

# The Impact of Group-Based Mindfulness Training on Self-Reported Mindfulness: a Systematic Review and Meta-analysis

Endre Visted · Jon Vøllestad · Morten Birkeland Nielsen · Geir Høstmark Nielsen

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**Abstract** Mindfulness-based interventions (MBIs) show promising results in both clinical and non-clinical settings. A number of studies indicate that self-reported mindfulness is associated with adaptive psychological functioning and decreased symptom distress. However, there have been no systematic reviews of research on self-reported mindfulness as an outcome of MBIs for clinical and non-clinical samples. It is also unclear to what extent MBIs actually lead to increased and stable self-reported mindfulness. A systematic literature search was conducted to identify studies measuring self-reported mindfulness before and after an MBI. Meta-analytic procedures were used to investigate self-reported mindfulness as an outcome of MBIs. The results show that several questionnaires have been designed to measure mindfulness, and these have been applied to a variety of samples. Although methodological issues preclude definite conclusions, the meta-analysis indicates that MBIs increase self-reported mindfulness. Effect sizes indicate that increases are in the medium range (Hedges'  $g=0.53$ ). However, over half of the studies found no significant effects of MBIs on self-reported mindfulness from pre- to post-intervention. Also, studies of MBIs against active control conditions show no significant advantage for MBIs in increasing self-reported mindfulness. This raises serious questions concerning the validity of the mindfulness questionnaires currently in use. The addition of a full or half day of intensive mindfulness training (retreats) as

part of the intervention moderate the effect sizes in positive direction. Implications for future research include the need for analysis of statistical mediation as well as further validation of questionnaires. Comparisons of MBIs to established evidence-based interventions as active control conditions are also called for.

**Keywords** Mindfulness · Mindfulness-based · Assessment · Questionnaire · Group · Intervention

## Introduction

Exercises aimed at developing mindfulness skills are increasingly being incorporated into psychological interventions (Chiesa and Malinowski 2011; Gilpin 2008; Shapiro and Carlson 2009). The concept of mindfulness is defined as “the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding experience moment by moment” (Kabat-Zinn 2003). The first program to include extensive cultivation of mindfulness was mindfulness-based stress reduction (MBSR; Kabat-Zinn 1990). Several interventions are now based on the systematic training of mindfulness skills to alleviate stress and suffering associated with a range of somatic and psychological disorders. Mindfulness-based interventions (MBIs), including MBSR, mindfulness-based cognitive therapy (MBCT; Segal et al. 2002; Teasdale et al. 2000), and mindfulness-based relapse prevention (MBRP; Bowen et al. 2011), are group-based interventions that provide an experiential introduction to mindfulness through various exercises and homework assignments aimed at developing mindfulness through formal practice and in daily life. MBIs are usually carried out through eight 2–3-h sessions weekly with groups comprising up to 30 participants. In addition, a whole or half day of intensive mindfulness training (“silent retreat”) is typically provided

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during the sixth week (Kabat-Zinn 1990). Although MBIs may differ somewhat in terms of the specific exercises they employ, they share a conceptual framework influenced by Buddhist psychology (Baer and Krietemeyer 2006; Fennell and Segal 2011). Consequently, they all rest on the assumption that systematic cultivation of non-judgmental and present-centered awareness will lead to decreased stress and suffering (Bishop et al. 2004).

Empirical studies indicate that MBIs are effective for various somatic and psychological disorders, as reduction in symptoms and improved well-being are consistently observed after participation (Keng et al. 2011). To understand how this impact comes about, it is important to establish that these interventions actually lead to an increased capacity for mindful awareness. Of relevance to this aim, a number of self-report questionnaires have been developed to quantify the construct of mindfulness (Baer 2011). These questionnaires assess mindfulness either as a trait- or state-like property. Mindfulness as a trait concerns the general tendency to be mindful in daily life (Brown and Ryan 2003), whereas state mindfulness denotes the ability to evoke a mindful mode of awareness at a given point in time (Lau et al. 2006).

Studies indicate that higher self-reported mindfulness is associated with aspects of psychological functioning that promote quality of life and well-being (e.g., Baer et al. 2006) and decreased distress related to several disorders, including depression (Gilbert and Christopher 2010; Sanders and Lam 2010), anxiety (Arch and Craske 2010; Rasmussen and Pidgeon 2010), eating disorders (Lavender et al. 2009), and chronic pain (McCracken and Thompson 2009; Schütze et al. 2010). There is also preliminary evidence that self-reported mindfulness serves as a statistical mediator of the relationship between MBIs and a number of outcome variables (Bränström et al. 2010; Carmody and Baer 2008).

A recent review by Sauer et al. (2013) identified a number of questionnaires aimed at measuring mindfulness. The review evaluated the questionnaires in terms of their conceptual framework, empirical support, and usage. However, the review did not investigate the characteristics of MBI trials assessing self-reported mindfulness, such as study design, target population, intervention type, and mindfulness questionnaire used. The authors also did not examine the possible statistical mediation of mindfulness on outcome. Consequently, we do not have systematic knowledge about the particular features of studies measuring mindfulness before and after a MBI and whether self-reported mindfulness mediates outcome.

One recent meta-analysis explored whether mindfulness training may increase self-reported mindfulness (Eberth and Sedlmeier 2012). The authors found that mindfulness training had a small effect on self-reported mindfulness. However, in that study, trials featuring clinical samples, as well as non-controlled trials, were excluded. In addition, the analysis did not investigate whether increased self-reported mindfulness

remained stable over time. Consequently, no previous studies have yet assessed the effect of MBIs on self-reported mindfulness in both clinical and non-clinical samples and whether the effect remains stable at follow-up.

The utilization of mindfulness in psychological interventions has been characterized as a paradigmatically different approach compared to established evidence-based behavioral therapies (Hayes 2004). For instance, cognitive behavioral therapy seeks to change the irrational content of cognition, whereas the emphasis in MBIs is to alter the quality of awareness and relationship to personal experience (Segal et al. 2004). Consequently, one should expect mindfulness training to lead to increases in self-reported mindfulness, while this would not be an expected outcome of other interventions. However, it is not, at present, clear whether increases in self-reported mindfulness can be attributed exclusively to mindfulness training.

We currently do not know which features of trials may promote increases in self-reported mindfulness. Hence, it is of interest to investigate whether any characteristics of study design, participants, or intervention type serves to moderate self-reported mindfulness. For instance, it is relevant to know whether non-clinical samples are different from clinical samples in terms of increased self-reported mindfulness. It is also of interest to investigate whether different mindfulness questionnaires are associated with different effect sizes. This may serve as an indicator of the sensitivity of change of the various instruments. Finally, MBIs vary in duration and treatment dosage. It is uncertain whether total intervention time and number of sessions affect self-reported mindfulness.

In sum, several key questions regarding the measurement of self-reported mindfulness before and after MBIs are still not answered. Thus, the primary aims of the present study were to systematically review controlled and uncontrolled trials of MBIs measuring pre- and post-intervention self-reported mindfulness in clinical and non-clinical samples and to evaluate their impact on self-reported mindfulness. We further wanted to answer the following questions:

1. What are the defining features of studies measuring self-reported mindfulness before and after a MBI? Specifically, what kinds of study designs, types of participant groups, and mindfulness interventions are found?
2. Which self-report questionnaires are currently used to measure mindfulness in MBI trials?
3. Does mindfulness training lead to increased self-reported mindfulness? If so, are these changes maintained over follow-up periods?
4. Do changes in self-reported mindfulness mediate the effects of interventions?
5. Are increases in self-reported mindfulness exclusively associated with MBI groups, or are changes also observed in control groups?

6. Do particular features of MBI trials and self-report questionnaires statistically moderate self-reported mindfulness?

## Method

### Identification of Studies

Eligible studies were identified by searching the databases MEDLINE, PsycINFO, FRANCIS, and ISI Web of Knowledge using the term “mindfulness” in combination with the terms “training”, “meditation”, “program\*”, “therapy”, “intervention”, “questionnaire\*”, “factor analysis”, “measure\*”, “psychometric”, “assess\*”, “self-report”, and “facet\*”. In addition, reference lists from other reviews were scanned to identify potential eligible studies. All peer-reviewed articles in languages mastered by the authors (English, Norwegian, Danish, Swedish, or German) describing a design using any MBI together with at least one assessment of mindfulness through self-report questionnaire(s) were included by the first author for further examination. Studies were finally included in the review if they met the following inclusion criteria:

1. Intervention was mindfulness-based (with “mindfulness-based” operationalized as “teaching participants techniques of formal and informal meditation practice as a fundamental aspect of the intervention”) and conducted in groups with a minimum length of 4 weeks.
2. Assessment instrument was a self-report questionnaire designed to measure mindfulness.
3. Study design had a pre-post within- and/or between-group assessment design and incorporated either randomized controlled trials or uncontrolled trials.
4. Reported data were sufficient for calculating effect sizes, including pre- and post-mindfulness scores ( $M$ ) and standard deviations/errors ( $SD$ ), number of participants ( $N$ ),  $p$  values, confidence intervals, and  $F$  values.

Studies were excluded if any of the following exclusion criteria were met:

1. Intervention lacked description to determine if it was rooted in mindfulness, featured other forms of meditation than mindfulness meditation, lacked a well-organized program, i.e., no clearly delineated structure, schedule of practice, or formal group setting, or was an intensive retreat.
2. Assessment instrument was not explicitly described as measuring mindfulness. Studies only incorporating questionnaires designed to measure theoretically overlapping constructs such as decentering (The Experience Questionnaire; Fresco et al. 2007) and self compassion

- (The Self Compassion Scale; Neff 2003) were excluded, because they do not claim to measure mindfulness as such.
3. Study incorporated single case or  $N=1$  study designs.

The selection process was aided by a screening form designed for the present purpose. The selection process was validated by the second author using the same screening form. Studies coded differently by the authors were discussed to reach consensus. Finally, corresponding authors were contacted for studies that did not report pre- and post-data. A study was excluded if authors did not respond and/or the data reported was insufficient to calculate effect sizes.

For articles reporting a full- or half-day retreat without reporting the precise duration, an estimated duration of 390 or 195 min, respectively, was added to the total intervention time as default. In cases where no retreat was reported, it was assumed that none was offered. For articles reporting a time interval for session time, the mean value of the interval was coded (e.g., 120–140 min=130 min). Standard errors (SEs) were converted to SDs using the following formula:  $SD = SE\sqrt{n}$  (Thalheimer and Cook 2002). Further, only the last follow-up assessment was included when several follow-up measures were reported. Computation of descriptive and frequency data were carried out in the software SPSS Version 19 for Windows.

### Estimation of Effect Sizes

Several options to calculate effect sizes are available (Borenstein et al. 2009; Schulze 2004). It was expected that many studies would have small sample sizes. Hedges’  $g$  was therefore considered the best choice, being a variation of Cohen’s  $d$  that corrects for biases due to small sample sizes (Hedges and Olkin 1985).

Hedges’  $g$  within-group effect sizes for self-reported mindfulness were calculated for all studies, given sufficient available data. These estimates were then combined to obtain a summary statistic across all studies.

For randomized controlled trials, Hedges’  $g$  for differences in treatment effects between MBIs and control conditions were calculated. Studies including “treatment as usual” as control conditions were classified as active control conditions.

Some studies included several mindfulness measures or applied multidimensional measurements. In these cases, effect sizes for each measure or dimension were calculated first, followed by calculation of the average Hedges’  $g$  effect size for each study. When subscales and total scale scores were reported, the total scale scores were excluded from the analyses to avoid confounding effect sizes.

The random effects model was used when calculating the pooled mean effect sizes. This allows for statistical inferences to a population of studies beyond those included in the meta-analysis. The interpretation of effect sizes was aided by Cohen

(1988) guidelines: a value of 0.2 represents a small effect, 0.5 a medium effect, and 0.8 a large effect.

### Moderator Analysis

The  $Q$  statistic was used to assess the heterogeneity of included studies. A significant  $Q$  value rejects the null hypothesis of homogeneity. The  $I^2$  statistic was computed as an indicator of heterogeneity in percentages. The  $I^2$  describes the percentage of total variation across studies that are due to heterogeneity rather than chance. The interpretation of the percentage was aided by Higgins and co-authors' guidelines, with values of 0 % indicating no heterogeneity, 50 % indicating moderate heterogeneity, and 75 % indicating high heterogeneity (Higgins et al. 2003).

To investigate potential moderator effects, a procedure proposed by Hedges and Olkin (1985) was used. According to that approach, meta-analytic evidence for the presence of moderators requires that effect size estimates are statistically different in the categories formed by the potential moderator variable (Borenstein et al. 2009). The degree of variability of the effect size estimates across studies is measured by separating studies according to potential moderators and then conducting a pooling of effect sizes separately for each subgroup. In order to assess the presence of a significant difference between groups, the between-group heterogeneity statistic  $Q_B$  was computed. A statistically significant  $Q_B$  indicates a moderator effect, suggesting a difference between mean effect sizes for the different groups.

Meta-regression analyses with total duration of intervention as the moderator variable was conducted to examine whether there was a dose-response relationship between intervention duration and the effects of MBIs on outcomes as well as between number of sessions and the established effect sizes. As it is not possible to combine several outcome measures from the same study in meta-regression analyses, the dose-response analyses were conducted separately for each mindfulness questionnaire.

Finally, a subgroup moderator analysis was conducted in order to determine whether effect sizes were dependent on the utilized mindfulness questionnaires.

### Publication Bias

The present paper included only published studies. Evidence shows that studies that report relatively high effect sizes are more likely to be published than studies that report lower effect sizes, an issue known as “file-drawer problem” or publication bias (Borenstein et al. 2009). Two approaches were applied to control for publication bias. First, the fail-safe  $N$  was calculated, representing the required number of studies reporting null results to reduce the overall effect size to non-significant.

Second, a funnel plot was visually inspected for asymmetry to assess potential biases in the distribution of effects. A funnel plot is a scatter plot of the effect sizes from individual studies (horizontal axis) against a measure of study size (vertical axis). In the absence of bias, studies with large sample sizes should be placed toward the top and smaller studies will scatter more widely at the bottom of the plot (Sterne et al. 2011).

Effect size calculations, meta-analysis, and publication bias analysis were carried out with the software Comprehensive Meta Analysis version 2 (Borenstein et al. 2011).

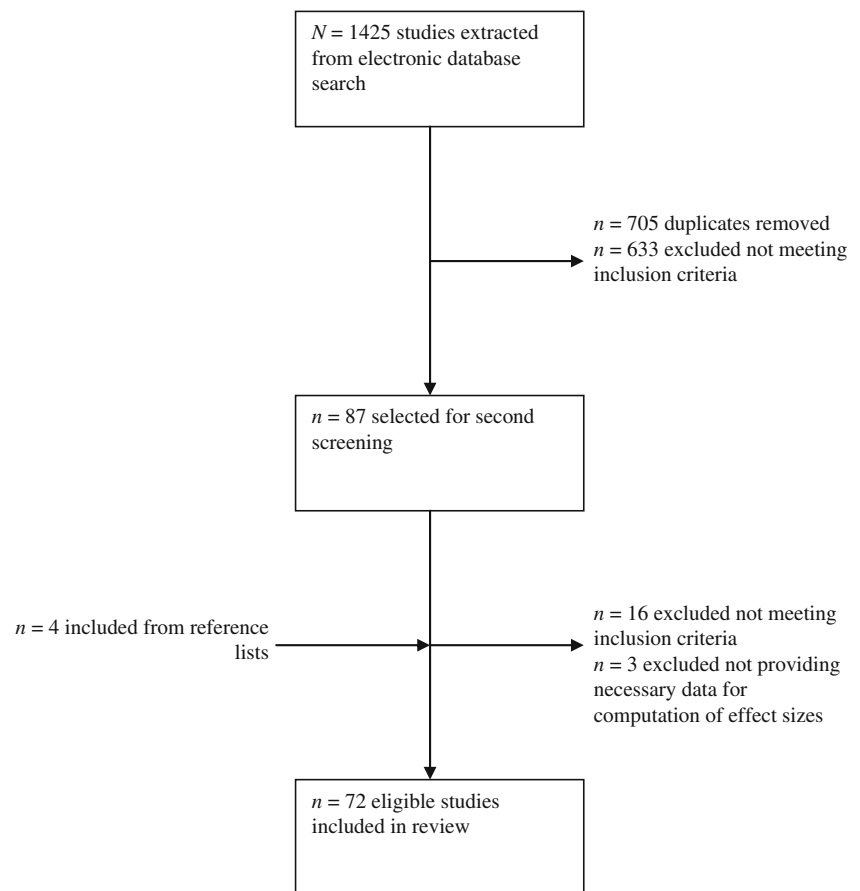
## Results

### Eligible Studies

The search was conducted through March 4th 2011 and yielded 1,425 results. Eighty-seven studies were included for the second screening; 1,338 studies were excluded ( $n=633$  not reaching inclusion criteria;  $n=705$  duplicates). After closer inspection of identified studies, 16 studies were excluded ( $n=1$  based on same data as another eligible study;  $n=2$  being protocol descriptions;  $n=9$  due to the nature of intervention; and  $n=4$  due to type of mindfulness questionnaire). Sixteen authors were contacted requesting missing data necessary to compute effect sizes from 18 trials. Eight authors provided necessary data; six studies were included using available statistical data, and three studies not providing necessary data were excluded. Four studies were included after reviewing reference lists of previous reviews and other relevant literature. In sum, a total of 72 studies were found eligible for inclusion. All included studies were in the English language. See Fig. 1 for flow chart and “Appendix A” for overview and summary of all included studies.

### Characteristics of Studies

The first study to be published appeared in 2005 (Cohen-Katz et al. 2005). Most studies were published after 2008 ( $n=61$ , 85 %). The majority of studies were uncontrolled or open trials ( $n=46$ , 64 %). Twenty-six studies (36 %) were randomized controlled trials (RCT), including waiting-list (WLC;  $n=13$ ), active (AC;  $n=6$ ), and treatment as usual (TAU;  $n=3$ ) control conditions. In addition, four studies applied a three-arm control design including experimental, active, and waiting-list control conditions (Oken et al. 2010; Ortner et al. 2007; Schmidt et al. 2010; Shapiro et al. 2008). Twenty-three (32 %) studies included follow-up measurements on average 4.56 months after intervention end (range 1–15).

**Fig. 1** Study flow diagram

### Characteristics of Participants

The aggregated number of participants receiving a MBI was 2,901. Subjects' mean age was 45 years, with a range from 14.4 to 78 ( $SD=12.1$ ). Aggregated dropout rate was 18 % and completion rate 82 %. Study sample size ranged from 10 to 320 participants ( $M=40.2$ ,  $SD=44.6$ ).

The majority ( $n=47$ , 65 %) of the trials consisted of clinical samples, including somatic disorders ( $n=17$ ), heterogeneous disorders (samples consisting of participants with more than one diagnosis;  $n=9$ ), affective disorders ( $n=5$ ), substance abuse disorders ( $n=5$ ), anxiety disorders ( $n=4$ ), and sleep disorders ( $n=2$ ). Further, single studies consisted of samples with personality disorders (Sachse et al. 2010), psychotic disorders (Chadwick et al. 2009), externalizing problems (conduct disorders, attention deficit hyperactivity disorder, and oppositional defiant disorder; Bögels et al. 2008), post-traumatic stress disorder (Kimbrough et al. 2010), and general distress (Nyklíček and Kuijpers 2008). Twenty-five studies (35 %) had non-clinical samples.

### Characteristics of Interventions

MBSR was the most frequent intervention ( $n=29$ , 40 %), followed by sample-specific interventions ( $n=27$ , 38 %) and

MBCT ( $n=16$ , 22 %). The mean number of facilitators per group was 1.5 ( $SD=0.7$ ), ranging from 1 to 4 (mode=1). Only two studies assessed therapists' competence and adherence to treatment manuals (Altmaier and Maloney 2007; Baum et al. 2010). Total number of sessions ranged from 4 to 18, with a mode of 8 sessions. Session length ranged from 20 to 180 min, with a mean of 125 min ( $SD=34.2$ ). The mean total intervention length, retreat time included, was 1,132.5 min (18.86 h;  $SD=521.9$ ), ranging from 120 to 3,120 min (2–52 h). These sessions were given within an average of 8 weeks ( $SD=1.8$ ), ranging from 4 to 18 weeks.

Although most studies ( $n=46$ , 64 %) did not report whether or not their intervention included a full- or half-day retreat, 21 studies (29 %) reported having a full-day retreat, 2 studies (3 %) half-day retreat, and 3 studies (4 %) explicitly reporting having no retreat.

Active control conditions included progressive muscle relaxation (Agee et al. 2009; Dalen et al. 2010; Schmidt et al. 2010), antidepressant treatment (Baum et al. 2010; Brown et al. 2011), individual psychotherapy (Brown et al. 2011), 12-step abstinence program for alcohol dependence (Bowen et al. 2009), cognitive group therapy (Brewer et al. 2009), guided visual imagery (Kingston et al. 2007), health education program (Morone et al. 2009), education classes for dementia caregivers (Oken et al. 2010), other meditation programs



(Ortner et al. 2007; Shapiro et al. 2008), and support groups for alcohol dependence (Garland et al. 2010) and obstructive lung disease (Mularski et al. 2009).

### Mindfulness Questionnaires

Ten independent self-report questionnaires were applied 84 times in the included studies, presented in Table 1.

*The Mindful Attention Awareness Scale* (MAAS; Brown and Ryan 2003) rates frequency of experience associated with lapses of inattentiveness. The instrument was constructed on the theoretical assumption that the respondent's degree of attention to, and awareness of, what is occurring in the present moment is the main variable in mindfulness.

*The Five Facet Mindfulness Questionnaire* (FFMQ; Baer et al. 2006) includes statements measuring mindfulness skills. Factor-analytic procedures were carried out on an item-pool consisting of items from five published and unpublished mindfulness questionnaires.

*The Kentucky Inventory of Mindfulness Skills* (KIMS; Baer et al. 2004) is the precursor to the FFMQ and shares attributes of the FFMQ in respect to number of items and rating scales. The item construction was based on four mindfulness modules applied in dialectical behavior therapy (Baer et al. 2004; Baum et al. 2010; Linehan and Dexter-Mazza 2008).

*The Toronto Mindfulness Scale* (TMS; Lau et al. 2006) assesses immediate respondent mindfulness experience. Two different versions of the TMS were found to be applied in studies included in the current review; an unpublished 10-item one-factor version ( $N=5$ ) and a published two-factor 13-item version ( $N=2$ ). The TMS assesses the capacity to invoke a state of mindfulness, and not the general tendency to be mindful in daily life like other questionnaires. The questionnaire is therefore typically administered after a session of meditation.

*The Freiburg Mindfulness Inventory* (FMI; Buchheld et al. 2001; Walach et al. 2006a, b) rates the frequency of experiences associated with mindfulness. Two versions of the FMI are available: A 14-item version recommended for meditation-naïve participants (Walach et al. 2006a, Walach et al. 2006b), and a 30-item version recommended for research purposes (Buchheld et al. 2001). One study used the 30-item version and five applied the short version.

### Other Mindfulness Questionnaires

The following questionnaires were applied once in the included studies. The Cognitive and Affective Mindfulness Scale Revised (CAMS-R; Feldman et al. 2007) rates the respondents' degree of mindfulness related to thoughts and feelings. The Southampton Mindfulness Questionnaire (SMQ;

**Table 1** Overview of questionnaires designed to measure mindfulness applied in included studies, summarizing practical and theoretical differences

Measurement	<i>n</i>	Items	Components	Key concepts
MAAS	34	15	One	Attention and awareness
FFMQ	18	39	Five	Observing Describing Acting with awareness Accepting without judgment Non-reactivity
KIMS	14	39	Four	Observing Describing Acting with awareness Accepting without judgment
TMS	7	13 and 10	Two and one	Awareness Attitudes of curiosity and acceptance Decentering
FMI	6	30 and 14	One	Present-moment disidentifying attention
MAAS-A	1	14	One	Same as MAAS
CAMS-R	1	12	One	Attention Present focus Awareness Acceptance
SMQ	1	16	One	Decentered vs. reactive awareness Attention to vs. avoidance of difficult cognition Acceptance of vs. judgment of difficult cognition and self Letting go of vs. worrying about cognition
SMVQ	1	12	One	Same as SMQ
KIMS-E	1	46	Five	Same as FFMQ

*FMI* Freiburg Mindfulness Inventory, *MAAS* Mindful Attention Awareness Scale, *MAAS-A* Mindful Attention Awareness Scale Adolescent, *TMS* Toronto Mindfulness Scale, *KIMS* Kentucky Inventory of Mindfulness Skills, *CAMS-R* Cognitive and Affective Mindfulness Scale Revised, *SMQ* Southampton Mindfulness Questionnaire, *SMVQ* Southampton Mindfulness of Voices Questionnaire, *FFMQ* Five Facet Mindfulness Questionnaire, *KIMS-E* Kentucky Inventory of Mindfulness Skills Extended

Chadwick et al. 2008) rates the participants' mindful awareness to distressing thoughts and images. Three mindfulness questionnaires were modified versions of questionnaires described above, including The Southampton Mindfulness of Voices Questionnaire (SMVQ; Chadwick et al. 2007), The Mindful Attention Awareness Scale-Adolescent (MAAS-A;

Brown et al. 2011), and The Kentucky Inventory of Mindfulness Skills-Extended (KIMS-E; Raes et al. 2009).

### Mediation Analyses

Eleven studies (16 %) investigated whether self-reported mindfulness mediated outcomes on other variables. Most studies found evidence of mediation in the expected direction. Results from mediator analyses are presented in Table 2.

### Meta-Analysis

Within-group effect sizes for self-reported mindfulness were computed for all studies reporting sufficient data ( $N=71$  studies, including 72 trials). Post to follow-up effect sizes were calculated for 20 trials. For between-group analyses, effect sizes were calculated and pooled separately for waiting-list ( $n=16$ ) and active control conditions ( $n=12$ ).

**Within-Group Effect Sizes** Within-group effect sizes for mindfulness scores for individual studies are displayed in Fig. 2. Pre- to post-treatment effect sizes for self-reported mindfulness ranged from  $-0.44$  to  $1.91$ . The overall within-group Hedges'  $g$  for self-reported mindfulness at post-treatment was  $0.53$  ( $p<.001$ , 95 % confidence interval (CI)= $0.46-0.61$ ). This effect size is in the medium range, indicating that at post-treatment, participants in MBIs averaged  $0.53$  standard deviations above their pre-intervention scores on self-reported mindfulness. Heterogeneity was low to moderate ( $Q=116.31$ ,  $p=.001$ ,  $I^2=38.96$ ). From pre- to post-intervention, 37 of 72 trials found no significant effect of MBIs on self-reported mindfulness.

Effect sizes indicated no significant change in self-reported mindfulness from post-treatment to follow-up (Hedges'  $g=-0.03$ ,  $p=.61$ , 95 % CI= $-0.15-0.09$ ). These findings of no change from post-treatment to follow-up indicate that the degree of self-reported mindfulness was maintained over time.

**Table 2** Overview of studies investigating mediation of mindfulness on other variables

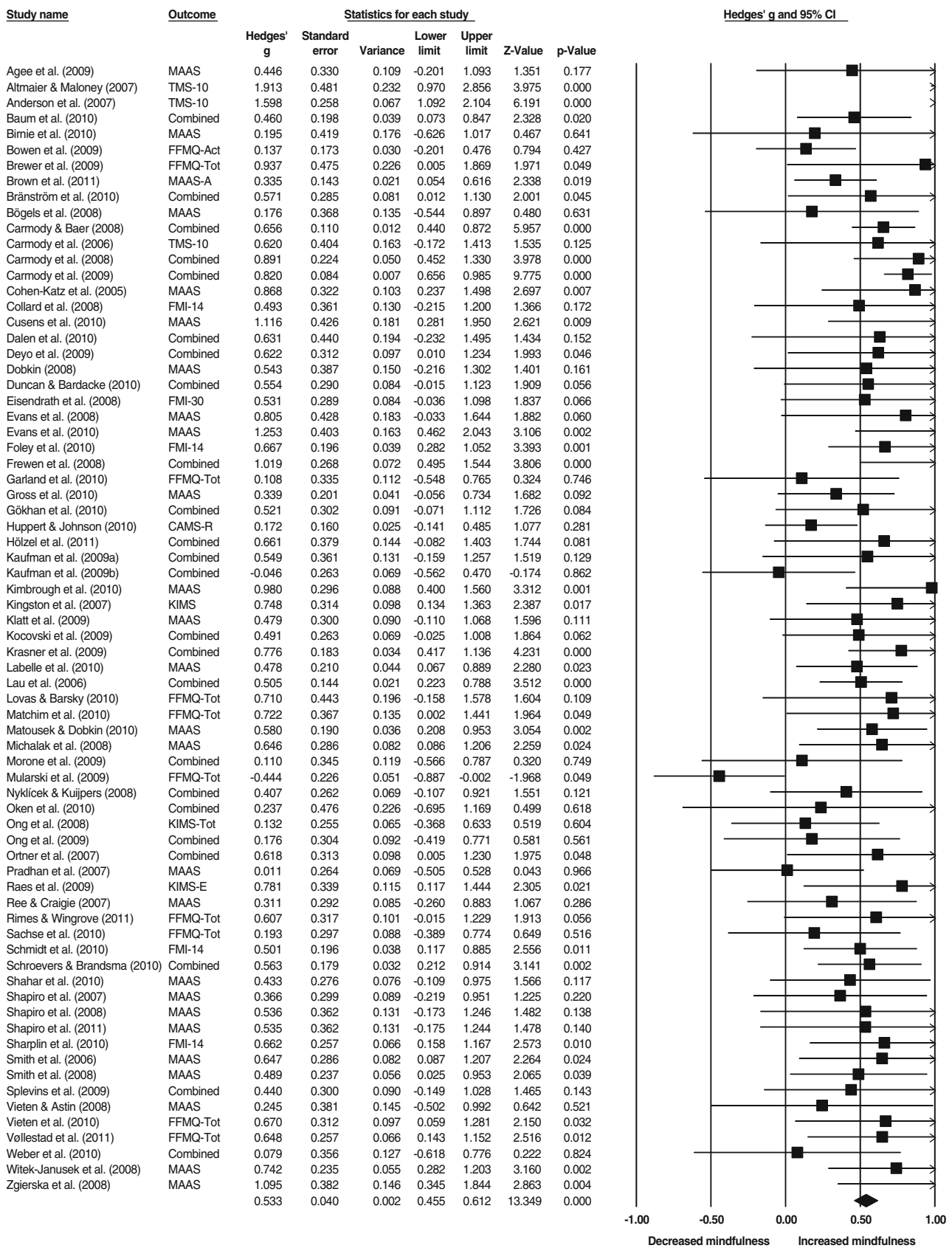
Author (year)	Mediating variable	Clinical outcome
Bränström et al. (2010)	FFMQ	Perceived stress <sup>a</sup> Avoidance of trauma-related symptoms <sup>a</sup> Positive states of mind <sup>b</sup>
Carmody and Baer (2008)	FFMQ	Psychological symptoms <sup>a</sup> Perceived stress <sup>a</sup> Psychological well-being <sup>b</sup>
Carmody et al. (2009)	FFMQ	Perceived stress <sup>a</sup>
Kingston et al. (2007)	KIMS	Perceived pain intensity <sup>c</sup> Pain tolerance <sup>c</sup> Blood pressure <sup>c</sup>
Kocovski et al. (2009)	KIMS (subscale "accept without judgment")	Social phobia <sup>a</sup>
Labelle et al. (2010)	MAAS	Depressive symptoms <sup>c</sup>
Nykliček and Kuijpers (2008)	MAAS	Perceived stress <sup>a</sup> Vital exhaustion (partially) <sup>a</sup> Quality of life <sup>b</sup>
Raes et al. (2009)	KIMS-E	Cognitive reactivity <sup>a</sup>
Shahar et al. (2010)	MAAS	Depressive symptoms <sup>a</sup>
Shapiro et al. (2007)	MAAS	Rumination <sup>a</sup> Trait anxiety <sup>a</sup> Perceived stress <sup>a</sup> Self compassion <sup>b</sup>
Shapiro et al. (2008)	MAAS	Perceived stress <sup>a</sup> Rumination <sup>a</sup>
Vøllestad et al. (2011)	FFMQ	Anxiety symptoms <sup>a</sup> Worry (partially) <sup>a</sup> Trait anxiety (partially) <sup>a</sup>

FFMQ Five Facet Mindfulness Questionnaire, KIMS Kentucky Inventory of Mindfulness Skills, MAAS Mindful Attention Awareness Scale, KIMS-E Kentucky Inventory of Mindfulness Skills Extended

<sup>a</sup> Mindfulness mediates decrease

<sup>b</sup> Mindfulness mediates increase

<sup>c</sup> No mediation





**Fig. 2** Within-group effect sizes and pre- to post-treatment change in mindfulness. *MAAS* the Mindful Attention Awareness Scale, *TMS-10* the Toronto Mindfulness Scale 10-item version, *Combined* mean effect size from several (sub)scales, *FFMQ-Act* the Five Factor Mindfulness Questionnaire act with awareness subscale, *FFMQ-Tot* the Five Factor Mindfulness Questionnaire total score, *MAAS-A* the Mindful Attention Awareness Scale-Adolescent, *FMI-14* the Freiburg Mindfulness Inventory 14-item version, *FMI-30* the Freiburg Mindfulness Inventory 30-item version, *CAMS-R* Cognitive and Affective Mindfulness Scale Revised, *KIMS-E* Kentucky Inventory of Mindfulness Skills Extended

**Between-Group Effect Sizes for Controlled Studies** Effect sizes computed for controlled trials with a waiting-list comparison condition yielded an overall Hedges' *g* of 0.47 ( $p < .001$ , 95 % CI=0.23–0.7). This estimate indicates that participants in MBI groups improve their self-reported mindfulness scores about half a standard deviation more than participants receiving no intervention. Heterogeneity was moderate to high ( $Q=42$ ,  $p < .001$ ,  $I^2=64.3$ ). Seven studies found a significant effect of MBIs on self-reported mindfulness, while nine studies did not. Effect sizes for studies with waiting-list control conditions are displayed in Fig. 3.

Effect sizes computed with active control group data indicated that there was no difference between MBIs and active control conditions in terms of self-reported mindfulness at post-treatment (Hedges'  $g=0.09$ ,  $p=.28$ , 95 % CI=-0.08–0.26). Only one study out of 12 favored the MBI condition (Baum et al. 2010). These results indicate that MBIs do not lead to greater increases in self-reported mindfulness compared to active control conditions. The effect sizes for studies with active control conditions are displayed in Fig. 4.

Moderator Analyses

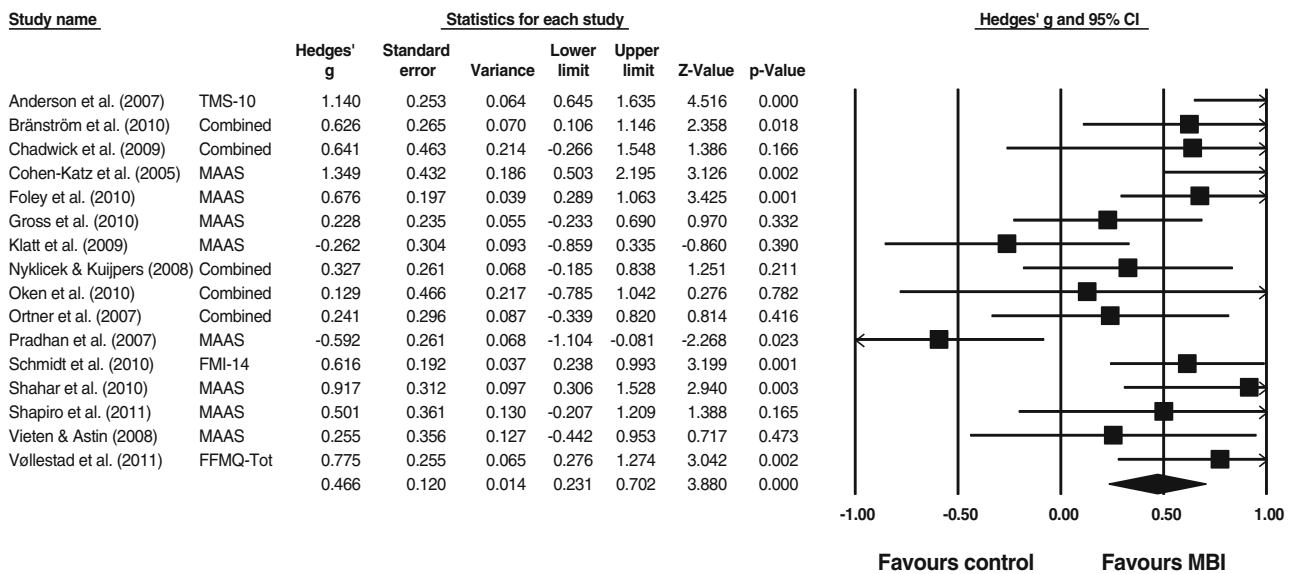
All moderator analyses were performed using within-group data.

**Study Design** No significant difference was observed when comparing effect sizes between randomized controlled trials (Hedges'  $g=0.45$ , 95 % CI=0.29–0.6) and uncontrolled trials (Hedges'  $g=0.59$ , 95 % CI=0.51–0.67;  $Q_B=2.5$ ,  $df=1$ ,  $p=.11$ ).

**Sample Characteristics** No significant differences in mean effect sizes for self-reported mindfulness was found when comparing clinical (Hedges'  $g=0.5$ , 95 % CI=0.41–0.6) to non-clinical samples (Hedges'  $g=0.61$ , 95 % CI=0.46–0.76;  $Q_B=1.47$ ,  $df=1$ ,  $p=.23$ ).

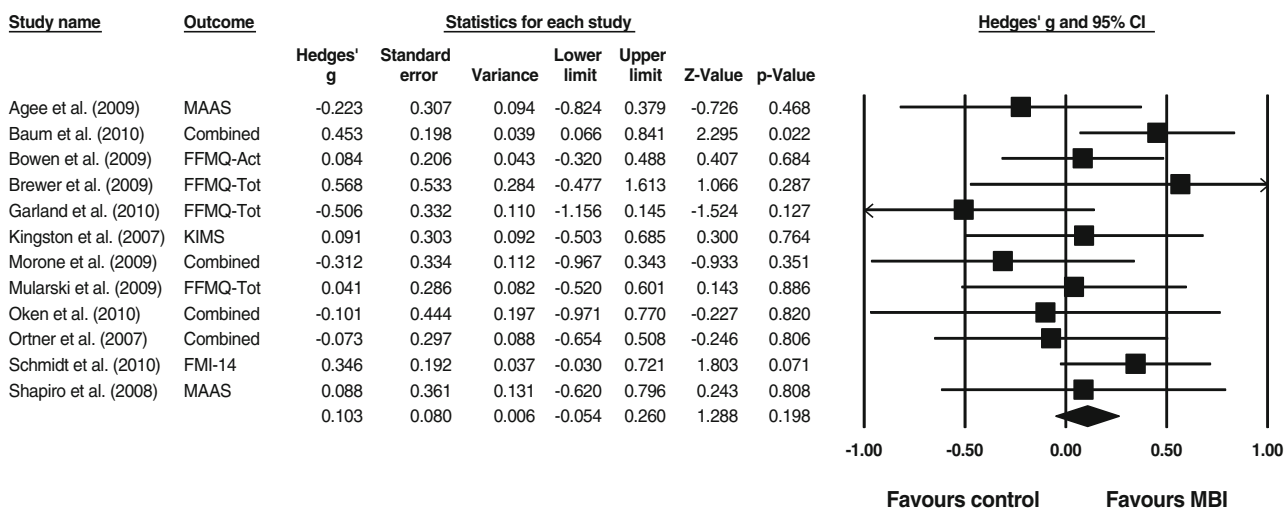
**Retreats** A significant difference in effect sizes was found between MBIs including retreats (Hedges'  $g=0.66$ , 95 % CI=0.57–0.74) and MBIs excluding retreats (Hedges'  $g=0.49$ , 95 % CI=0.38–0.6;  $Q_B=5.76$ ,  $df=1$ ,  $p=.02$ ). This indicates that participants in MBIs including a retreat reported larger gains in self-reported mindfulness compared to participants in MBIs not including a retreat.

**Intervention Duration** Due to the limited number of studies that used some of the inventories, dose-response analyses were only conducted for the MAAS, FFMQ, and KIMS inventories. The findings from the meta-regression analyses provided no evidence for a dose-response relationship between duration and the effect sizes for neither the MAAS ( $\beta=0.00$ ;  $Q=.11$ ;  $df=1$ ;  $p=.74$ ), the FFMQ ( $\beta=0.00$ ;



**Fig. 3** Effect sizes for controlled studies with waiting-list control conditions. *TMS-10* the Toronto Mindfulness Scale 10-item version, *Combined* mean effect size from several (sub) scales, *MAAS* the Mindful Attention

Awareness Scale, *FMI-14* the Freiburg Mindfulness Inventory 14-item version, *FFMQ-Tot* the Five Factor Mindfulness Questionnaire total score



**Fig. 4** Effect sizes for controlled studies including active control conditions. *MAAS* Mindful Attention Awareness Scale; *Combined* mean effect size from several (sub)scales; *FFMQ-Act* Five Factor Mindfulness Questionnaire, act with awareness subscale; *FFMQ-Tot* Five Factor

Mindfulness Questionnaire, total score; *KIMS* Kentucky Inventory of Mindfulness Skills; *FMI-14* the Freiburg Mindfulness Inventory 14-item version

$Q=3.16$ ;  $df=1$ ;  $p=.07$ ), nor the *KIMS* ( $\beta=0.00$ ;  $Q=.58$ ;  $df=1$ ;  $p=.45$ ). Similarly, no dose-response relationships were found between number of sessions and effect sizes for the *MAAS* ( $\beta=0.03$ ;  $Q=.36$ ;  $df=1$ ;  $p=.55$ ), *FFMQ* ( $\beta=0.01$ ;  $Q=.82$ ;  $df=1$ ;  $p=.36$ ), or *KIMS* ( $\beta=0.07$ ;  $Q=3.62$ ;  $df=1$ ;  $p=.06$ ).

**Mindfulness Questionnaires** The subgroup analyses showed significant differences between the questionnaires ( $Q=10.46$ ;  $df=4$ ;  $p<.05$ ). Yet, as displayed in Table 3, the confidence intervals indicate that the only actual difference is between TMS and *KIMS*. It can therefore be concluded that the use of different measurement instruments has little impact on effect sizes.

**Publication Bias**

The effect sizes obtained for measures of self-reported mindfulness corresponded to a  $z$  value of 17.37. It

would require 5,582 studies with null results to bring the two-tailed  $p$  value to exceed .05. This fail-safe  $N$  estimate indicates that the effect sizes observed in the present meta-analysis are likely to be robust. In addition, inspection of the funnel plot for precision did not indicate presence of systematic biases in publishing (Fig. 5). In sum, these analyses indicate that effect size estimates of the within-group analyses are unbiased.

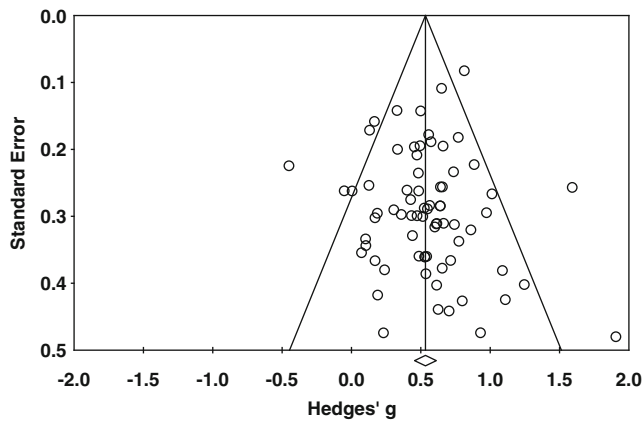
**Discussion**

The general aim of the present study was to systematically review controlled and uncontrolled trials of MBIs measuring pre- and post-intervention self-reported mindfulness in clinical and non-clinical samples and to evaluate their efficacy on self-reported mindfulness. Seventy-two studies were systematically selected from a total of 1,425 studies. Our systematic search showed that the majority of MBIs has been studied using uncontrolled designs on a variety of clinical and non-clinical samples. Most interventions followed the MBSR protocol, confirming previous findings that MBSR is the most frequently applied MBI (Baer 2003; Hofmann et al. 2010). An interesting finding was the relatively high number of adapted MBIs, that is, interventions based on MBSR or MBCT protocols modified to suit a particular population. These interventions typically differed in respect to number of sessions, ranging from 4 (Huppert and Johnson 2010; Kaufman et al. 2009) to 18 sessions (Krasner et al. 2009) and in session length, ranging from 40 min (Huppert and Johnson 2010) to 180 min (Duncan and Bardacke 2010; Kaufman et al. 2009).

**Table 3** Differences in effect sizes between mindfulness questionnaires

Questionnaire	K	Hedges' g	95 % CI
FFMQ	41	.57	.46–.68
FMI	5	.57	.34–.80
KIMS	50	.44	.35–.53
MAAS	35	.55	.46–.64
TMS	7	1.00	.61–1.40
Overall	138	.53	.47–.58

*FFMQ* Five Facet Mindfulness Questionnaire, *FMI* Freiburg Mindfulness Questionnaire, *KIMS* Kentucky Inventory of Mindfulness Skills, *MAAS* Mindful Attention Awareness scale, *TMS* Toronto Mindfulness Scale



**Fig. 5** Funnel plot of standard error by Hedges'  $g$

The results indicate that the measurement of self-reported mindfulness is a recent and growing trend. Ten different self-report questionnaires were identified. The main difference between the questionnaires was the number of dimensions or facets seen to comprise mindfulness, ranging from one (Brown and Ryan 2003; Buchheld et al. 2001) to five (Baer et al. 2006). In addition, one questionnaire assessing mindfulness as a state was employed in a number of studies (Lau et al. 2006). This indicates that a consensual definition of mindfulness has not been reached, as has also been pointed out by other authors (Garland and Gaylord 2009; Grossman and Van Dam 2011; Rappagay and Bystrisky 2009). It also confirms the complexity of mindfulness and the challenges inherent in attempts to operationalize it.

The MAAS (Brown and Ryan 2003) was the most frequently used questionnaire, being employed in nearly half of the included studies. Consisting of 15 items, the MAAS is short and therefore reduces strain on participants often required to fill out multiple forms and questionnaires. Nevertheless, the validity of the MAAS has been criticized by several authors. First, the items of the MAAS are assessing the degree of *mindlessness* by inquiring lapses of inattentiveness to the present moment. The item scores are then reversed to reflect the degree of mindfulness. Such a strategy was chosen because mindless states were considered more accessible for the general population than mindful states (Brown and Ryan 2003). Grossman and Van Dam (2011) question the construct validity of the MAAS by comparing this way of assessment to the measurement of depression assessing participant's degree of happiness. Second, the relative simple operationalization of mindfulness as a one-dimensional concept on which the MAAS is built has been questioned by several authors. They claim that mindfulness is a multi-dimensional concept comprised of several interacting factors contributing to mindful functioning (Baer et al. 2004; Baer et al. 2006; Bishop et al. 2004). The current

meta-analysis did not find evidence of any differential sensitivity between the different questionnaires in detecting changes in self-reported mindfulness.

The majority of studies that investigated potential mediation of self-reported mindfulness on clinical outcomes demonstrated mediation in the predicted direction. For example, the mediator analyses showed that increased self-reported mindfulness was associated with changes in variables associated with depression, anxiety, and general stress. This supports the construct validity of the questionnaires, as the increased capacity of present-oriented, non-judgmental awareness lead to positive changes in clinical outcomes and quality of life. It also supports the hypothesis that self-reported mindfulness works as a potential mechanism of change in interventions. It should be mentioned, however, that other mechanisms of change of MBIs have been suggested. One example is self-compassion, which refers to the attitude of openness, caring, and kindness toward oneself in episodes of suffering, inadequacies, and failures (Neff 2003). Preliminary evidence suggests that self-compassion may be a mechanism of change in MBIs (Kuyken et al. 2010). The mindfulness training offered in MBIs may teach participants another way of relating to adversity, thus contributing to the alleviation of suffering through the development of a kinder and more accepting view of oneself and one's experience (Van Dam et al. 2010). Furthermore, it has been suggested that self-regulation, i.e., the maintenance of stability of functioning and adaptability to change, may be a contributor to the positive changes in MBIs (Shapiro and Carlson 2009). Mindfulness training may contribute to less experiential avoidance, by enabling a wider, more adaptive range of coping skills. Finally, decentering has been suggested as a possible mechanism of change in MBIs. Defined as the ability to observe one's thoughts and feelings as temporary, objective events in the mind, as opposed to reflections of the self that are necessarily true, the concept of decentering is highly overlapping with mindfulness (Fresco et al. 2007). Preliminary evidence suggests that decentering may work as a mechanism of change in MBIs (Bieling et al. 2012).

The present meta-analysis demonstrated that within-group, pre-post estimate was in the medium range for increasing self-reported mindfulness (Hedges'  $g=0.53$ ). This effect is larger than the result from a previous meta-analysis, which found a small effect of mindfulness training on self-reported mindfulness in non-clinical samples (Eberth and Sedlmeier 2012). Post-intervention to follow-up calculations indicated that the gains were maintained over time. This indicates that participation in an MBI leads to stable increases in self-reported

mindfulness, supporting the notion of mindfulness as a trait-like tendency that can be modified by practice. The high number of trials reporting non-significant findings should be commented upon. Over half of the included trials (37 of 72) found no significant increase in self-reported mindfulness from pre- to post-treatment. This is probably due to the fact that majority of the included studies were uncontrolled studies or pilot investigations with small samples sizes, making them insufficiently powered to detect potential effects of treatment. According to Kazdin (2003), at least 32 participants are required in an experimental condition to detect a medium effect size at a .05 confidence level. It is a concern that of the included studies, only 30 fulfill these criteria. The between-group analysis with waiting-list controls supported the hypothesis that mindfulness training leads to increased self-reported mindfulness. Effect sizes were typically in the predicted direction, i.e., participants in MBIs increased their self-reported mindfulness, while participants not receiving any intervention did not. A surprising finding in the present meta-analysis was that participants in active control groups increased their self-reported mindfulness as much as participants cultivating mindfulness in the MBIs. Several factors may explain this finding. First, similarities in the nature of the interventions in the active control conditions might have influenced the outcome. Five of the active control groups included exercises that might affect similar psychological processes as mindfulness practices, including concentration exercises (Kingston et al. 2007; Ortnor et al. 2007; Shapiro et al. 2008) and progressive muscle relaxation (Agee et al. 2009; Schmidt et al. 2010). The former may increase ability to regulate and sustain attention, while the latter may increase participant awareness of bodily sensations and non-reactivity, both of which are key features of the definition of mindfulness. One study (Brewer et al. 2009) comparing an MBI to group cognitive behavior therapy did favor the MBI condition, but the between-group effect size was not significant most likely due to the small sample size. Consequently, it becomes difficult to assess the unique contribution of mindfulness training in the facilitation of self-reported mindfulness. Second, the findings may also indicate that mindfulness is a universal inherent capacity that potentially may be altered through other methods than mindfulness meditation (Brown and Ryan 2004). The capacity of mindful awareness may represent both a trans-theoretical and trans-diagnostic process that could account for positive outcomes across interventions and therapies (Baer 2007). For example, cognitive restructuring in cognitive therapy may promote a non-judgmental attitude toward present experience. A final explanation may be that mindfulness questionnaires are

subject to low construct validity. Some authors have suggested that the definitions on which the self-report measurements are built are too simplified compared to the origin of the concept (Ragay and Bystrisky 2009). The ancient theory and practice on which the concept of mindfulness is based on is much more complex and advanced than the modern conceptualization of mindfulness. Consequently, though designed to assess mindfulness, the questionnaires may be measuring a more general capacity that improves with many forms of treatment, and not mindfulness per se. This potential lack of construct validity is a major concern for the research of mindfulness. Logically, it is difficult to argue that mindfulness questionnaires measure both trans-theoretical phenomenon common to most psychotherapies and mindfulness per se. In order to validate the questionnaires designed to measure mindfulness, it needs to be more clearly demonstrated that MBIs uniquely affect self-reported mindfulness when compared to active control conditions.

The moderator analyses showed that features of the trials, including study design, sample characteristics, type of MBI, total intervention time, and number of sessions did not moderate the overall effect size. The subgroup analysis of the questionnaires indicated that the questionnaires did not differ in terms of sensitivity of change. This indicates that all questionnaires are equivalent in terms of detecting change in self-reported mindfulness as a result of mindfulness training.

A novel finding was that the inclusion of retreats as part of the intervention significantly affects self-reported mindfulness. Retreats therefore represent an opportunity for participants to deepen and elaborate their mindfulness skills, resulting in increased self-reported mindfulness. The review yielded that the majority of studies excluded retreats without explicitly stating the reasons for this. One study stated that the retreat was excluded to minimize strain on participants (Klatt et al. 2009). Segal et al. (2013) have pointed out that retreats may be difficult to include in trials investigating health economics, as the extra time commitment will deviate from other therapies. Furthermore, in active control conditions, the total intervention time should be similar across control groups. The retreats are therefore excluded, as other forms of therapy typically do not include a whole day of intervention-specific activities.

#### Methodological Limitations

Although the present review identified and selected eligible studies through a systematic literature search and extensive review of reference lists, potentially eligible studies may not have been detected in the search process. Nevertheless, the analyses of publication bias suggest that the results are unbiased.

Another limitation of the present paper is the study characteristics of the included studies. A majority of the



studies were uncontrolled, and about half of them attained non-significant effect sizes, possibly due to small sample sizes. Clearly, larger and more well-designed studies are called for to more robustly assess the effect of MBIs on self-reported mindfulness as well as on other outcome measures. Conversely, uncontrolled studies may offer advantages with respect to ecological validity. One example is the selection criteria in controlled studies, which may not reflect “real world” clinical practice. It can thus be argued that uncontrolled trials, in a better way, mimic real client populations to which MBIs are actually administered (Walach et al. 2006a, b).

A further point concerns the quality of the interventions provided in the included studies. Major sources of bias may result from non-standardized treatment protocols and non-adherence to manuals by facilitators (Kazdin 2003). The present review yielded a considerable variation within MBIs, but only two studies assessed facilitators’ competence and whether they followed the treatment manuals (Altmaier and Maloney 2007; Baum et al. 2010). Furthermore, descriptions of treatment protocols were often vague. It is therefore not clear whether the quality of interventions was subject to systematic variation.

Moreover, a shortcoming regarding the mediation analysis of the included studies was the lack of temporal investigation. A mediator variable should increase during treatment, and effects of this increase should be observed after the increase of the mediator (Kraemer et al. 2002). None of the studies demonstrated that increase in self-reported mindfulness preceded changes in the outcome variables, thereby precluding definite causal inferences. However, a recent study including weekly assessments of self-reported mindfulness demonstrated increases in self-reported mindfulness before decreases in perceived stress (Baer et al. 2012).

Finally, some authors have argued that mindfulness cannot be captured by self-report questionnaires (Grossman and Van Dam 2011). It is still uncertain how one might best capture the central quality of mindfulness by self-report measures. However, other complex psychological variables have successfully been operationalized and measured using such methodology. As this review and meta-analysis has demonstrated, it is a potential weakness of current mindfulness questionnaires that they do not capture changes uniquely associated with mindfulness training offered in MBIs. While a number of unresolved issues remain, it, nevertheless, seems premature to entirely dismiss the possibility of assessing the phenomenon by self-report. Instead, further conceptual and empirical investigation should be pursued in order to clarify the meaning of the construct and its measurement.

## Future Directions

Results from the present review indicate that continued investigations of the assessment of mindfulness are required. As for study characteristics, further investigations through randomized controlled trials with larger sample sizes should be carried out in order to ensure that studies are adequately powered to detect reliable and significant effect sizes. Furthermore, interventions used in active control conditions should be different in terms of hypothesized mechanisms of change, making it easier to attribute changes in MBIs to the processes of mindfulness. It would be interesting to investigate whether participation in an intervention based on cognitive behavior therapy would affect self-reported mindfulness, to further test the construct validity of mindfulness questionnaires. It would also be of interest to investigate whether mindfulness may be a primary mechanism of change in other forms of therapy. Forthcoming studies would also benefit from increased standardization of interventions, including competence and compliance assessment to study validity and confidence (Baer 2003).

The inclusion of several data collection points during the delivery of intervention should be included to detect temporal sequences of change; i.e., that reported change in self-reported mindfulness precedes changes in other clinical variables. It would also be of interest to further investigate the relation between mindfulness and other overlapping constructs like self-compassion, self-regulation, and decentering. It will be important to the field of mindfulness assessment to further clarify the relationship of mindfulness to these types of processes or mechanisms. There is evidently some conceptual overlap between measures, as questionnaires such as FFMQ incorporates elements of self-compassion, while MAAS relies on the conceptual foundation of self-determination theory emphasizing attentional and behavioral self-regulation. Further research is needed to delineate to what extent such mechanisms should be seen as aspects of the construct of mindfulness or rather as self-contained constructs best measured separately.

The moderator analysis showed that inclusion of retreats increase self-reported mindfulness. Hence, future trials should consider the inclusion of retreats because of its beneficial effects in cultivating self-reported mindfulness.

## Conclusion

The present review and meta-analysis provides evidence that MBIs are beneficial for several samples in terms of increased self-reported mindfulness. However, the study has also pointed out several methodological issues and limitations, which should be considered in the planning of future trials.



## Appendix A

Table 4 Main findings and characteristics for included studies

Study characteristics			Sample characteristics		Intervention characteristics			Outcome
Author (year)	Design	Control condition	Sample type	No. of subjects (mean age)	Type	No. of sessions/length (min)	Retreat	Mindfulness questionnaire
Agee et al. (2009)	RCT	Active: progressive muscle relaxation	Non-clinical: community sample	19 (41.65)	Mindfulness meditation (MM) based on MBSR	5 (60)	Not reported	MAAS
Almaier and Maloney (2007)	UCT	–	Non-clinical: recently divorced parents	14 (33.58)	Mindful parenting program (MPP)	12 (150)	Not reported	TMS-10
Anderson et al. (2007)	RCT	Waiting-list	Non-clinical: healthy adults	46 (37)	MBSR	8 (120)	Not reported	TMS-10
Baum et al. (2010)	RCT	Treatment as usual: antidepressant treatment	Affective disorders: depression	61 (48.95)	MBCT	8 (120)	Not reported	KIMS
Birmie et al. (2010)	UCT	–	Somatic disorders: cancer	82 (62.9)	MBSR	8 (90)	Half day	MAAS
Bowen et al. (2009)	RCT	Treatment as usual: 12-step abstinence program	Addictive disorders: alcohol and drug use	93 (40.5)	Mindfulness-based relapse prevention (MBRP)	8 (120)	Not reported	FEMQ
Brewer et al. (2009)	RCT	Active: cognitive group therapy	Addictive disorders: alcohol and/or cocaine dependence	21 (35.6)	MBRP (adapted)	8 (60)	Not reported	FEMQ
Brown et al. (2011)	RCT	Treatment as usual: individual or group psychotherapy and/or psychotropic medication	Heterogeneous disorders: mainly mood and anxiety disorders	50 (15.7)	MBSR (adapted for adolescents)	8 (not reported)	Not reported	MAAS-A
Bränström et al. (2010)	RCT	Waiting-list	Somatic disorders: cancer	32 (51.8)	MBSR	8 (120)	No	FEMQ
Bögels et al. (2008)	UCT	Active: mindful parenting training for parents	Adolescents diagnosed with conduct disorders, pervasive development disorders, Asperger's syndrome, ADHD, or ODD	14 (14.4)	MBCT	8 (90)	Not reported	MAAS
Camrudy and Baer (2008)	UCT	–	Heterogeneous disorders: stress, chronic pain, anxiety	206 (47.05)	MBSR	8 (150)	Full	FEMQ
Camrudy et al. (2009)	UCT	–	Heterogeneous disorders: stress, chronic pain, anxiety	320 (49.5)	MBSR	8 (150)	Full	FEMQ
Camrudy et al. (2006)	UCT	–	Somatic disorders: women with hot flashes	18 (53.65)	MBSR	8 (150)	Full	TMS-10
Camrudy et al. (2008)	UCT	–	Heterogeneous disorders	62 (47.8)	MBSR	8 (150)	Full	TMS-10 and MAAS
Chadwick et al. (2009)	RCT	Waiting-list	Psychotic disorders	11 (41.6)	Person-based cognitive therapy (PBCT)	10 (not reported)	Not reported	SMQ and SMVQ
Cohen-Katz et al. (2005)	RCT	Waiting-list	Non-clinical: nurses	14 (46)	MBSR	8 (150)	Full	MAAS
Collard et al. (2008)	UCT	–	Non-clinical: university students	20 (not reported)	MBCT	8 (120)	Not reported	FMI-14

**Table 4** (continued)

Study characteristics			Sample characteristics		Intervention characteristics			Outcome
Author (year)	Design	Control condition	Sample type	No. of subjects (mean age)	Type	No. of sessions/length (min)	Retreat	Mindfulness questionnaire
Cusens et al. (2010)	UCT	–	Somatic disorders: chronic pain	13 (46.7)	Breathworks mindfulness-based pain management program	10 (150)	Not reported	MAAS
Dalen et al. (2010)	UCT	–	Somatic disorders: obesity	10 (44)	Mindful Eating and Living (MEAL)	6 (120)	Not reported	KIMS
Deyo et al. (2009)	UCT	–	Heterogeneous disorders: various psychological and medical problems	34 (44)	MBSR	8 (not reported)	Not reported	KIMS
Dobkin (2008)	UCT	–	Somatic disorders: cancer	13 (54)	MBSR	Not reported (not reported)	Not reported	MAAS
Duncan and Bardacke (2010)	UCT	–	Non-clinical: pregnant women	35 (34.61)	Mindfulness-based childbirth and parenting program (MBCP)	10 (180)	Full	FFMQ (3 subscales: act with awareness, non-judgment, and non-reactivity)
Eisendrath et al. (2008)	UCT	–	Affective disorder: treatment-resistant depression	55 (not reported)	MBCT	8 (120)	Not reported	FMI-30
Evans et al. (2010)	UCT	–	Non-clinical: community-based sample	14 (48)	MBSR	8 (120)	Not reported	MAAS
Evans et al. (2008)	UCT	–	Anxiety disorder: generalized anxiety disorder	12 (49)	MBCT	8 (120)	Not reported	MAAS
Foley et al. (2010)	RCT	Waiting-list	Somatic disorders: cancer	55 (54.82)	MBCT	8 (120)	Full	FMI-14
Frewen et al. (2008)	UCT	–	Heterogeneous disorders: treatment-seeking students with mild to moderate mood, anxiety, and/or stress disorders	43 (not reported)	Mindfulness meditation-based clinical intervention (MMCI)	8 (120–150)	Not reported	KIMS and MAAS
Garland et al. (2010)	RCT	Active control: evidence-based alcohol dependence support group (ASG)	Substance abuse disorders: alcohol dependence	27 (39.9)	Mindfulness-oriented recovery enhancement (MORE)	10 (not reported)	Not reported	FFMQ
Gross et al. (2010)	RCT	Waiting-list	Somatic disorders: organ transplant recipients	55 (55)	MBSR	8 (150)	Full	MAAS
Gökhan et al. (2010)	UCT	Active control: experimental psychology course	Non-clinical: students	22 (24.8)	6-week MBSR	6 (20)	Not reported	KIMS, MAAS, and FMI-14
Huppert and Johnson (2010)	UCT	Treatment as usual: religion study lessons	Non-clinical: adolescent boys	78 (14–15)	4-week MBSR	4 (40)	Not reported	CAMS-R
Hölzel et al. (2011)	UCT	Waiting-list	Non-clinical: self-reported psychological and physically healthy individuals	18 (37.89)	MBSR	8 (150)	Full	FFMQ
Kaufman et al. (2009)	UCT	–	Non-clinical: community sample active in sports	32 (52.19)	Mindful sport performance enhancement (MSPE)	4 (150–180)	Not reported	KIMS and TMS-13 (latter excluded from meta-analysis)
Kimbrough et al. (2010)	UCT	–	Child abuse survivors	27 (45)	MBSR	8 (150–180)	Full	MAAS

Table 4 (continued)

Study characteristics			Sample characteristics		Intervention characteristics			Outcome
Author (year)	Design	Control condition	Sample type	No. of subjects (mean age)	Type	No. of sessions/length (min)	Retreat	Mindfulness questionnaire
Kingston et al. (2007)	RCT	Active control: 2 sessions of guided visual imagery	Non-clinical: university students	21 (23)	Stress-reduction classes	6 (60)	Not reported	KIMS
Klatt et al. (2009)	RCT	Waiting-list	Non-clinical: university staff	24 (43.41)	Low-dose MBSR (MBSR-ld)	6 (60)	No	MAAS
Kocovski et al. (2009)	UCT	–	Anxiety disorders: social anxiety	42 (34.17)	Mindfulness and acceptance-based group therapy (MAGT)	12+1 follow-up post treatment (120)	Not reported	KIMS and MAAS
Krasner et al. (2009)	UCT	–	Non-clinical: primary care physicians	70 (not reported)	Intervention based on MBSR	18 (150)	Full	FFMQ (factors observe and non-react)
Labelle et al. (2010)	UCT	Waiting-list	Somatic disorders: women with cancer	46 (53.1)	Mindfulness-based cancer recovery (MBCR)	8 (90)	Full	MAAS
Lau et al. (2006)	UCT	–	Heterogeneous disorders: mood, anxiety, pain, cancer, stress	99 (46.68)	MBSR	8 (not reported)	Not reported	TMS-13
Lovas and Barsky (2010)	UCT	–	Anxiety disorders: hypochondriasis/severe health anxiety	10 (35.6)	MBCT	8 (120)	Not reported	FFMQ
Matchim et al. (2010)	UCT	Passive	Somatic disorders: cancer	19 (56.87)	MBSR	8 (120–160)	Full	FFMQ
Matousek and Dobkin (2010)	UCT	–	Somatic disorders: cancer	59 (56.4)	MBSR	8 (150)	Full	MAAS
Michalak et al. (2008)	UCT	–	Affective disorders: major depression	29 (47.6)	MBCT	8 (150)	Not reported	MAAS
Morone et al. (2009)	RCT	Active: 8-week health education program	Somatic disorders: elderly with chronic low back pain	20 (78)	MBSR	8 (90)	Not reported	FFMQ and MAAS
Mularski et al. (2009)	RCT	Active: 8-week support group	Somatic disorders: elderly with chronic obstructive lung disease	44 (70.6)	Mind-body breathing therapy (MBBT)	8 (not reported)	Not reported	FFMQ
Nyklíček and Kuipers (2008)	RCT	Waiting-list	Stress/distress disorders	30 (not reported)	MBSR	Not reported (not reported)	Not reported	KIMS (factors non-judgment and observe) and MAAS
Oken et al. (2010)	RCT	Active: education class based on powerful tools for caregivers (PTC) and waiting-list	Non-clinical: dementia caregivers	10 (62.5)	Mixed MBSR and MBCT	6 (90)	Not reported	FFMQ (factor non-judgment) and MAAS
Ong et al. (2008)	UCT	–	Sleep disorders	30 (36.4)	Integrated MBSR and cognitive behavioral therapy for insomnia (MBSR+CBT-I)	6 (90–120)	Not reported	KIMS
Ong et al. (2009)	UCT	–	Sleep disorders	30 (38.7)	MBSR+CBT-I	6 (120)	Not reported	KIMS
Ortner et al. (2007)	RCT	Active: relaxation meditation (RM) and waiting-list	Non-clinical: recruited from an urban university	28 (not reported)	Kilner mindfulness meditation intervention (KMIMI)	7 (90)	Not reported	TMS-10 and MAAS

**Table 4** (continued)

Study characteristics			Sample characteristics			Intervention characteristics			Outcome
Author (year)	Design	Control condition	Sample type	No. of subjects (mean age)	Type	No. of sessions/length (min)	Retreat	Mindfulness questionnaire	
Pradhan et al. (2007)	RCT	Waiting-list	Somatic disorders: rheumatoid arthritis	31 (56)	MBSR	8 (150)	Full	MAAS	
Raes et al. (2009)	UCT	Waiting-list	Non-clinical: recruited from a mindfulness institute	24 (43.29)	MBCT	8 (not reported)	Not reported	KIMS-E	
Ree and Craigie (2007)	UCT	–	Heterogeneous disorders: psychiatric outpatients	26 (39.5)	MBCT	8 (150)	Not reported	MAAS	
Rimes and Wingrove (2011)	UCT	–	Non-clinical: trainee clinical psychologists	20 (not reported)	MBCT	8 (not reported)	Not reported	FEMQ	
Sachse et al. (2010)	UCT	–	Borderline personality disorder	22 (not reported)	MBCT adapted for borderline personality disorder (MBCT-a)	8 (150)	Not reported	FEMQ	
Schmidt et al. (2010)	RCT	Active: Jacobson progressive muscle relaxation training and fibromyalgia-specific stretching exercises and waiting-list	Somatic disorders: fibromyalgia	59 (53.4)	MBSR	8 (150)	Full	FMI-14	
Schroevers and Brandsma (2010)	UCT	–	Non-clinical: sample from the local community, no exclusion criteria	85 (43.23)	MBCT	8 (150)	Full	KIMS (factors non-judgment and observe) and MAAS	
Shahar et al. (2010)	RCT	Waiting-list	Affective disorders: depression	29 (46.58)	MBCT	8 (180)	Full	MAAS	
Shapiro et al. (2007)	UCT	Active control: classes in research methods and psychological theory	Non-clinical: psychology counseling students	22 (29.2)	MBSR	8 (120)	Not reported	MAAS	
Shapiro et al. (2011)	RCT	Waiting-list	Non-clinical: students	17 (18.73)	MBSR	8 (not reported)	Not reported	MAAS	
Shapiro et al. (2008)	RCT	Active: Easwaran's eight point program and waiting-list	Non-clinical: students	16 (not reported)	MBSR	8 (90)	No	MAAS	
Sharplin et al. (2010)	UCT	–	Somatic disorders: cancer	25 (51.36)	MBCT	8 (120)	Not reported	FMI-14	
Smith et al. (2008)	UCT	Active: cognitive-behavioral stress reduction	Non-clinical: community sample	45 (not reported)	MBSR	8 (180)	Full	MAAS	
Smith et al. (2006)	UCT	–	Non-clinical: community sample	27 (47.8)	MBSR	8 (180)	Full	MAAS	
Splevins et al. (2009)	UCT	–	Heterogeneous: older adults with various complaints	43 (65)	MBCT	8 (120)	Not reported	KIMS	
Vieten and Astin (2008)	RCT	Waiting-list	Non-clinical: pregnant women	15 (not reported)	Mindful motherhood intervention (MMI)	8 (120)	Not reported	MAAS	

Table 4 (continued)

Study characteristics			Sample characteristics		Intervention characteristics			Outcome
Author (year)	Design	Control condition	Sample type	No. of subjects (mean age)	Type	No. of sessions/length (min)	Retreat	Mindfulness questionnaire
Vieten et al. (2010)	UCT	–	Substance abuse disorders: alcohol dependence	33 (45)	Acceptance-based coping intervention for alcohol dependence relapse prevention (ABCRP)	8 (120)	Not reported	FFMQ
Vøllestad et al. (2011)	RCT	Waiting-list	Anxiety disorders: panic, agoraphobic, social, and general anxiety disorders	39 (41.4)	MBSR	8 (150)	Half	FFMQ
Weber et al. (2010)	UCT	–	Affective disorders: bipolar depressive disorder	23 (not reported)	MBCT	8 (120)	Not reported	KIMS
Witek-Janusek et al. (2008)	UCT	Assessment only and cancer-free control	Somatic disorder: women newly diagnosed with early stage breast cancer	44 (55)	MBSR	8 (150)	Full	MAAS
Zgierska et al. (2008)	UCT	–	Substance abuse: alcohol dependence	19 (38.4)	MBRP	8 (120)	Not reported	MAAS

*RCT* randomized controlled trial; *UCT* uncontrolled trial; *MBSR* mindfulness-based stress reduction; *MBCT* mindfulness-based cognitive therapy; *MAAS* Mindful Attention Awareness Scale; *TMS-10* Toronto Mindfulness Scale, 10-item version; *KIMS* Kentucky Inventory of Mindfulness Skills; *FFMQ* Five Facet Mindfulness Questionnaire; *MAAS-4* Mindful Attention Awareness Scale Adolescent; *ADHD* attention deficit hyperactivity disorder; *ODD* oppositional defiant disorder; *SMQ* Southampton Mindfulness Questionnaire; *SMFQ* Southampton Mindfulness of Voices Questionnaire; *FMI-14* Freiburg Mindfulness Inventory, 14-item version; *FMI-30* Freiburg Mindfulness Inventory, 30-item version; *CAMS-R* Cognitive and Affective Mindfulness Scale Revised; *TMS-13* Toronto Mindfulness Scale, 13-item version; *KIMS-E* Kentucky Inventory of Mindfulness Skills Extended



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**\*Study was included in the meta-analysis**

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