obtained effect sizes. Heterogeneity was confirmed by the Q test and I^2 statistics, with $Q(22) = 672.97$, $p < .001$, and $I^2 = 96.7\%$ ($\tau^2 = 0.09$). The significant heterogeneity indicated a need for moderator analysis.

The funnel plot (see Fig. 3) shows asymmetrical publication bias, as there was an absence of studies on the bottom right and middle left of the funnel. The missing points at the bottom of the plot represent studies with smaller sample size, which tended to be less influential. Moreover, Orwin's fail-safe N was 23, indicating that at least 23 additional studies with an effect size near zero would be needed to nullify the effect. The Trim and Fill test suggested imputing one missing case to make the plot symmetric, but the average effect size (0.40) after imputing was even higher than the original one. Therefore, the impact of publication bias was minimal and did not threaten the results.

3.2.3. Moderator analysis

The results of moderator analyses showed that control conditions and special protocols significantly moderated the impact of FIM

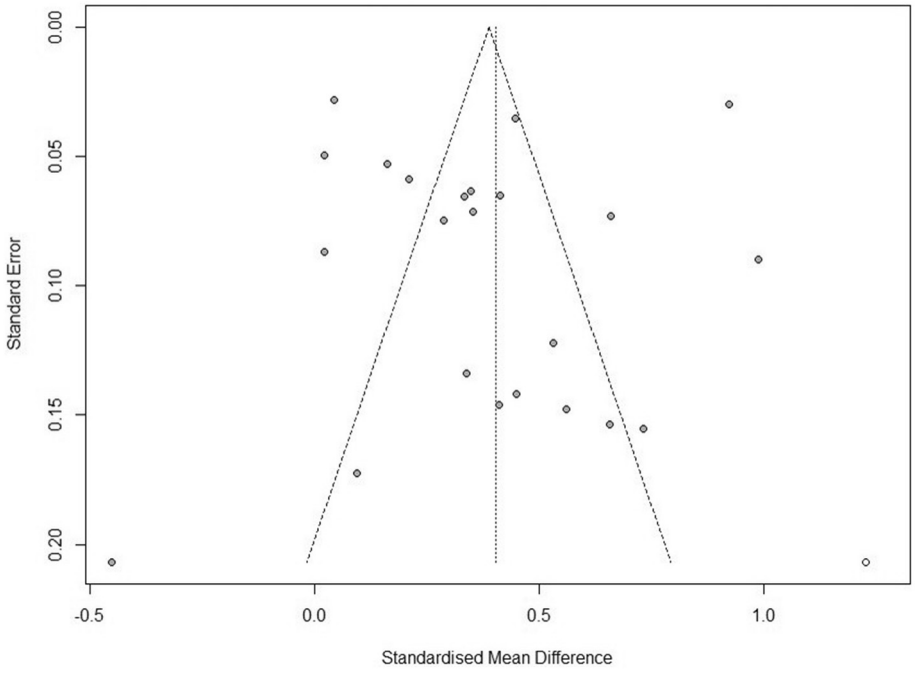

Fig. 3. Funnel plot for meta-analysis for RCT studies.

intervention on depressive symptoms. For the control conditions (Q (1) = 10.16, p = .001), the average effect size was higher when comparing intervention groups with waitlist control groups (i.e., d_{ppc} = 0.55, 95% CI = [0.36, 0.74], k = 11) than with active control groups (d_{ppc} = 0.20, 95% CI = [0.04, 0.36], k = 11). For special protocols ($Q(1) = 2.47, p < .001$), FIM intervention tended to be more effective when the protocol was based on Mindful Self-Compassion (MSC; d_{ppc} = 0.67, 95% CI = [−2.57, 3.91], k = 2) rather than Cognitive-Based Compassion Training (CBCT; d_{ppc} = 0.28, 95% CI = [−0.01, 0.57], k = 8). However, this result only indicates the preprimary estimates of the effect because of the quite small group size (i.e., k = 2) and broadly overlapped confidence intervals (i.e., 95% CI = [−2.57, 3.91], zero was included in the 95% CI) of MSC.

Participant type, measures, intervention length, and intervention components were not significant moderators. Differences across all investigated participant types (i.e., $Q(2) = 0.19, p = .910$) or between adults with clinical conditions and healthy adults ($Q(1) < 0.01$, p = .964) were not significant. The average effect based on healthy adults was d_{ppc} = 0.39 (95% CI = [0.19, 0.59], k = 15); the average effect based on adults with various clinical conditions was d_{ppc} = 0.36 (95% CI = [0.18, 0.55], k = 6); and the average effect based on adolescents was d_{ppc} = 0.27 (95% CI = [−2.96, 3.50], k = 2). Similarly, the moderator effect was not significant across measures (i.e., $Q(3) = 3.60, p = .31$). That is, d_{ppc} = 0.39 (95% CI = [0.28, 0.50], k = 7) when depressive symptoms were measured by BDI or BDI-II; d_{ppc} = 0.24 (95% CI = [−1.21, 1.69], k = 3) when depressive symptoms were measured by DASS-21 or DASS-42; d_{ppc} = 0.34 (95% CI = [0.07, 0.60], k = 5) when depressive symptoms were measured by Centre for Epidemiological Studies Depression Scale (CES-D); and d_{ppc} = 0.27 (95% CI = [−0.31, 0.84], k = 3) when depressive symptoms were measured by Patient Health Questionnaire (PQH-9). The meta regression showed that the impact of intervention length was marginally significant, as the test of the moderator was $F(1,21) = 4.01$, p = .058. The longer interventions tended to be more effective in reducing depressive symptoms, as the regression model was d_{ppc} = 0.108 + 0.046 * weeks. Though the moderator effect components of interventions was not significant ($Q(2) = 0.69, p = .71$), all intervention types reduced depressive symptoms, where the average effect sizes were d_{ppc} = 0.47 (95% CI = [0.06, 0.87], k = 5), d_{ppc} = 0.36 (95% CI = [0.09, 0.63], k = 10), d_{ppc} = 0.33 (95% CI = [0.14, 0.52], k = 8) for self-compassion, other-compassion and other interventions, respectively.

3.3. Meta-analyses for uncontrolled trials

3.3.1. Handling of effect sizes

All 16 uncontrolled pre-post comparisons provided enough information for meta-analysis and included 376 participants. One study measured depressive symptoms with two measures, and thus the weighted average effect size was used as the final effect size (Hofmann et al., 2015). Therefore, the meta-analysis for uncontrolled studies included 16 independent effect sizes. The information used for the meta-analyses are presented in Table 2, and additional information is presented in Table A.3 in Appendices.

3.3.2. Overall effects

The weighted average effect size across 16 trials was d_{ppc} = 0.87 (95% CI = [0.45, 1.29]), indicating a large effect of FIM intervention in reducing depressive symptoms across designs. The forest plot shown in Fig. 4 indicates a large variation across studies. The results of the Q test and I^2 statistic confirmed significant heterogeneity, with $Q(15) = 733.35$, p < .001 and I^2 = 98% (τ^2 = 0.60). Significant heterogeneity also indicated the need for moderator analysis.

The funnel plot (see Fig. 5) was asymmetrical with an absence of studies on the bottom left, which suggested publication bias. Similar to the RCT results, the bias tended to be less influential as a result of

Table 2
Summary of studies included in pre-post meta-analysis.

Study	Participants	Participant Type	Protocol	Intervention Components	Length	Measure	n	d
Alba (2013) 1	community adults	Adults Healthy	Buddhist retreat	Others	consecutive 4 days	DASS-21	20	0.32
Alba (2013) 2	community adults	Adults Healthy	Buddhist retreat	Others	consecutive 10 days	DASS-21	31	0.02
Bartels-Velthuis et al. (2016)	psychiatric outpatients	Adults Clinical	MBCL	Other-Compassion	9 weeks	BDI-II	33	0.20
Bluth and Eisenlohr-Moul (2017)	adolescents	Adolescents	MFY	Self-Compassion	8 weeks	SMFQ	47	0.48
Finlay-Jones et al. (2018)	community adults	Adults Healthy	MSC	Self-Compassion	8 weeks	DASS-21	44	1.47
Hofmann et al. (2015) 1	adults with moderate depressive disorders	Adults Clinical-Depression	Unamed (a)	Others	12 weeks	BDI-II	10	2.99
Hofmann et al. (2015) 2	adults with persistent depressive disorders	Adults Clinical-Depression	Unamed (a)	Others	8 weeks	BDI-II/HRDS (pooled)	8	1.86
Johnson (2010)	outpatients with schizophrenia-spectrum disorders	Adults Clinical	Unamed	Others	6 weeks	CDS	18	0.31
Kearney et al. (2013)	veterans with PTSD	Adults Clinical	Unamed	Others	12 weeks	PROMIS	42	0.32
Lang et al. (2017)	veterans with PTSD	Adults Clinical	CBCT	Other-Compassion	9 weeks	PHQ-9	26	0.65
Müller-Engelmann et al. (2019)	patients with PTSD	Adults Clinical	Unamed	Others	8 weeks	BDI-II	14	0.82
Neff and Germer (2013)	community adults	Adults Healthy	MSC	Self-Compassion	8 weeks	BDI	21	1.07
Schuling et al. (2018) 1	people with recurrent depression	Adults Clinical-Depression	MBCL	Other-Compassion	8 weeks	BDI-II	14	0.26
Schuling et al. (2018) 2	people with recurrent depression	Adults Clinical-Depression	MBCL	Other-Compassion	8 weeks	BDI-II	9	0.66
Uchino et al. (2016)	community adults	Adults Healthy	Unamed	Others	6 weeks	CES-D	9	1.97
Wong (2011)	community adults	Adults Healthy	Buddhist retreat	Others	consecutive 4 days	POMS-SF	30	0.93

Note. (a) These two unnamed protocols were considered the same as each other, while all other unnamed protocols were considered different from each other. MBCL = Mindfulness-Based Compassionate Living; MFY = Making Friends with Yourself; CBCT = Cognitive Based Compassion Training; MSC = Mindful Self-Compassion. BDI = Beck Depression Inventory; CDS = Calgary Depression Scale; CES-D = Centre for Epidemiological Studies Depression Scale; SMFQ = Short Mood and Feelings Questionnaire; HRDS = Hamilton Rating Scale for Depression; PHQ = Patient Health Questionnaire; PROMIS = NIH-sponsored Patient-Reported Outcomes Measurement Information System; DASS = Depression Anxiety and Stress Scale.

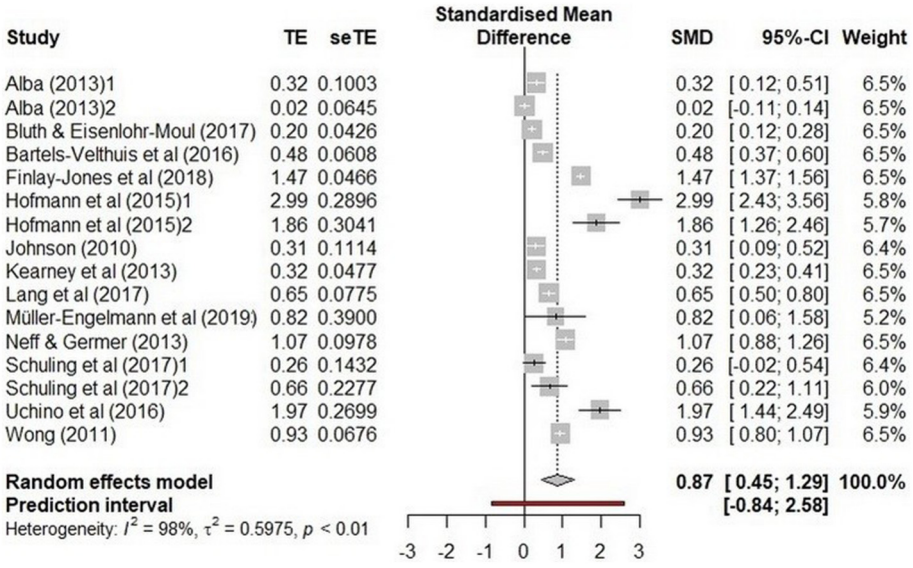

Fig. 4. Forest plot for meta-analysis for uncontrolled studies.

missing smaller sample size cases. The fail-safe *N* was 16, indicating that at least 16 additional null studies would be needed to nullify the effect. The Trim and Fill test suggested imputing at least two missing cases to avoid publication bias and result in a smaller average effect size of 0.65. Even if the effect size was smaller, it still represented a medium effect size, suggesting that our findings were credible.

3.3.3. Moderator analysis

Similar as the participant type results in RCT analysis, the difference between healthy adult target effect sizes (d = 0.94, 95% CI = [0.20, 1.68], k = 6) and those of adults with clinical conditions (d = 0.90, 95% CI = [0.21, 1.59], k = 9) was not significant (Q(1) = 0.11, p = .741). Within the subgroup of adults with clinical conditions, effect sizes for people with depressive disorders (d = 1.43, 95% CI = [−0.54, 3.39], k = 4) were not significantly different from effect sizes for people with other conditions (d = 0.44, 95% CI = [0.19, 0.69], k = 5), Q(1) = 2.5, p = .114. The moderator effect for measures also was not significant (Q(1) = 0.52, p = .471), where both BDI and BDI-II (d = 1.03, 95% CI = [0.002, 2.06], k = 6) and DASS-21 (d = 0.60, 95% CI = [−1.30, 2.50], k = 3) showed large or medium impact for FIM interventions reducing depressive symptoms. There were also no significant differences between the three intervention types (Q(2) = 3.21, p = .201). The confidence interval of the effect sizes for self-compassion interventions included zero (d = 0.91, 95% CI = [−0.70, 2.52], k = 3), whereas the confidence intervals or the effect sizes of other-compassion interventions (d = 0.51, CI = [0.24,0.78], k = 4) and other interventions (d = 1.03; 95% CI = [0.27, 1.80], k = 9) did not.

The difference between the low-intensity interventions (d = 0.96, 95% CI = [0.65, 1.27], k = 13) and the Buddhist retreat (d = 0.42, 95% CI = [−0.74, 1.59], k = 3) was not significant (Q(1) = 2.44, p = .118). Furthermore, meta-regression evaluated the impact of intervention length for the low-intensity FIM interventions, and showed a marginally significant moderator effect (F(1,11) = 0.42, p = .53; d = 0.232 + 0.088 * weeks). Unlike the above investigated moderators, special protocols were found to be a significant moderator (Q

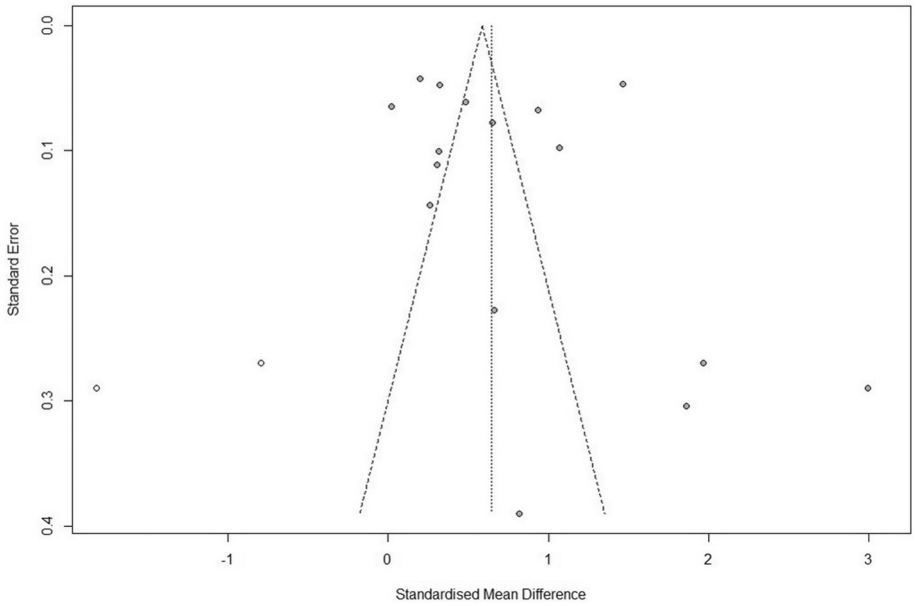

Fig. 5. Funnel plot for meta-analysis for uncontrolled studies.

(3) = 24.84, $p < .001$). The confidence intervals of the effect sizes of MSC ($d = 1.28$, 95% CI = [−1.24, 3.80], $k = 2$), protocols used in Hofmann et al. (2015; $d = 2.43$, 95% CI = [−4.77, 9.63], $k = 2$) and Buddhist treatments ($d = 0.42$, 95% CI = [−0.74, 1.59], $k = 3$) included zero, but mindfulness-based compassionate living (MBCL) ($d = 0.45$, 95% CI = [0.03, 0.87], $k = 3$) provided positive confidence intervals for the effect sizes.

3.4. Narrative review

Information on mediators, moderators, meditation practice contributions, and long-term effects were coded. However, limited studies have conducted a meaningful meta-analysis in current literature. Thus, the information coming from individual studies were summarized in the narrative form. Of note, the narrative review was based on all 40 reviewed articles, including the two articles that were not included in the meta-analysis (Fredrickson et al., 2008; Shapira, 2012).

3.4.1. Potential mediators and moderators

Self-compassion and mindfulness were two of the most widely tested mediators. Kearney et al. (2013) and Dundas, Binder, Hansen, and Stige (2017) only tested self-compassion, finding that changes in self-compassion significantly mediated or correlated with changes in depressive symptoms. For those that tested both self-compassion and mindfulness, three studies reported that both self-compassion and mindfulness predicted change in depressive symptoms (Bluth & Eisenlohr-Moul, 2017; LoParo, Mack, Patterson, Negi, & Kaslow, 2018; Müller-Engelmann et al., 2019). Neff and Germer (2013; Study 2) reported that changes in self-compassion significantly predicted changes in depressive symptoms, and further pointed out that changes in mindfulness did not provide an additional explanation when changes in self-compassion was included in the model. In contrast, Bluth, Gaylord, Campo, Mullarkey, and Hobbs (2016) found that changes in depressive symptoms were correlated with changes in mindfulness, but not with changes in self-compassion. Additionally, one study reported that responders (i.e., those with a minimum 35% reduction in depressive symptoms) had higher changes in mindfulness, self-compassion, and attention flexibility than non-responders in both the intervention and active control groups, but attention flexibility was the only significant predictor for depressive symptoms when mindfulness, self-compassion and attention flexibility combined predicted depressive symptoms (Haukaas, Gjerde, Varting, Hallan, & Solem, 2018).

As for other variables, Johnson et al. (2018) also found that the changes in self-criticism significantly predicted changes in depressive symptoms, which was also reported by Müller-Engelmann et al. (2019). Uchino et al. (2016) reported that compared with social support, change in social negativity had a closer association with change in depressive symptoms, although the finding was only marginally significant. Fredrickson et al. (2008) found that positive emotions directly predicted changes in depressive symptoms and indirectly predicted changes in depressive symptoms through mediation of eight variables (mindfulness, pathways thinking, savoring the future, environmental mastery, self-acceptance, purpose in life, positive relations with others, and illness symptoms).

Two studies explored the potential moderators in depressive symptoms changes. Finlay-Jones et al. (2018) hypothesized that perfectionism moderated the effects on depressive symptoms and other variables, but they did not find the hypothesized significant differences. Shapira (2012) explored whether self-criticism and neediness (i.e., maladaptive fears of rejection or loneliness) impacted the effectiveness of interventions. The results showed that loving-kindness meditation was more effective in general than the control condition at post-intervention. Furthermore, such relative effectiveness also occurred in people who were high in self-criticism and neediness and lasted from post-intervention to one-month follow-up.

3.4.2. Contribution of meditation practice

Among the reviewed studies, 16 independent trials reported on the amount of meditation practice, and nine of them calculated correlations with effects on depressive symptoms (see Table A.2, Table A.3 in the Appendices). Three trials found that meditation practice time did not predict any outcome variables (Haukaas et al., 2018; Mascaro et al., 2018; Müller-Engelmann et al., 2019), and the other six trials found that meditation practice time predicted other variables such as hopefulness and anxiety but not depressive symptoms (three trials in Baltman, 2017; Desbordes et al., 2012; Dodds et al., 2015; Reddy et al., 2013). That is, no study found a direct relationship between the amount of meditation practice and depressive symptoms.

On the other hand, some reports suggested an indirect contribution of meditation practice. Neff and Germer (2013) reported that meditation practice could predict self-compassion, and that self-compassion could predict other outcomes including depressive symptoms. Similarly, Fredrickson et al. (2008) supported that meditation practice predicted positive emotions, which in turn predicted resources, and finally, depressive symptoms. It is notable that these two studies did not report direct associations between the amount of meditation practice and depressive symptoms; therefore, whether there were significant direct associations in these studies was unknown.

3.4.3. Long-term effects

Seventeen independent trials reported follow-up results after post-intervention measures (see Table A.2, Table A.3 in the Appendices). The interval from post-intervention varied from one week (Baltman, 2017) to six months (Haukaas et al., 2018), and there were other problems, such as high dropout rates at follow-up (e.g., Alba, 2013), and no follow-up measure for the waitlist group (Brito-Pons et al., 2018). Considering these issues, the current review summarized the long-term effects in narrative ways, rather than meta-analysis.

As shown in Table A.2 and Table A.3 in the Appendices, most trials found that the effects were maintained to follow-up, that is, pre-intervention to post-intervention comparisons and pre-intervention to follow-up comparisons were consistent in terms of their statistical significance (e.g., Finlay-Jones et al., 2018), or there was no significant difference between post-intervention and follow-up (e.g., Dundas et al., 2017). The following seven studies found that significance levels were different between pre-intervention to post-intervention and pre-intervention to follow-up, although direct comparison between post-intervention and follow-up was not available. Kearney et al. (2013) and Müller-Engelmann et al. (2019) reported that effects on depressive symptoms became significant at follow-up. Arimitsu (2016) also emphasized that the intervention group showed significant decreases in depressive symptoms from pre-intervention to follow-up, although no time by group interaction was found in this RCT. On the other hand, three studies reported that effects on depressive symptoms were no longer significant at follow-up (Dodds et al., 2015; Johnson, 2010; Shahar et al., 2015). Additionally, Shapira (2012) reported loving-kindness meditation was more effective than the control condition at post intervention but not at follow-up, and that relative effectiveness among people high in both self-criticism and neediness was maintained at one-month but not two-month follow-up.

4. Discussion

4.1. Current status of investigation and overall effects

A systematic literature search showed that empirical FIM studies were still scarce, but new studies have increased sharply, with 59% of studies published within the past five years. Nearly one-fifth (35 of 192) of FIM studies measured depressive symptoms, although not all of them highlighted depressive symptoms as a primary outcome. That is, depressive symptoms were actually a commonly-evaluated outcome in FIM studies, and the current review provided the first comprehensive

summary of the findings that scarred across studies.

FIM interventions effectively reduced depressive symptoms in uncontrolled designs, and also showed comparative effectiveness in RCT studies. At the same time, the effects showed heterogeneity across studies. A closer look into the RCT studies suggested that the effect sizes comparing FIM interventions with waitlist conditions seemed to be larger than those comparing FIM interventions with the active control group condition, although the subgroup analysis was not significant. Particularly, FIM interventions were favored in most studies, but an exception existed in comparisons with active control group (Mascaro, 2012). Additionally, long term effects measures had various interval and mixed results; thus, whether there were essential changes from post-intervention to follow-up is not yet clear. In sum, FIM interventions are promising for effectively reducing depressive symptoms, although effectiveness may vary under different conditions, as discussed below.

4.2. Effects among different groups

To conduct meaningful comparisons, the participant groups were coded into healthy adults, adults with clinical conditions, and adolescents. While previous reviews were limited to depressive symptoms among clinical or subclinical samples (Graser & Stangier, 2018; Shonin et al., 2014), the current review found that half of the studies (21 of 40) evaluated depressive symptoms among healthy adults. The meta-analyses supported that FIM interventions could effectively reduce depressive symptoms in healthy adults. The specific clinical conditions among adults with clinical conditions varied across studies. The meta-analyses findings also supported that FIM interventions could effectively reduce depressive symptoms for people with clinical conditions, and the effect sizes for the clinical samples were quite close to the effect sizes for healthy people, with no significant differences observed between the two types of samples. That is, although the effects of emotion regulation technique were often different between healthy and clinical samples (Garnefski et al., 2002), there was no clear evidence indicating that the effects of FIM on depressive symptoms were different for healthy and clinical samples.

The samples with depressive disorders were further divided from samples with other clinical conditions, and there was no significant difference between these two participant types. However, large effect sizes were observed for trials on depressive disorders, which implied that FIM was very promising for treating depressive disorders. The limitation of such findings, as noted by the authors, was that the trials lacked control conditions, which might have led to confounding with other factors, such as medical treatments (Hofmann et al., 2015). Furthermore, compared to other studies, the higher depressive symptoms at baseline also provided more room for symptom reduction among people with depressive disorders, and stronger expectancy effects may have existed since these interventions targeted depressive disorders. Considering that depressive symptoms were primary problems of depressive disorders, studies with more rigorous designs were advocated to draw solid conclusions for this promising application.

Finally, only three reviewed trials were conducted among adolescents. FIM studies among adolescents were quite rare, with only five in all of the identified FIM studies (see Kirby & Laczko, 2017; Pace et al., 2013 for the other two). Because these three FIM studies varied in terms of study design (uncontrolled or RCT) and participants (normal or at-risk adolescents), statistical summary or further comparison with adults was not meaningful. Nevertheless, these three studies showed the FIM interventions, after adjusting for adolescents, were acceptable and beneficial for adolescents (see Bluth et al., 2016; Reddy et al., 2013), although more solid conclusions about their effects on depressive symptoms or other outcomes require more evidence.

4.3. Impact from different measures

As listed in Tables 1 and 2, the studies in meta-analysis used 13 different measures for depressive symptoms. The meta-analysis compared measures used in more than one trial, and did not identify significant differences in the measures as a whole. A notable issue was that only one study used an other-rater depressive symptoms measure (Hamilton Rating Scale for Depression; Hofmann et al., 2015); future studies should rely less on self-report scales.

4.4. FIM intervention components

The current review included seven named protocols and 18 unnamed protocols or Buddhist retreats. Of these, 20 protocols had only one trial. The protocol components varied in terms of meditation practice and didactic components (e.g., psychoeducation), and it is unfortunate that many protocol details were not well illustrated. Thus, the current review coded different interventions into three types according to the available information. The findings showed that all three intervention types reduced depressive symptoms and we observed no significant differences across types. That is, although self-compassion was considered an important component with potential treatment effects, the current study did not find that interventions emphasizing more self-compassion led to significantly better effectiveness. A notable phenomenon is that the term “loving-kindness meditation” could be used as a general reference for all subtypes of FIM or specifically for the subtype that cultivates loving-kindness (Zeng et al., 2015), which made it hard to identify which FIM subtypes were used in some protocols. This issue had little impact on the current review, because all protocols that did not focus on self-compassion or compassion for others were coded as “other interventions.” Nevertheless, the exact FIM subtype is important, considering that a recent study found FIM subtypes had different effects on emotions (Zeng, Chan, et al., 2017). Therefore, we strongly recommend that future studies clarify the intervention components, especially the meditation practice.

Meta-analysis also evaluated effect sizes for protocols with at least two RCTs or two uncontrolled trials, and the moderator analysis suggested that different protocols may differ significantly in terms of their effectiveness in reducing depressive symptoms. Among these protocols, MSC showed large effect sizes in pre-post comparisons and medium effect sizes in comparison with the waitlist control group. These results support MSC as a promising intervention for reducing depressive symptoms. However, the small number of studies that included MSC did not provided sufficient evidence yet (i.e., 95% CI of estimated effect size still included 0), and further comparisons between MSC and active control groups are also needed. CBCT showed medium effect sizes in RCTs, that were significantly smaller than those of MSC. However, CBCT RCTs included both waitlist and active control groups. Considering such confounding factors, more solid evidence is needed to draw conclusions regarding the relative effectiveness between the two protocols. As recently developed protocols, MBCL and the unnamed protocol used in Hofmann et al. (2015) have only been studied with uncontrolled trials. Meta-analysis supported a significant medium effect size for MBCL. The protocol used in Hofmann et al. (2015) actually had large effect sizes, although the small sample size resulted in non-significant effect size in meta-analysis. It is also notable that in the current review, all four trials in people with depressive disorders were based on MBCL and the protocol used by Hofmann et al. (2015). Future studies should use more rigorous designs to further evaluate the effectiveness of these protocols for treating depressive disorders.

The Buddhist retreats showed non-significant but medium effect sizes in uncontrolled designs. Buddhist retreats may differ from other interventions in several ways, and the three reviewed trials were all short term high-intensity interventions. Additionally, these retreats provided by Buddhist institutions may involve more Buddhist components, and may attract more people who are interested in Buddhism,

although these details were not illustrated in the reviewed studies. It is also notable that similar Buddhist retreats are frequently held (Alba, 2011), but the empirical research on their impact is quite scarce.

4.5. Intervention length and contribution of meditation

Meditation practice is time-consuming; thus, it is important to ask whether longer intervention and more intensive meditation practice would lead to better outcomes. This was considered an important issue for the best practices of FIM and other meditation interventions (Zeng et al., 2015). The current review found marginally significant associations between intervention length and effects in both RCT and uncontrolled trials. This was the first time that such an association was supported by evidence, as previous meta-analyses did not find similar association between intervention length and effects on positive emotions ($p > .349$ in Zeng et al., 2015). Our findings were consistent with evidence from other therapies for depressive disorders showing that reducing depressive symptoms requires sufficient time (Barkham et al., 1996). However, the current analysis could not exclude the possibility that studies with longer interventions simply allow more time for the depressive symptoms to decrease, especially since further improvement was observed at the follow-up in some studies. In addition, longer interventions are not necessarily deeper or more intense, because other factors such as meditation practice time were not included here.

Only a small portion of reviewed studies (11 of 35) investigated the contribution of meditation practice time. None found a direct association between meditation practice time and changes in depressive symptoms, but two studies suggested indirect paths from meditation practice to depressive symptoms through mediators, suggesting that the contribution of meditation practice may be indirect, and thus the test of direct association was not comprehensive. Of note, a previous review pointed out several methodological factors that could result in underestimates or over-estimates of meditation practice contributions (Zeng, Chio, et al., 2017). For example, self-reported meditation practice may not be accurate, which could explain the cases where meditation practice was not associated with any outcomes. Furthermore, the observed association between meditation practice and effects was essentially correlational, thus it does not exclude the possibility that people who benefited more from the interventions were more motivated to practice meditation. Additionally, among those studies reported follow-up measures for depressive symptoms, none reported whether participants continued their FIM practice after the intervention ended. Thus, it is unknown whether continuous meditation practice is necessary to maintain the effects—an important point for best practices planning. As noted by Zeng, Chio, et al. (2017), researchers should develop clear theoretical hypotheses on how FIM practice contributes to certain outcomes. For example, one may assume that FIM generates immediate positive emotions, which change depressive moods in the short term and thus require frequent practice; or one may assume that the FIM experience changes the beliefs underlying self-criticism, permanently altering the cause of depressive symptoms and thus no further practice would be required. The reviewed studies consistently calculated the total amount of meditation practice and change in depressive symptoms throughout the interventions; future studies could develop more flexible tests built on clear theoretical hypotheses. In sum, meditation practice is the core component of the FIM interventions, but more investigations are required to understand its contribution and design the best practices.

4.6. Mechanism of change

The above discussion noted the importance of understanding the mechanism behind the effects, but few reviewed studies conducted empirical tests on potential mediators of depressive symptoms (11 of 35). The association between mindfulness and depressive symptoms was consistently supported across studies, although whether mindfulness is more important than other meditators had is still open to debate. Such findings are consistent with the well-established evidence that mindfulness benefits the treatments of depressive symptoms (Goldberg et al., 2018). It is notable that many FIM interventions, including the frequently used MSC and CBCT, started with one or two sessions of mindfulness meditation (Neff & Germer, 2013; Reddy et al., 2013). Thus, although the entire FIM interventions had mindfulness as a potential mechanism, it is not clear whether the mindfulness change is a result of FIM.

Seven studies supported the association between self-compassion and depressive symptoms and one study did not. Given the limited number of studies, the current review could not evaluate whether the mediator role of self-compassion is protocol-dependent, that is, whether self-compassion is more important for some protocols and less important for others. Nevertheless, the current review supported self-compassion a contributor, and evidence beyond the FIM studies also supported self-compassion as beneficial for treatment of depressive symptoms (Muris & Petrocchi, 2017). Thus, future FIM protocols for treating depressive symptoms should consider integrating self-compassion as a component, although how much and what kind of effort (e.g., meditation, psychoeducation) is needed to cultivate self-compassion requires further investigation.

Other potential mediators were less investigated and more research is required to draw solid conclusions. Notably, a lack of positive emotions is a core symptom of depression, and the FIM effect on generating positive emotions is an important reason that FIM has been used to treat depressive disorders (see Hofmann et al., 2015). However, only one study in the current review directly tested the mediator role of positive emotions on depressive symptoms (Fredrickson et al., 2008). Most of the reviewed studies did not list depressive symptoms as top priority in their studies, and thus the specific mediators relevant to depressive symptoms were not measured or tested. It is notable that different FIM subtypes have different effects on generating positive emotions (Zeng, Chan, et al., 2017). If future studies show that positive emotions are a key mechanism for reducing depressive symptoms, future FIM interventions could apply meditation that more effectively enhance positive emotions when intervening to reduce depressive symptoms. In a similar vein, the mediating roles of attention flexibility (Haukass et al., 2018) and social support (Uchino et al., 2016) are promising, but how they contribute to depressive symptoms requires further investigation. Furthermore, many FIM interventions only involved a small portion of mindfulness meditation or FIM focused on the participants themselves, but mainly about FIM focused on others. Therefore, in addition to mindfulness and self-compassion, future studies should consider mechanisms associated more with FIM focused on others, such as social connection (Lang et al., 2019). At the same time, other key variables that are relevant to mindfulness meditation and depression, such as decentering or rumination (Kearney et al., 2014; Lang et al., 2019), are also worth to be explored as potential mediators.

Only two reviewed studies tried to identify individual differences as potential moderators, and the robustness of those findings are unknown. Additionally, Weytens et al. (2014) noted that their FIM intervention suffered from high dropout, possibly because some trainees disliked meditation, which implies that FIM interventions may not be suitable for all. In fact, most of the reviewed studies only provided data based on the completers, and thus the observed effects may not generalize to others and should be interpreted with caution. The current review supported FIM interventions are promising for reducing depressive symptoms, but there are many other effective interventions. In addition to comparing FIM interventions with other interventions, it is also important to identify who can benefit most from FIM interventions.

4.7. Limitations

The current systematic review and meta-analysis has several limitations. First, the current meta-analysis did not follow a pre-registered

plan, and some analyses were adjusted according to available data. This post-hoc approach to analysis may lead to biased or unstable findings. Second, given the limited numbers of studies, the different moderator analyses may confound each other (e.g., Buddhist retreats and high-intensity interventions are the same studies), and the power for the moderator analyses was also low. Third, information on intervention components was limited, so the coding for intervention components may be subjective. Fourth, only studies published in English were included. Despite these limitations, we believe the findings on the overall effectiveness of FIM interventions on depressive symptoms are robust. Although some limitations influenced the findings on moderator analyses, the moderator analyses and information from the narrative review nevertheless provided a comprehensive picture of what is currently known, which will benefit future studies.

5. Conclusion

In sum, the effects of FIM interventions on depressive symptoms have been evaluated across many studies, although not necessarily as primary outcomes. Current evidence supports FIM interventions for reducing depressive symptoms overall. However, more studies are needed to evaluate the effectiveness of certain protocols. In addition, more rigorous designs are needed, such as RCTs that compare FIM interventions with an active control group. More attention should be paid to details associated with best practices, including the necessary amount of meditation practice, the mechanisms (mediators) and individual differences (moderators).

Role of funding sources

Funding for this study was provided the Fundamental Research Funds for the Central Universities under Grant 2018NTSS39. It was also sponsored by peak discipline construction project of education at East China Normal University. The research funders had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Contributors

XZ, TO designed the study, JLv analyzed the data, XZ, QL, YL, KX, HH and JLiu reviewed studies and extracted the data, all authors discussed the results and wrote the article.

Declaration of Competing Interest

All authors declare that they have no conflicts of interest.

Acknowledgements

Dr. Oei is now an Emeritus Professor of University of Queensland. This work was supported by the Fundamental Research Funds for the Central Universities under Grant 2018NTSS39. It was also sponsored by peak discipline construction project of education at East China Normal University.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cpr.2020.101814.

References*

*Alba, B. (2013). Loving-kindness meditation: A field study. *Contemporary Buddhism, 14*(2), 187–203. https://doi.org/10.1080/14639947.2013.832494.

*Arimitsu, K. (2016). The effects of a program to enhance self-compassion in Japanese individuals: A randomized controlled pilot study. *The Journal of Positive Psychology, 11*, 559–571. https://doi.org/10.1080/17439760.2016.1152593.

*Baltman, J. (2017). Mechanisms of change in lovingkindness meditation (Doctoral dissertation). *Retrieved from ProQuest Dissertations & Theses* Order No. 10618789.

Barkham, M., Rees, A., Stiles, W. B., Shapiro, D. A., Hardy, G. E., & Reynolds, S. (1996). Dose–effect relations in time-limited psychotherapy for depression. *Journal of Consulting and Clinical Psychology, 64*(5), 927–935. https://doi.org/10.1037/0022-006x.64.5.927.

*Bartels-Velthuis, A. A., Schroevers, M. J., van der Ploeg, K., Koster, F., Fleer, J., & van den Brink, E. (2016). A mindfulness-based compassionate living training in a heterogeneous sample of psychiatric outpatients: A feasibility study. *Mindfulness, 7*(4), 809–818. https://doi.org/10.1007/s12671-016-0518-8.

*Bluth, K., & Eisenlohr-Moul, T. A. (2017). Response to a mindful self-compassion intervention in teens: A within-person association of mindfulness, self-compassion, and emotional well-being outcomes. *Journal of Adolescence, 57*, 108–118. https://doi.org/10.1016/j.adolescence.2017.04.001.

*Bluth, K., Gaylord, S. A., Campo, R. A., Mullarkey, M. C., & Hobbs, L. (2016). Making friends with yourself: A mixed methods pilot study of a mindful self-compassion program for adolescents. *Mindfulness, 7*(2), 479–492. https://doi.org/10.1007/s12671-015-0476-6.

*Brito-Pons, G., Campos, D., & Cebolla, A. (2018). Implicit or explicit compassion? Effects of compassion cultivation training and comparison with mindfulness-based stress reduction. *Mindfulness, 9*(5), 1494–1508. https://doi.org/10.1007/s12671-018-0898-z.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

*Desbordes, G., Negi, L. T., Pace, T. W., Wallace, B. A., Raison, C. L., & Schwartz, E. L. (2012). Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state. *Frontiers in Human Neuroscience, 6*, 292. https://doi.org/10.3389/fnhum.2012.00292.

*Dodds, S. E., Pace, T. W., Bell, M. L., Fiero, M., Negi, L. T., Raison, C. L., & Weihs, K. L. (2015). Feasibility of Cognitively-Based Compassion Training (CBCT) for breast cancer survivors: A randomized, wait list controlled pilot study. *Supportive Care in Cancer, 23*(12), 3599–3608. https://doi.org/10.1007/s00520-015-2888-1.

*Dundas, I., Binder, P. E., Hansen, T. G., & Stige, S. H. (2017). Does a short self-compassion intervention for students increase healthy self-regulation? A randomized control trial. *Scandinavian Journal of Psychology, 58*(5), 443–450. https://doi.org/10.1111/sjop.12385.

Duval, S. (2005). The trim and fill method. In A. Rothstein, A. Sutton, & M. Borenstein (Eds.). *Publication bias in meta-analysis: Prevention, assessment, and adjustments* (pp. 127e144). West Sussex, England: John Wiley & Sons Ltd.

*Finlay-Jones, A., Xie, Q., Huang, X., Ma, X., & Guo, X. (2018). A pilot study of the 8-week mindful self-compassion training program in a Chinese community sample. *Mindfulness, 9*(3), 993–1002. https://doi.org/10.1007/s12671-017-0838-3.

Follmann, D., Elliott, P., Suh, I., & Cutler, J. (1992). Variance imputation for overviews of clinical trials with continuous response. *Journal of Clinical Epidemiology, 45*(7), 769–773. https://doi.org/10.1016/0895-4356(92)90054-q.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: Positive emotions, induced through loving-kindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95*(5), 1045–1062. https://doi.org/10.1037/a0013262.

*Friis, A. M., Johnson, M. H., Cutfield, R. G., & Consedine, N. S. (2016). Kindness matters: A randomized controlled trial of a mindful self-compassion intervention improves depression, distress, and HbA1c among patients with diabetes. *Diabetes Care, 39*(11), 1963–1971. https://doi.org/10.2337/dc16-0416.

*Galante, J., Bekkers, M. J., Mitchell, C., & Gallacher, J. (2016). Loving-kindness meditation effects on well-being and altruism: A mixed-methods online RCT. *Applied Psychology. Health and Well-Being, 8*(3), 322–350. https://doi.org/10.1111/aphw.12074.

Galante, J., Galante, I., Bekkers, M. J., & Gallacher, J. (2014). Effect of kindness-based meditation on health and well-being: A systematic review and meta-analysis. *Journal of Consulting and Clinical Psychology, 82*(6), 1101–1114. https://doi.org/10.1037/a0037249.

Garnefski, N., Van Den Kommer, T., Kraaij, V., Teerds, J., Legerstee, J., & Onstein, E. (2002). The relationship between cognitive emotion regulation strategies and emotional problems: Comparison between a clinical and a non-clinical sample. *European Journal of Personality, 16*(5), 403–420. https://doi.org/10.1002/per.458.

Goldberg, S. B., Tucker, R. P., Greene, P. A., Davidson, R. J., Wampold, B. E., Kearney, D. J., & Simpson, T. L. (2018). Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis. *Clinical Psychology Review, 59*, 52–60. https://doi.org/10.31231/osf.io/etghn.

*Gonzalez-Hernandez, E., Romero, R., Campos, D., Burychka, D., Diego-Pedro, R., Baños, R., ... Cebolla, A. (2018). Cognitively-Based Compassion Training (CBCT®) in breast cancer survivors: A randomized clinical trial study. *Integrative Cancer Therapies, 17*(3), 684–696. https://doi.org/10.1177/1534735418772095.

Graser, J., Höfling, V., Weßlau, C., Mendes, A., & Stangier, U. (2016). Effects of a 12-week mindfulness, compassion, and loving kindness program on chronic depression: A pilot within-subjects wait-list controlled trial. *Journal of Cognitive Psychotherapy, 30*(1), 35–49. https://doi.org/10.1891/0889-8391.30.1.35.

* References marked with an asterisk indicate studies included in the meta-analysis.

Graser, J., & Stangier, U. (2018). Compassion and loving-kindness meditation: An overview and prospects for the application in clinical samples. *Harvard Review of Psychiatry, 26*(4), 201–215. https://doi.org/10.1097/hrp.0000000000000192.

Hartung, J., Knapp, G., & Sinha, B. K. (2008). *Statistical meta-analysis with application.* INC, USA: John Willey and Sons.

*Haukaas, R. B., Gjerde, I. B., Varting, G., Hallan, H., & Solem, S. (2018). A randomized controlled trial comparing the attention training technique and mindful self-compassion for students with symptoms of depression and anxiety. *Frontiers in Psychology, 9*, 827. https://doi.org/10.3389/fpsyg.2018.00827.

Hedges, L. V., & Olkin, I. (1985). *Statistical model of meta-analysis.* New York, NY: Academic Press.

Hedges, L. V., & Vevea, J. L. (1998). Fixed and random-effects models in meta-analysis. *Psychological Methods, 3*, 486–504. https://doi.org/10.1037/1082-989X.3.4.486.

Higgins, J., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analysis. *British Medical Journal, 327*, 557–560. https://doi.org/10.1136/bmj.327.7414.557.

Hofmann, S. G., Grossman, P., & Hinton, D. E. (2011). Loving-kindness and compassion meditation: Potential for psychological interventions. *Clinical Psychology Review, 31*(7), 1126–1132. https://doi.org/10.1016/j.cpr.2011.07.003.

*Hofmann, S. G., Petrocchi, N., Steinberg, J., Lin, M., Arimitsu, K., Kind, S., ... Stangier, U. (2015). Loving-kindness meditation to target affect in mood disorders: A proof-of-concept study. *Evidence-based Complementary and Alternative Medicine.* https://doi.org/10.1155/2015/269126.

*Johnson, D. P. (2010). Loving-kindness meditation to enhance the psychological recovery of individuals with persistent negative symptoms of schizophrenia: A pilot study (Doctoral dissertation). *Retrieved from ProQuest Dissertations & Theses* Order No. 3366358.

*Johnson, S. B., Goodnight, B. L., Zhang, H., Daboin, I., Patterson, B., & Kaslow, N. J. (2018). Compassion-based meditation in African Americans: Self-criticism mediates changes in depression. *Suicide and Life-threatening Behavior, 48*(2), 160–168. https://doi.org/10.1111/sltb.12347.

Judge, L., Cleghorn, A., McEwan, K., & Gilbert, P. (2012). An exploration of group-based compassion focused therapy for a heterogeneous range of clients presenting to a community mental health team. *International Journal of Cognitive Therapy, 5*(4), 420–429. https://doi.org/10.1521/ijct.2012.5.4.420.

Kang, Y., Gray, J. R., & Dovidio, J. F. (2015). The head and the heart: Effects of understanding and experiencing lovingkindness on attitudes toward the self and others. *Mindfulness, 6*(5), 1063–1070. https://doi.org/10.1007/s12671-014-0355-6.

*Kearney, D. J., Malte, C. A., McManus, C., Martinez, M. E., Felleman, B., & Simpson, T. L. (2013). Loving-kindness meditation for posttraumatic stress disorder: A pilot study. *Journal of Traumatic Stress, 26*(4), 426–434. https://doi.org/10.1002/jts.21832.

Kearney, D. J., McManus, C., Malte, C. A., Martinez, M. E., Felleman, B., & Simpson, T. L. (2014). Loving-kindness meditation and the broaden-and-build theory of positive emotions among veterans with posttraumatic stress disorder. *Medical Care, 52*, S32–S38.

Kirby, J. N., & Laczko, D. (2017). A randomized micro-trial of a loving-kindness meditation for young adults living at home with their parents. *Journal of Child and Family Studies, 26*(7), 1888–1899. https://doi.org/10.1007/s10826-017-0692-x.

*Lang, A. J., Casmar, P., Hurst, S., Harrison, T., Golshan, S., Good, R., ... Negi, L. (2017). Compassion meditation for veterans with posttraumatic stress disorder (PTSD): Anonrandomized study. *Mindfulness,* 1–12. https://doi.org/10.1007/s12671-017-0866-z.

*Lang, A. J., Malaktaris, A. L., Casmar, P., Baca, S. A., Golshan, S., Harrison, T., & Negi, L. (2019). Compassion meditation for posttraumatic stress disorder in veterans: A randomized proof of concept study. *Journal of Traumatic Stress, 32*(2), 299–309. https://doi.org/10.1002/jts.22397.

*LoParo, D., Mack, S. A., Patterson, B., Negi, L. T., & Kaslow, N. J. (2018). The efficacy of cognitively-based compassion training for African American suicide attempters. *Mindfulness, 9*(6), 1941–1954. https://doi.org/10.1007/s12671-018-0940-1.

*Mascaro, J. S. (2012). A longitudinal investigation of empathic behavior and neural activity and their modulation by compassion meditation (Doctoral dissertation). *Retrieved from ProQuest Dissertations & Theses* Order No. 3476857.

*Mascaro, J. S., Kelley, S., Darcher, A., Negi, L. T., Worthman, C., Miller, A., & Raison, C. (2018). Meditation buffers medical student compassion from the deleterious effects of depression. *The Journal of Positive Psychology, 13*(2), 133–142.

*Mongrain, M., Barnes, C., Barnhart, R., & Zalan, L. B. (2018). Acts of kindness reduce depression in individuals low on agreeableness. *Translational Issues in Psychological Science, 4*(3), 323–334. https://doi.org/10.1080/17439760.2016.1233348.

Morris, S. B. (2008). Estimating effect sizes from pretest-posttest-control group designs. *Organizational Research Methods, 11*(2), 364–386. https://doi.org/10.1177/1094428106291059.

*Müller-Engelmann, M., Schreiber, C., Kümmerle, S., Heidenreich, T., Stangier, U., & Steil, R. (2019). A trauma-adapted mindfulness and loving-kindness intervention for patients with PTSD after interpersonal violence: A multiple-baseline study. *Mindfulness, 10*(6), 1105–1123. https://doi.org/10.1007/s12671-018-1068-z.

Muris, P., & Petrocchi, N. (2017). Protection or vulnerability? A meta-analysis of the relations between the positive and negative components of self-compassion and psychopathology. *Clinical Psychology & Psychotherapy, 24*(2), 373–383. https://doi.org/10.1002/cpp.2005.

*Neff, K. D., & Germer, C. K. (2013). A pilot study and randomized controlled trial of the mindful self-compassion program. *Journal of Clinical Psychology, 69*(1), 28–44. https://doi.org/10.1002/jclp.21923.

Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics, 8*, 157–159. https://doi.org/10.2307/1164923.

Pace, T. W., Negi, L. T., Dodson-Lavelle, B., Ozawa-de Silva, B., Reddy, S. D., Cole, S. P., ... Raison, C. L. (2013). Engagement with cognitively-based compassion training is associated with reduced salivary C-reactive protein from before to after training in foster care program adolescents. *Psychoneuroendocrinology, 38*(2), 294–299. https://doi.org/10.1016/j.bbi.2012.07.179.

*Reddy, S. D., Negi, L. T., Dodson-Lavelle, B., Ozawa-de Silva, B., Pace, T. W., Cole, S. P., ... Craighead, L. W. (2013). Cognitive-based compassion training: A promising prevention strategy for at-risk adolescents. *Journal of Child and Family Studies, 22*(2), 219–230. https://doi.org/10.1007/s10826-012-9571-7.

Rosenzweig, D. (2013). The sisters of mindfulness. *Journal of Clinical Psychology, 69*(8), 793–804. https://doi.org/10.1002/jclp.22015.

*Schuling, R., Huijbers, M., Jansen, H., Metzemaekers, R., Van Den Brink, E., Koster, F., ... Speckens, A. (2018). The co-creation and feasibility of a compassion training as a follow-up to mindfulness-based cognitive therapy in patients with recurrent depression. *Mindfulness, 9*(2), 412–422. https://doi.org/10.1007/s12671-017-0783-1.

Schweizer, S., Kievit, R. A., Emery, T., & Henson, R. N. (2018). Symptoms of depression in a large healthy population cohort are related to subjective memory complaints and memory performance in negative contexts. *Psychological Medicine, 48*(1), 104–114. https://doi.org/10.1101/101642.

*Shahar, B., Szepsenwol, O., Zilcha-Mano, S., Haim, N., Zamir, O., Levi-Yeshuvi, S., & Levit-Binnun, N. (2015). A wait-list randomized controlled trial of loving-kindness meditation programme for self-criticism. *Clinical Psychology & Psychotherapy, 22*(4), 346–356. https://doi.org/10.1002/cpp.1893.

Shapira, L. B. (2012). Exploring online loving-kindness and CBT interventions: Do individuals vulnerable to depression improve? (Doctoral dissertation). *Retrieved from ProQuest Dissertations & Theses* Order No. NS00174.

Shonin, E., Van Gordon, W., Compare, A., Zangeneh, M., & Griffiths, M. D. (2014). Buddhist-derived loving-kindness and compassion meditation for the treatment of psychopathology: A systematic review. *Mindfulness, 6*(5), 1161–1180. https://doi.org/10.1007/s12671-014-0368-1.

Sujiva, V. (2007). Loving-kindness meditation. Retrieved from http://enlight.lib.ntu.edu.tw/FULLTEXT/JR-MAG/mag140106.pdf.

Thalheimer, W., & Cook, S. (2002). How to calculate effect sizes from published research: A simplified methodology. *Work-Learning Research,* 1–9.

Tickell, A., Ball, S., Bernard, P., Kuyken, W., Marx, R., Pack, S., ... Crane, C. (2019). The effectiveness of Mindfulness-Based Cognitive Therapy (MBCT) in real-world healthcare services. *Mindfulness,* 1–12. https://doi.org/10.1007/s12671-018-1087-9.

*Uchino, B. N., Bowen, K., de Grey, R. G. K., Smith, T. W., Baucom, B. R., Light, K. C., & Ray, S. (2016). Loving-kindness meditation improves relationship negativity and psychological well-being: A pilot study. *Psychology, 7*(01), 6–11. https://doi.org/10.4236/psych.2016.71002.

*Weytens, F., Luminet, O., Verhofstadt, L. L., & Mikolajczak, M. (2014). An integrative theory-driven positive emotion regulation intervention. *PLoS One, 9*(4), e95677. https://doi.org/10.1371/journal.pone.0095677.

*Wong, G. (2011). Live to love as a way to love your living: Cultivating compassion by loving-kindness meditation. (Doctoral Dissertation). *Retrieved from ProQuest Dissertations and Theses database* UMI No. 3450042.

World Health Organization (2017). *Depression and other common mental disorders: global health estimates (No. WHO/MSD/MER/2017.2).* World Health Organization.

Zeng, X., Chan, V. Y., Liu, X., Oei, T. P., & Leung, F. Y. (2017). The four Immeasurables meditations: Differential effects of appreciative joy and compassion meditations on emotions. *Mindfulness, 8*(4), 949–959. https://doi.org/10.1007/s12671-016-0671-0.

Zeng, X., Chio, F. H., Oei, T. P., Leung, F. Y., & Liu, X. (2017). A systematic review of associations between amount of meditation practice and outcomes in interventions using the four immeasurables meditations. *Frontiers in Psychology, 8*, 141. https://doi.org/10.3389/fpsyg.2017.00141.

Zeng, X., Chiu, C., Wang, R., Oei, T., & Leung, F. (2015). The effect of loving-kindness meditation on positive emotions: A meta-analytic review. *Frontiers in Psychology, 6*, 1693. https://doi.org/10.3389/fpsyg.2015.01693.

Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood and middle adulthood: Age differences, gender differences, and emotion-specific developmental variations. *International Journal of Behavioral Development, 38*(2), 182–194. https://doi.org/10.1177/0165025413515405.

Jing Lv, Ph.D., is an assistant researcher at East China Normal University. Her research interests include investigating issues in meta-analytic structural equation modeling and multilevel structural equation modeling, and applying quantitative methods in research of social science.

Qiuling Liu is in her final year of the undergraduate program in Psychology at Beijing Normal University's School of Psychology. She takes interest in meditations' effects on mental health.

Xianglong Zeng, PhD., is an assistant professor in Faculty of Psychology, Beijing Normal University. He studies clinical psychology and positive psychology, and his research topics focus on Four Immeasurables Meditations and relevant concepts such as appreciative joy.

Tian PS Oei, Ph.D., is an emeritus professor of Clinical Psychology at the University of Queensland, and also the director, CBT Unit, Toowong Private Hospital, Brisbane, Australia.

Yidan Liu is in her first year of the professional master program in Psychology at Beijing Normal University's Faculty of Psychology. She is interested in effects of Four Immeasurables Meditations.

Kexin Xu is in her second year of the undergraduate program in Psychology at Beijing Normal University's Faculty of Psychology. She has an interest in the effects of meditations on mental health.

Wenxiang Sun is in his second year of the undergraduate program in Education at Beijing Normal University's Faculty of Education, he takes interest in psychology, pathology and human development.

Hanchao Hou is currently an RHD student in the Centre for Positive Psychology, University of Melbourne. His research is about wellbeing literacy and its measurement, and before that he has more than three years of experience in designing, conducting, and evaluating positive education projects.

Jing Liu, M.D., is a psychiatrist and associate professor. Currently she works as the director of the clinical psychological ward in Beijing Anding Hospital, Capital Medical University. She has focused on the clinical practice and research of CBT for MDD and anxiety disorder.