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Effects of mindfulness exercises as stand-alone intervention on symptoms of anxiety and depression: Systematic review and meta-analysis

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ABSTRACT

Mindfulness-based interventions (MBIs) are currently well established in psychotherapy with meta-analyses demonstrating their efficacy. In these multifaceted interventions, the concrete performance of mindfulness exercises is typically integrated in a larger therapeutic framework. Thus, it is unclear whether stand-alone mindfulness exercises (SAMs) without such a framework are beneficial, as well. Therefore, we conducted a systematic review and meta-analysis regarding the effects of SAMs on symptoms of anxiety and depression. Systematic searching of electronic databases resulted in 18 eligible studies (n = 1150) for meta-analyses. After exclusion of one outlier SAMs had small to medium effects on anxiety (*SMD* = 0.39; *CI*: 0.22, 0.56; *PI*: 0.07, 0.70; $p < .001$, $I^2 = 18.90\%$) and on depression (*SMD* = 0.41; *CI*: 0.19, 0.64; *PI*: −0.05, 0.88; $p < .001$; $I^2 = 33.43\%$), when compared with controls. Summary effect estimates decreased, but remained significant when corrected for potential publication bias. This is the first meta-analysis to show that the mere, regular performance of mindfulness exercises is beneficial, even without being integrated in larger therapeutic frameworks.

Mindfulness can be defined as a specific form of attention that is (1) focused on the present moment, (2) intentional, and (3) non-judgmental (Kabat-Zinn, 1990). Having its origins in an Eastern Buddhist tradition that is over 2500 years old, it is currently well established in cognitive-behavioral therapy (CBT) and most prominently applied in structured, manualized group settings, like mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) or mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002). In these interventions, participants intensively practice mindfulness both during group sessions and by means of daily homework. Additionally, the eight sessions are supplemented with specific contents regarding coping with stress or depressive symptoms.

The efficacy of mindfulness-based interventions (MBIs) is sufficiently confirmed with meta-analyses demonstrating moderate to strong effect sizes for the reduction of anxiety and depression (Hofmann, Sawyer, Witt, & Oh, 2010; Khoury, Sharma, Rush, & Fournier, 2015; Khoury et al., 2013). These findings are of particular importance, as anxiety and depression are the two most frequent mental health problems (Somers, Goldner, Waraich, & Hsu, 2006; Waraich, Goldner, Somers, & Hsu, 2004). With a life time prevalence of 20% for anxiety and 30% for depression, these mental problems cause high economic costs (Fluckiger, Del Re, Munder, Heer, & Wampold, 2014). Furthermore an analysis of disease burden shows that depression and anxiety together account for 55.1% of all disability-adjusted life years attributable to mental and substance disorders (Whiteford et al., 2013).

Mindfulness is theoretically assumed to be the central change mechanism of MBIs (Kabat-Zinn, 1982; Segal et al., 2002). However, MBIs comprise several other components, including psychoeducation and group-related factors, such as group cohesion and social support (Chiesa & Serretti, 2011; Toneatto & Nguyen, 2007; Williams et al., 2014). Additionally, mindfulness itself is not only cultivated by performance of mindfulness exercises, but also by a teacher introducing the concept and encouraging participants to reflect on experiences generated during the practice of mindfulness (*inquiry*). Due to this intertwining, it remains unclear whether mindfulness exercises are beneficial as a stand-alone intervention. In the present systematic review and meta-analysis, we define stand-alone mindfulness exercises (SAMs) as the isolated, regular performance of mindfulness exercises. In a prototypical SAM intervention, individuals merely practice a specific mindfulness exercise (e.g. bodyscan) over a certain time span. Thus, by

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contrast with manualized mindfulness interventions, SAMs do not include additional components such as psychoeducation and group related factors.

From mediation analyses and dismantling studies, there are contradictory findings regarding potential effects of SAMs. On the one hand, mediation analyses moderately support the theory that an increase in participants' dispositional mindfulness accounts for the beneficial effects of MBIs (Gu, Strauss, Bond, & Cavanagh, 2015; van der Velden et al., 2015). Hence, one could assume that SAMs are also capable of increasing mindfulness, which, in turn, should result in a reduction of anxiety and depression. On the other hand, dismantling studies did not find significant differences between MBCT and a structurally matched active control group, thereby questioning the contribution of the mindfulness component (Shallcross et al., 2015; Williams et al., 2014). In view of this rather inconclusive evidence, further research is needed to clarify the effects of SAMs. This is especially because of mediation analyses and dismantling studies not directly targeting SAMs: While mediation analyses do not test whether observed increases in mindfulness are due to the performance of mindfulness exercises, dismantling studies examine the mindfulness component in the context of already working treatment conditions.

Taken together, there is a research gap concerning the effects of isolated mindfulness exercises that are not integrated in a structured intervention. Therefore, the aim of the present systematic review and meta-analysis is to systematically aggregate the evidence regarding the reduction of symptoms of anxiety and depression through SAMs. We specifically focus on symptoms of anxiety and depression as this parallels meta-analyses of manualized MBIs (Hofmann et al., 2010; Khoury et al., 2013, 2015) thereby maximizing comparability. A meta-analysis of SAMs is highly relevant, both from a conceptual and a practical perspective. Conceptually, the results can foster our understanding of mindfulness exercises as one specific component of MBIs. Studying one specific component in greater detail is in line with recommendations to increase the public health impact of research on MBIs (Dimidjian & Segal, 2015). From a practical perspective, the study of SAMs can deliver ideas concerning the implementation of mindfulness exercises as a single component into routine therapy: If SAMs exhibit effects on symptoms of anxiety and depression, the two most common mental health problems (Fluckiger et al., 2014), mindfulness exercises could be considered a form of a brief, mostly self-guided, intervention that can be recommended to patients or non-clinical populations. In the present systematic review and meta-analysis, we hypothesize that SAMs have small to medium effects on the reduction of anxiety and depression when compared with controls.

1. Methods

1.1. Eligibility criteria

The systematic review and meta-analysis were designed and conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRSIMA; Moher, Liberati, Tetzlaff, & Altman, 2009) statement. Inclusion criteria were specified in advance and documented in a protocol at PROSPERO (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=33441).

1.1.1. Intervention

Only studies investigating the effect of SAMs were reviewed. To be eligible, interventions had to meet the following inclusion criteria: (a) The intervention exclusively consists of the repeated performance of mindfulness exercises (e.g. bodyscan, breathing space). Interventions incorporating a brief introduction to the concept of mindfulness or the particular exercise were included only if a clear focus is given to the performance of mindfulness exercises. (b) Following Bishop et al. (2004) operational definition of mindfulness, exercises were considered mindful if they (1) involved self-regulation of attention on immediate experience, and (2) emphasized an attitude of curiosity, openness and acceptance. Exercises were permitted to vary over the course of the intervention (e.g., participants were given an audio CD with various mindfulness exercises). Regarding treatment modality both face-to-face (exercise guided by a clinician) and online interventions (via downloadable audiotapes) were included. We specifically excluded: (a) Manualized interventions that go beyond the mere performance of mindfulness exercises by incorporating additional (unspecific) components (e.g., group discussions, psychoeducation). Hence, established mindfulness interventions (e.g., MBSR, MBCT) or other psychotherapeutic approaches relying on mindfulness (e.g., DBT, ACT) were not included in the scope of this review. (b) Interventions incorporating compassion-focused approaches (e.g., loving kindness meditation). These approaches are considered to be promising mindfulness-related psychotherapeutic techniques, but do not fit the rather narrow operational definition of mindfulness we pursued in the present examination.

1.1.2. Comparator

To be eligible, studies had to compare SAMs to a control condition.

1.1.3. Outcome

Studies had to contain a validated, continuous clinical measure of anxiety and/or depression and provide data before and after the intervention.

1.1.4. Participants

Participants had to be at least 18 years old. Both non-clinical and clinical samples were eligible.

1.1.5. Study design

Controlled trials; both inactive and active control conditions were included.

1.2. Search strategy

PsycINFO and PubMed were searched on February 24, 2016, using the following, pre-defined search terms. PsycINFO: (mindful* or meditat* or bodyscan or breathing space) AND (brief or short* or exercise or training or session-introducing or intervention or time-limited or single or internet or low-intensity or audio* or induc* or condition or smartphone). PubMed: (mindful*[tiab] or meditat*[tiab] or bodyscan [tiab] or breathing space [tiab] or mindfulness[MeSH] or meditation [MeSH]) AND (brief[tiab] or short*[tiab] or exercise[tiab] or training [tiab] or session-introducing[tiab] or intervention[tiab] or time-limited [tiab] or single[tiab] or internet[tiab] or low-intensity[tiab] or audio*[tiab] or induc*[tiab] or condition[tiab] or smartphone[tiab] or Psychotherapy, Brief[MeSH]). Studies had to be published after 1980 and written in English or German. On August 17, 2017, the search was updated by entering the same search terms again. Additionally, reference lists of selected studies were inspected.

1.3. Study selection

After removal of duplicates, the first author (PB) screened titles and abstracts. Only clearly non-eligible studies (e.g. theoretical papers, study protocols) were excluded at this stage. The first (PB) and second (SP) authors then assessed full texts of the remaining studies and independently judged their eligibility based on the aforementioned inclusion criteria. Disagreement was resolved by discussion including the last author (JM). Finally, authors of eligible studies were contacted when studies did not provide sufficient data for effect size calculation.

1.4. Coding procedures

A data extraction sheet was developed by the last author (JM), and the first (PB) and second (SP) authors independently collected the

following data from the included studies: (a) participant characteristics (age, sex, sample size), (b) intervention (type of mindfulness exercise being used, practice time, treatment modality), (c) study design, (d) type of control group, (e) outcome measures, (f) methodological quality of studies. Regarding treatment modality we differentiated between online (audiotaped) and guided (presence of a clinician providing the respective mindfulness exercise) interventions. Rating of methodological quality was conducted independently by the first (PB) and second (SP) author using the scale by van Tulder, Furlan, Bombardier, and Bouter (2003). This scale judges a study's internal validity based on 11 criteria: appropriateness of randomization, allocation concealment, similarity of baseline characteristics, patient blinding, caregiver blinding, observer blinding, co-intervention, compliance, dropout rate, timing of outcome assessment and intention-to-treat analysis. For each fulfilled criterion a point is given. A summary score is computed (*range*: 0–11) and a score of at least 6 points is suggested as an indicator of high methodological quality (van Tulder et al., 2003). Any disagreements regarding quality rating of studies were resolved by discussion. Inter-rater reliability was good ($ICC = 0.85$, $F(21,22) = 12.2$, $p < .0001$).

1.5. Statistical methods

We used standardized weighted mean differences (*SMD*) based on Hedges' *g* as an effect size (ES) parameter. Hedges' *g* is an adjustment of Cohen's *d* (Cohen, 1988), taking into account potential bias due to small sample sizes (Hedges & Olkin, 1985). According to Cohen (1988), the magnitude of Hedges' *g* can be considered small (0.2), medium (0.5), or large (0.8). In a first step, we manually calculated controlled pre-post ESs for each study (see formula[1]). This was executed separately for measures of anxiety and depression. If studies provided data for more than one eligible outcome measure of either anxiety or depression, we collapsed data to ensure independence of obtained ESs. In a similar vein, data was combined for studies using multiple, eligible treatment conditions (e.g., conditions employing different mindfulness exercises).

Once ESs were calculated, we performed separate meta-analyses for anxiety and depression using the inverse variance random effects model (DerSimonian & Laird, 1986). In this model, ESs are aggregated across studies via weighting ESs by the inverse standard error, thereby taking the precision of studies into account. It is further assumed that individual ESs consist of both a common *true effect* that is shared across studies, and a unique *true effect* that is specific for the particular study. In a random effects model, it is possible to compute both a mean effect size and a prediction interval. While the mean effect size is an estimate of the common *true effect,* with the confidence interval quantifying the estimate's accuracy, the prediction interval indicates the amount of dispersion of the various unique *true effects* (Borenstein, Hedges, Higgins, & Rothstein, 2009). This variation in *true effect* sizes is referred to as heterogeneity. The *Q* statistic (a measure of weighted square differences), the between-studies variance (T^2), and the ratio of true heterogeneity to total observed variation (I^2) are different measures of heterogeneity that additionally allow for significance testing of heterogeneity and computation of the prediction interval.

To maximize comparability across studies, we based our main analyses on ESs obtained by comparison with inactive control conditions. Additionally, we ran exploratory analyses using ESs obtained by comparison with active controls.

We carried out the following analyses to examine and correct for any potential publication biases that might have affected our results: First, we applied funnel plots to visually inspect if our results could be subject to bias. In a funnel plot, ESs are plotted against their respective standard errors. In the absence of bias, ESs are distributed symmetrically around the mean effect size, with ESs more spread out at the bottom where small studies (large standard errors) are located. We also included a formal test of funnel plot asymmetry, provided by Egger, Davey Smith, Schneider, & Minder. (1997). Second, we calculated Rosenthal's *Fail-safe N* (Rosenthal, 1979), a parameter denoting how many studies with an effect size of zero would be needed for the overall mean effect size to become nonsignificant. According to Rosenthal (1991), a *Fail-safe N* larger than $5K + 10$, with *K* being the number of included studies in the quantitative synthesis, can be considered an indicator of no publication bias. Third, if there were signs of publication bias, we conducted sensitivity analyses by checking for disproportionally influential studies and conducting the analyses with and without outliers. Finally, we applied the *Trim and Fill* method (Duval & Tweedie, 2000): In the *Trim and Fill* approach, the number *k* of missing studies is iteratively estimated; then, the meta-analysis is rerun, this time with *k* imputed ESs that mirror the most extreme small studies from the positive side of the funnel plot.

We performed meta-regression analyses to examine whether heterogeneity can be explained by moderating variables. Based on theoretical assumptions, we added total practice time (as intended in the intervention), duration of individual exercises and guidance as predictors. Practice time is known to moderate the effect of MBI s (Parsons, Crane, Parsons, Fjorback, & Kuyken, 2017), the importance of guidance is often emphasized by mindfulness experts (Crane, Kuyken, Hastings, Rothwell, & Williams, 2010). Finally, to further examine the robustness of our findings, study quality was added as a predictor. Computation of ESs and all statistical analyses were performed with *R,* Version 3.3.3 (R Core Team, 2017) and the metafor-package (Viechtbauer, 2010).

2. Results

2.1. Study selection

The initial database search yielded 8181 results, 2405 new records were found after updating the search. 52 additional records were identified through reference lists of eligible studies (Fig. 1). After removal of duplicates, the initial abstract screening led to an exclusion of 8524 studies. The independent full-text screening of 578 articles found that 21 studies met inclusion criteria. Agreement between raters was high with only three studies being rated differently ($\kappa = 0.93$, $z = 22.4$, $p < .001$). In these cases, consensus could be reached after discussion with the study's last author, JM. Of seven authors contacted, five provided data for effect size calculation. The remaining two studies and a study applying a conflated measure of anxiety and depression had to be excluded from the quantitative synthesis.

2.2. Study characteristics

Table 1 gives an overview of characteristics of the 21 included studies. One paper (Parkin et al., 2014) contained two independent studies that were both eligible for inclusion in the meta-analyses. Four categories of mindfulness exercises were identified: Breathing meditation ($n = 12$), bodyscan ($n = 6$), sitting meditation ($n = 5$), and soundscan ($n = 2$). Two studies investigated bodyscan and soundscan as separate treatment conditions, and in one study, the intervention included both bodyscan and sitting meditation. In the remaining studies, interventions comprised only one mindfulness exercise. Seven studies (31.81%) applied a guided exercise, in the remaining studies the exercises were delivered online (audiotape presented). The mean duration of mindfulness exercises was 22.32 min (*sd* = 10.28; *range:* 10–45). Total practice time across the intervention averaged out at 372.18 min (*sd* = 421.89; *range:* 60–1440). In total, 1341 individuals (76.36% female) were represented in the included studies. Samples

[1] Controlled Pre-Post ESs were calculated using the following formula: $d = \frac{\Delta_1 - \Delta_2}{\sqrt{\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{n_1+n_2-2}}}$, Δ_1 and Δ_2 denote pre-post differences of intervention and control group, respectively. n_1 and n_2 are the sample sizes of each group, S_1 and S_2 refer to the standard deviation of the respective post-intervention scores. Cohen's *d* is converted to Hedges's *g* by a correction factor: $g = d \times J$, *with* $J = 1 - \frac{3}{4df-1}$ and .

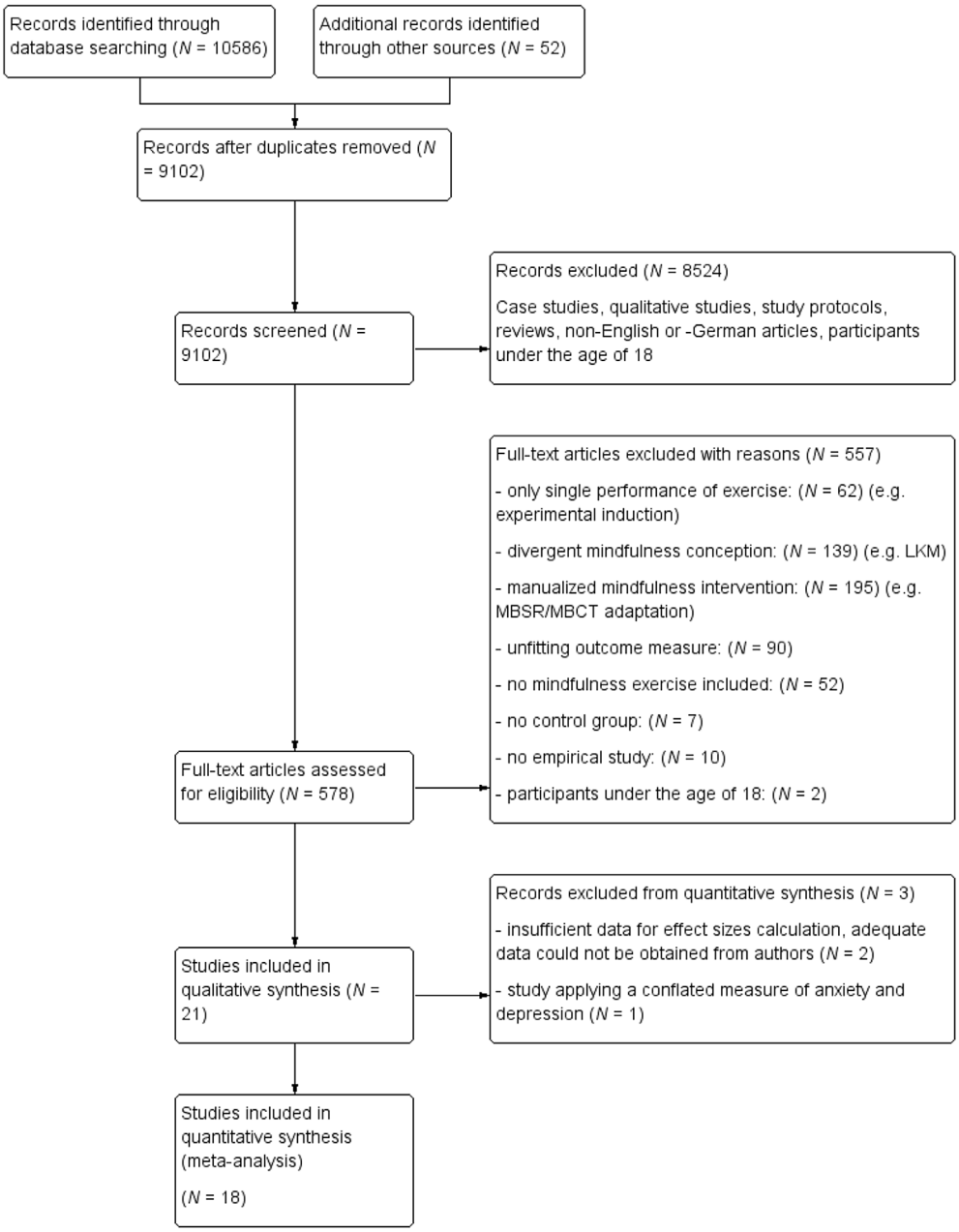

Fig. 1. Flow of information from identification of studies to inclusion in quantitative synthesis.

used were mostly student populations. One study investigated depressed individuals, another investigated patients with chronic cough, other than that, no clinical samples were included. Mean age was 30.23 years. According to the van Tulder Quality Assessment Scale, the mean methodological quality was 5.59 (*SD* = 1.56, *Range*: 3–8). 10 studies (45%) had a rating of at least 6 points and could thus be considered to be of high methodological quality. Another 5 studies (23%) had a rating of 5 points thereby falling only slightly below the suggested cut-off point.

Data from 1150 individuals (75.48% female) contributed to the meta-analyses. Mean age was 30.45 years. Except for one study investigating depressed individuals no clinical samples contributed to the meta-analyses. Of the 16 studies that included an eligible measure of anxiety, 14 studies contained inactive control conditions and 8 studies contained active control conditions. Of the 13 studies that included an eligible measure of depression, 10 studies contained inactive control conditions and 7 studies contained active control conditions.

2.3. Effects of SAMs on anxiety

Table 2 gives an overview of summary ES estimates and heterogeneity statistics of the four performed meta-analyses. The random effects model yielded a significant effect of SAMs on symptoms of anxiety when compared with inactive control conditions (*SMD* = 0.58; *CI*: 0.26, 0.89; *PI*: −0.50, 1.65; $p < .001$; $I^2 = 77.34\%$). However, as can be seen from the forest plot (see Fig. 2), there was one clear outlier (study from Yamada & Victor, 2012) that vastly influenced the results. This was mirrored by *leave-one-out analyses* demonstrating that only the removal of that particular study substantially changed the results, as indicated by an exclusive drop of the I^2 parameter by 58.44%. Hence, we conducted the meta-analysis again, this time without the disproportionally influential study and still obtained a significant, albeit somewhat smaller, summary effect (*SMD* = 0.39; *CI*: 0.22, 0.56; *PI*: 0.07, 0.70; $p < .001$, $I^2 = 18.90\%$).

Table 1
Summary of included studies.

Study	Sample used (% female, mean age)	Study design	Mindfulness exercise (s) (n)	Format	Control group(s) (n)	Anxiety measures	*g*	95% CI	Depression measures	*g*	95% CI	van Tulder score
Bell (2015)	57 participants (77%, 21.00)	RCT	Audiotaped BS, audiotaped BM (20)	30 min sessions, four times per week, for 12 weeks	Silence (17); Eyes-closed relaxation (20)	STAI			CESD-R			6
Call et al. (2014)	91 students (100%, 22.73)	CT	Audiotaped BS (27)	45 min sessions, once per week, for 3 weeks	WL (35); Hatha Yoga (29)	DASS-21-Anxiety	0.38	[-0.13, 0.89]				4
Cavanagh et al. (2013)	104 students (88.50%, 24.70)	RCT	Audiotaped BM (54)	10 min home practice, once per day, for 2 weeks	WL (50)	PHQ-4			PHQ-4			7
Chen et al. (2013)	60 nursing students (86.67%, 19.50)	CT	Guided BM (30)	30 min sessions, once per day, for 1 week	No IV (30)	SAS	0.47	[-0.04, 0.98]	SDS	0.13	[-0.38, 0.64]	5
Cho et al. (2016)	36 students (58.30%, 20.10)	RCT	Audiotaped BM (12)	One 30 min session, 30 min home practice, once per day, for 6 days	Cognitive Reappraisal (12); No IV (12)	RTA	0.66 0.15^{+}	[-0.14, 1.46] [-0.63, 0.93]$^{+}$				7
Chu (2010)	19 students (47.37%, 24.42)	CT	Guided BM (10)	20 min sessions, once per week, for 8 weeks	No IV (9)	GHQ-28-anxiety and insomnia	1.32	[0.36, 2.28]	GHQ-28-severe depression	1.27	[0.33, 2.21]	4
Costa & Barnhofer (2016)	37 depressed individuals (75.68%, 38.50)	RCT	Audiotaped SM (19)	One 1 h session, 30 min home practice, once per day, for 6 days	Guided imagery relaxation (18)				BDI-II	−0.39^{+}	[-1.04, 0.26]$^{+}$	8
Course-Choi et al. (2017)	60 participants (75%, 28.67)	CT	Audiotaped SM (15)	One 21 min session, 21 min home practice, once per day, for 7 days	working memory training (15); combined IV (15); No IV (15)	STAI-S	0.78 1.04^{+}	[0.05, 1.51] [0.31, 1.77]$^{+}$				6
Howells et al. (2016)	121 participants (86.60%, 40.70)	RCT	Audiotaped BM (57)	10 min home practice, once a day, for 10 days	Smartphone based list-making (64)				CES-D	0.33^{+}	[-0.01, 0.67]$^{+}$	7
Josefsson et al. (2014)	104 employees (91.27%, 48.14)	CT	Guided SM (38)	45 min sessions, twice per week, for 4 weeks	WL (31); Relaxation training (35)	HAD-A	0.17 0.02^{+}	[-0.30, 0.64] [-0.42, 0.46]$^{+}$	HAD-D	0.32 −0.03^{+}	[-0.15, 0.79] [-0.47, 0.41]$^{+}$	4
Mirams et al. (2013)	62 students (90.32%, 19.21)	CT	Audiotaped BS (31)	15 min exercise, once per day, for 8 days (2 sessions, 6 times home practice)	Audiobook listening (31)	STAI-S	0.00^{+}	[-0.48, 0.48]$^{+}$				7
O'Leary & Dockray (2015)	35 participants (100%, 28.35)	CT	Audiotaped BS (13)	10-15 min home practice, 4 times per week, for 3 weeks	WL (7); Gratitude online IV (15)				EDS	0.89 0.79^{+}	[-0.03, 1.81] [0.03, 1.55]$^{+}$	3
Paholpak et al. (2012)	58 medical students (50.00%, 23.29)	RCT	Audiotaped BM (30)	20 min sessions, 5 times per week, for 4 weeks	No IV (28)	SCL-90-anxiety; SCL-90-phobic anxiety	0.39	[-0.06, 0.84]	SCL-90-depression	0.13	[-0.38, 0.64]	5
Parkin et al. (2014) - Study A	60 participants (62.00%, 43.17)	CT	Audiotaped BS (20); Audiotaped SS (20)	15 min exercise, once per day, for 1 week (1 session, 6 times home practice)	No IV (20)	STAI-T	−0.28	[-0.81, 0.25]	BDI-II	−0.02	[-0.55, 0.51]	4
Parkin et al. (2014)- Study B	60 participants (71.70%, 43.79)	CT	Audiotaped BS (20); Audiotaped SS (20)	15 min exercise, once per day, for 8 days (2 sessions, 6 times home practice)	No IV (20)	STAI-T	0.05	[-0.48, 0.58]	BDI-II	0.35	[-0.18, 0.88]	5
Sears and Kraus (2009)	57 students (59.00%, 22.80)	CT	Guided BM (19)	10-15 min sessions, once per week, for 12 weeks; home practice encouraged	No IV (10); LKM (17); Combined meditation (11)	BAI	0.58 −0.16^{+}	[-0.18, 1.34] [-0.81, 0.49]$^{+}$				5

(*continued on next page*)

Table 1 (*continued*)

Study	Sample used (% female, mean age)	Study design	Mindfulness exercise (s) (n)	Format	Control group(s) (n)	Anxiety measures	*g*	95% CI	Depression measures	*g*	95% CI	van Tulder score
Semple (2010)	45 participants (73.34%, 40.20)	RCT	Audiotaped BM (15)	20 min home practice, twice per day, for 4 weeks; two training sessions	WL (16); PMR (14)	STAI; POMS-anxiety	0.53 0.25+	[0.04, 1.02] [-0.23, 0.73]+	POMS-depression	0.32 0.34+	[-0.37, 1.01] [-0.34, 1.02]	8
Warnecke et al. (2011)	65 medical Students (64.62%, 23.92)	RCT	Audiotaped BM (31)	30 min home practice, once per day, for 8 weeks	WL (34)	DASS-anxiety	0.44	[-0.05, 0.93]	DASS-depression	0.58	[0.09, 1.07]	8
Yamada & Victor (2012)	60 students (73.34%, 25.90)	CT	Guided SM (37)	10 min sessions, twice per week, for 15 weeks	No IV (23)	STAI	2.53	[1.90, 3.16]				4
Young et al. (2009)	30 patients with chronic cough (66.67%, 58.00)	RCT	Audiotaped BM (10)	30 min home practice, once per day, for 7–10 days	No IV (11); Voluntary cough suppression (9)	STAI-T						4
Zeidan et al. (2010a)	49 students (59.50%, 22.50)	CT	Guided BM (24)	20 min sessions, once per day, for 4 days	Audiobook listening (25)	POMS-anxiety; STAI-S	0.35+	[-0.13, 0.83]+	CES-D; POMS-depression	0.05+	[-0.39, 0.49]+	5
Zeidan et al. (2010b)	82 students (58.54%, 20.67)	CT	Guided BM (29)	20 min sessions, once per day, for 3 days	No IV (26); Sham mindfulness (27)	POMS-anxiety; STAI-S	0.54 0.62+	[0.07, 1.01] [0.18, 1.06]+	POMS-depression	0.95 0.95+	[0.40, 1.50] [0.40, 1.50]+	7

Note: BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; BM = breathing meditation; BS = bodyscan; CES-D = Center for Epidemiologic Studies Depression Scale; CI = confidence interval; CT = controlled trial; DASS = Depression, Anxiety and Stress Scale; EDS = Edinburgh Depression Scale; *g* = hedges's g; GHQ-28 = General Health Questionnaire-28; HAD = Hospital Anxiety and Depression Scale; IV = intervention; PHQ-4 = Patient Health Questionnaire for Depression and Anxiety; PMR = Progressive Muscle Relaxation; POMS = Profile of Mood States; RCT = randomized controlled trial; RTA = Revised Test Anxiety Scale; SAS = Self-Rating Anxiety Scale; SCL-90 = Symptom Checklist 90; SDS = Self-Rating Depression Scale; SM = sitting meditation; SS = soundscan; STAI = Spielberger State-Trait Anxiety Inventory; WL = wait-list; $^{+}$ = comparison with active control; bold = studies included in meta-analyses.

2.3.1. Risk of bias

Visual inspection of the funnel plot (see Fig. 3) indicated asymmetry of ESs at the bottom that might have been the consequence of publication bias. Rosenthal's *Fail-safe N* was 119, thereby exceeding the critical value of $N = 75$. However, Egger's test of funnel plot asymmetry was significant ($z = 1.98$; $p < .05$). Thus we applied the Trim and Fill method, which led to the imputation of three potentially missing studies (see Fig. 3). This resulted in a further decline of the summary ES, which remained significant nonetheless (*SMD* = 0.32; *CI*: 0.15, 0.50; *PI*: −0.10, 0.75; $p < .001$, $I^2 = 30.70\%$).

2.3.2. Meta-regression

Neither total practice time (in hours) across the intervention ($Q(1) = 2.06$, $\beta = 0.004$, $p = .15$), nor duration (in hours) of individual exercises ($Q(1) = 0.01$, $\beta = -0.0009$, $p = .91$), nor guidance ($Q(1) = 0.74$, $\beta = 0.16$, $p = .39$) nor quality of studies ($Q(1) = 2.08$, $\beta = 0.08$, $p = .15$) were significant predictors in a random effects meta-regression model. However, by including total practice time as a predictor, a substantial amount of variation in true effects could be explained ($R^2 = 37.35\%$).

2.3.3. Comparisons with active controls

When compared with active controls, SAMs still exhibited a significant summary effect on anxiety (*SMD* = 0.27; *CI*: 0.03, 0.50; *PI*: −0.20, 0.73; $p < .05$, $I^2 = 36.54\%$).

2.4. Effects of SAMs on depression

The random effects model yielded a significant effect of SAMs on symptoms of depression when compared with inactive control conditions (*SMD* = 0.41; *CI*: 0.19, 0.64; *PI*: −0.05, 0.88; $p < .001$; $I^2 = 33.43\%$). *Leave-one-out analyses* indicated that the summary effect and the I^2 parameter were rather robust to the removal of particular studies.

2.4.1. Risk of bias

Visual inspection of the funnel plot (see Fig. 3) again demonstrated asymmetry of ESs at the bottom that might be due to publication bias. Rosenthal's *Fail-safe N* was 71, thereby exceeding the critical value of $N = 60$. Egger's test of funnel plot asymmetry was not significant ($z = 1.94$; $p = .05$). Nevertheless, as the lack of significance could very well be due to small statistical power, we applied the Trim and Fill method, which led to the imputation of one study (see Fig. 3). As a consequence, there was a slight decrease in the summary ES, which remained significant nonetheless (*SMD* = 0.37; *CI*: 0.14, 0.61; *PI*: −0.18, 0.92; $p < .01$, $I^2 = 41.70\%$).

2.4.2. Meta regression

Neither total practice time (in hours) across the intervention ($Q(1) = 0.26$, $\beta = 0.002$, $p = .61$), nor duration (in hours) of individual exercises ($Q(1) = 0.09$, $\beta = -0.004$, $p = .76$), nor guidance ($Q(1) = 0.87$, $\beta = 0.22$, $p = .35$) nor quality of studies ($Q(1) = 0.47$, $\beta = 0.05$, $p = .49$) were significant predictors in a random effects meta-regression model. The inclusion of these predictors did not result in a further explanation of unaccounted variance.

2.4.3. Comparisons with active controls

When compared with active controls, SAMs exhibited no longer a significant summary effect on depression (*SMD* = 0.27; *CI*: −0.04, 0.58; *PI*: −0.41, 0.95; $p = .08$, $I^2 = 58.45\%$).

3. Discussion

A core element of mindfulness as taught in MBIs refers to the regular performance of formal mindfulness exercises. Yet, the efficacy of these exercises as a stand-alone intervention is seldom explored, since most

Table 2
Summary effect estimates for anxiety and depression.

	Sample size		Summary effect size estimate			Heterogeneity				
Outcome measure	*K*	*n*	Hedges's *g*	95% CI	*p*	95% PI	*Q*	*p*	I^2 (%)	T^2
Inactive controls										
Anxiety	13	786	0.39	[0.22, 0.56]	< .001	[0.07, 0.70]	14.80	.25	18.90	0.02
Depression	10	588	0.41	[0.19, 0.64]	< .001	[-0.05, 0.88]	13.52	.14	33.43	0.04
Trim and Fill										
Anxiety	16	901	0.32	[0.15, 0.50]	< .001	[-0.10, 0.75]	21.64	.12	30.70	0.04
Depression	11	607	0.37	[0.14, 0.61]	< .01	[-0.18, 0.92]	17.15	.07	41.70	0.06
Active controls										
Anxiety	8	484	0.27	[0.03, 0.50]	< .05	[-0.20, 0.73]	11.03	.14	36.54	0.04
Depression	7	473	0.27	[-0.04, 0.58]	.08	[-0.41, 0.95]	14.44	< .05	58.45	0.09

Note. The table presents summary effect sizes and heterogeneity parameters of the meta-analyses before and after correction for potential publication bias. Effect sizes are controlled pre-post differences. For anxiety, results of analyses excluding the outlying study are presented. *K* = number of studies; *n* = number of participants; CI = confidence interval; PI = prediction interval.

studies investigate fully-fletched MBIs, which are composed of several components (Dimidjian & Segal, 2015; Mander et al., 2017). Therefore, the aim of the present systematic review and meta-analysis was to isolate one specific component and sight the existing evidence concerning the effects of SAMs on symptoms of anxiety and depression. While there are meta-analyses regarding adapted or shortened versions of the standard MBSR/MBCT procedure, including online-MBIs (Spijkerman, Pots, & Bohlmeijer, 2016) and self-help-MBIs (Cavanagh, Strauss, Forder, & Jones, 2014), to our knowledge, the present meta-analysis is the first to exclusively focus on SAMs.

In a thorough screening process, we were able to identify 21 studies that met our eligibility criteria and included 18 in the meta-analyses. By comparison with inactive controls, we obtained significant, small to medium ES estimates for the reduction of symptoms of anxiety and depression. Interestingly, with a hedges' *g* of 0.39 (anxiety) and 0.41 (depression), our results are quite similar to those found by Hofmann et al. (2010) in their meta-analysis regarding the efficacy of MBSR and MBCT: $g = 0.33$ (anxiety) and 0.41 (depression), when compared with inactive controls. More recent meta-analyses, however, demonstrate medium to large controlled effect estimates on symptoms of anxiety and depression for manualized MBIs (anxiety: $g = 0.64$–1.00; depression: $g = 0.53$–0.80), thereby exceeding the summary effect estimates obtained in the present examination (Khoury et al., 2013, 2015). This might be due to inherent characteristics of SAMs that focus exclusively on the mere performance of mindfulness exercises and thus lack additional components (e.g. group cohesion, inquiry, psychoeducation) constituting manualized MBIs.

Though funnel plots and the Trim-and-Fill method indicated that publication bias might have affected our analyses, our results can be considered robust, since we still obtained significant summary ES estimates after correction for potentially missing studies. Regarding heterogeneity, prediction intervals demonstrated that there was some dispersion in true effects, but that it was rather unlikely for SAMs to exhibit an adverse effect. The *Q*-statistic did not reach significance, and the I^2 parameter fell into a low to moderate range, according to Higgins, Thompson, Deeks & Altman. (2003), suggesting that a large portion of variation in ESs was due to error. Nevertheless, we applied meta-regression to account for heterogeneity due to real differences in true effects; we found that, albeit not significant, the total amount of practice time over the course of an intervention could moderate the influence of mindfulness exercises on anxiety. Additionally, although not significant, effect sizes were higher when the respective mindfulness exercise was guided face-to-face by a clinician. Specifically, summary effect sizes were 0.49 (guided) vs 0.33 (online audiotape) for anxiety and 0.55 (guided) vs 0.33 (online audiotape) for depression. For further investigation, a larger number of studies are required to clarify the role of practice time and guidance in SAMs. Turning to our comparisons with active controls, we found the summary ES estimates to decrease for anxiety and to be no longer significant for depression. This finding is consistent with existing research demonstrating that the effects of manualized MBIs tend to decrease or even become non-significant when compared with active controls (Goyal et al., 2014; Khoury et al., 2013, 2015).

From a theoretical perspective, it is of importance that the mere performance of mindfulness exercises, not surrounded by a complex, therapeutic framework has beneficial effects on anxiety and depression. In effect, existing meta-analyses of manualized MBIs and dismantling studies have confounded the actual performance of mindfulness exercises with elaborate introductions to the concept of mindfulness, inquiry of experiences, and communication of mindfulness as an attitude (Ivanovic, Swift, Callahan, & Dunn, 2015; Mander et al., 2017). Hence, it was not yet known whether SAMs are effective because such factors are eliminated. Furthermore, experts have often emphasized the significance of guidance and inquiry by an experienced mindfulness teacher (Crane et al., 2010; Michalak, Heidenreich, & William, 2012; Segal et al., 2002). Our findings do not contradict this stance, since SAMs cannot in any event be considered equivalent to established MBIs, which offer a therapeutic framework that a reflection of mindfulness can build upon. Still, because of the popularity of mindfulness, many practitioners implement mindfulness exercises into routine therapy, even without much guidance, inquiry, or personal experience in mindfulness (Crane et al., 2012). Hence, it is necessary to critically examine the empirical basis of this approach. Our analyses are a preliminary step in this direction, since we could demonstrate that SAMs exhibit beneficial effects on anxiety and depression. However, recommendations for practitioners cannot be yet provided, as eligible studies did predominantly not investigate clinical samples. Thereby, it is unknown whether SAMs work for these populations, as well. Thus, experimental studies that examine SAMs in clinical samples in routine practice are necessary. Future studies should additionally investigate change mechanisms of SAMs, for example, via mediation analyses that test whether increases in trait mindfulness account for observable effects.

In the field of MBI research, it is not quite clear yet whether mindfulness, the theoretical foundation of MBIs, constitutes its *active ingredient* (Baer, 2003; Fjorback, Arendt, Ørnbøl, Fink, & Walach, 2011; Khoury et al., 2015). While dismantling studies and mediation analyses are better suited to answer this question, our analyses allow for the following, cautious conclusions: Given the beneficial effects of SAMs, one could assume that the efficacy of MBIs could partly be due to training in mindfulness. However, since fully-fletched MBIs seem to outperform SAMs, factors going beyond the mere performance of formal mindfulness exercises are involved. This reasoning is supported by a meta-analysis demonstrating only a small correlation between amount of home practice and outcome in MBIs (Parsons et al., 2017). Whether these additional factors are more likely to consist of

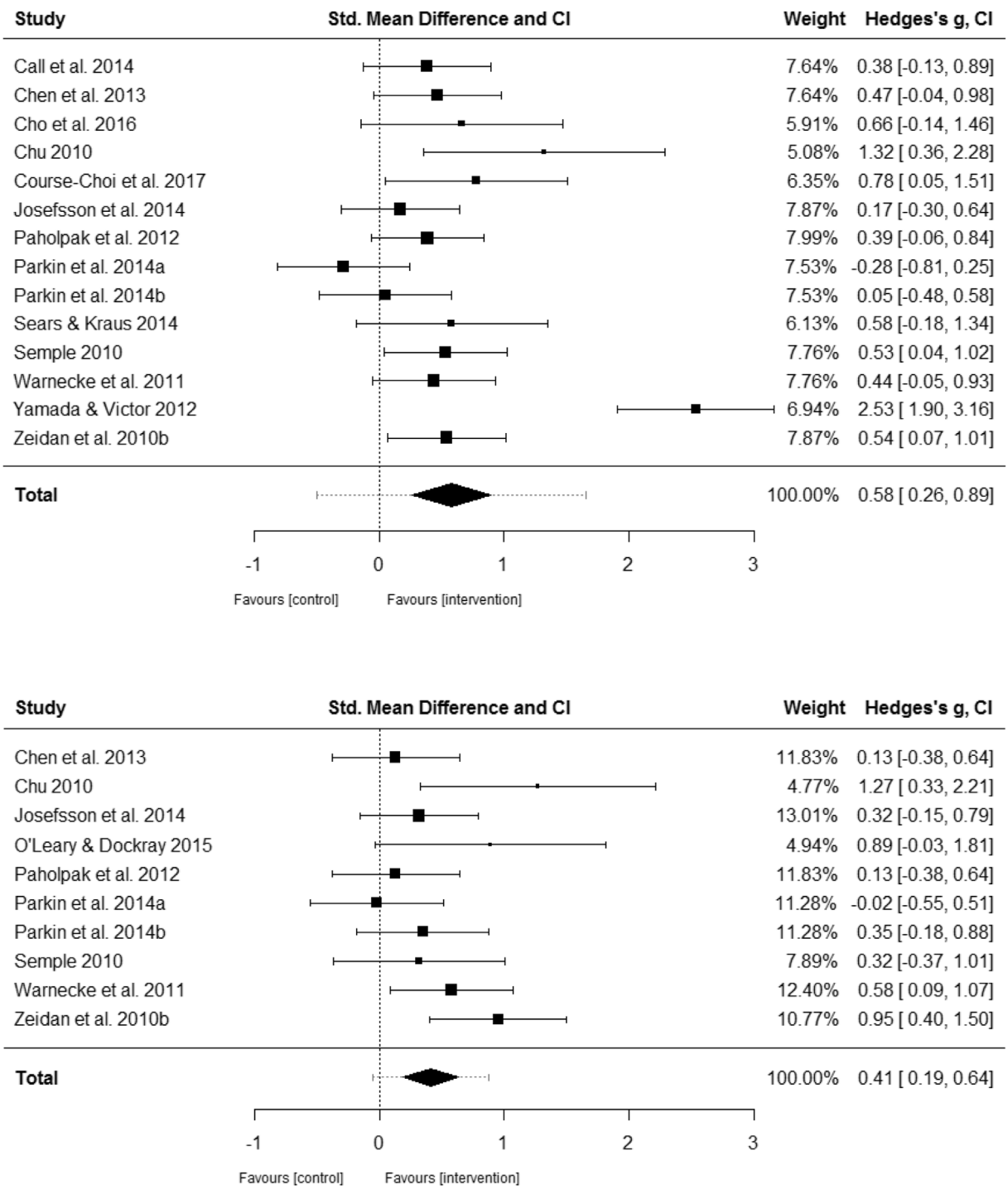

Fig. 2. Effects of SAMs on anxiety (top) and depression (bottom) compared with inactive controls. Forest plot includes the outlying study that was removed from further analysis.

nonspecific factors (e.g., social support) or therapeutic work with experiences generated during mindfulness exercises cannot be answered based on our analyses. Future studies should directly manipulate the amount of practice time to clarify its role in MBIs.

From a practical perspective, it is noteworthy that SAMs, provided that future studies demonstrate efficacy for clinical populations, could potentially be integrated as an economic mini-intervention into routine practice, since there is no absolute need for time intensive guidance and inquiry. Furthermore, the prediction intervals demonstrate that it is rather unlikely for SAMs to exhibit negative effects on anxiety and depression. However, it is not yet clear whether such a mini-intervention results in an additional effect in the context of already working treatments. This is an open research question that could potentially be addressed by component studies (Mander et al., 2015).

3.1. Strengths

The present examination has several strengths: First, we investigated one specific component of MBIs in greater detail and applied a transparent definition of mindfulness. This is especially important in view of the multitude of various mindfulness definitions (Nilsson & Kazemi, 2016) that result in quite heterogeneous mindfulness exercises. Our approach to apply a rather narrow definition of mindfulness enabled us to eliminate typical confounders and aligns with

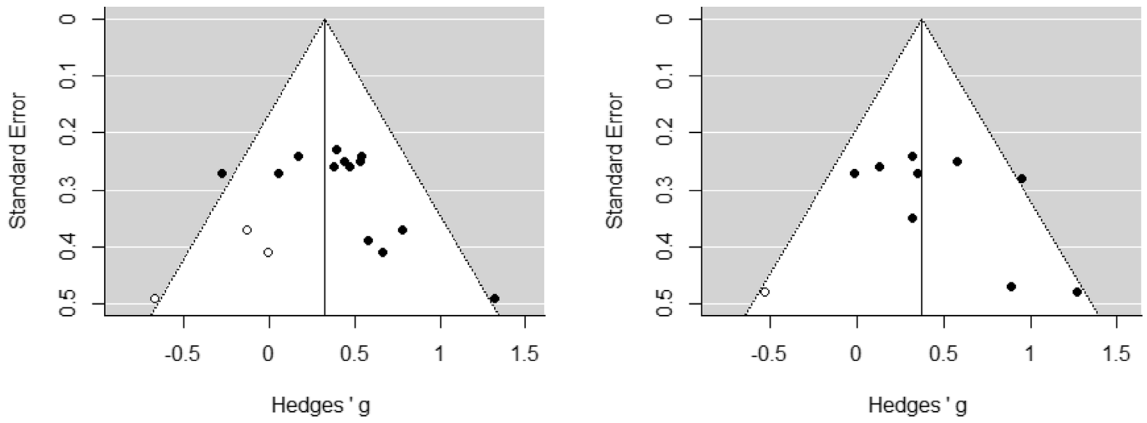

Fig. 3. Funnel plots of anxiety (left) and depression (right). Empty circles indicate imputed effect sizes by the Trim-and-Fill method.

recommendations to increase the public health impact of MBI research (Dimidjian & Segal, 2015). Finally, we conducted a thorough literature review by screening more than 9000 records and independently assessing more than 500 records for eligibility.

3.2. Limitations

Likewise, some limitations should be mentioned: First, we were unable to locate any studies in the *grey literature*. Although we carefully considered publication bias, the best strategy for preventing the *file drawer problem* (Rosenthal, 1979) would have been to include unpublished studies in our analyses (Borenstein et al., 2009). Second, observed effect sizes must be interpreted with caution as only a small number of studies contributed to our meta-analyses. Especially our meta-regression models suffered from low statistical power, making it likely that meaningful covariates could not be identified. Third, our summary estimate of interventions on anxiety was heavily dependent on one outlying study that we excluded from further analyses. However, the summary ES estimate remained significant after eliminating the outlier. Fourth, active control groups of eligible studies were somewhat heterogeneous, for which reason the respective results should be interpreted with caution. By focusing our main analyses on inactive controls, we ensured that SAMs were compared with sufficiently similar conditions. Fifth, due to practical constraints the initial screening of titles and abstracts was done by the first author only. Although an independent rating of two authors would have been preferable the screening was performed very carefully with only clearly non-eligible studies being excluded. Lastly, there were predominantly no clinical samples in our analyses, thereby questioning the generalizability of our results. However, effects of SAMs on anxiety and depression could be even larger in clinical populations, as more variation in these clinical variables is to be expected.

3.3. Conclusions

SAMs have a small to medium effect on symptoms of anxiety and depression. Regarding our conceptual understanding of MBIs, this indicates that their efficacy could partly be due to the actual practice of mindfulness. From a practical perspective, it is noteworthy that mindfulness exercises are beneficial without being integrated in any larger therapeutic framework, and that adverse effects are rather unlikely. Future research should investigate SAMs in clinical samples and investigate their unique contribution to established therapeutic interventions.

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Contributors

PB and JM designed the study and wrote the protocol. Independent screening and data extraction of eligible studies was conducted by PB and SP. PB conducted the statistical analysis and wrote the first draft of the manuscript. TH, PK, BD, HB and JM critically revised the manuscript for important intellectual content. All authors contributed to and have approved the final manuscript.

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Note. References with an asterisk denote studies that were included in the systematic review.