Efficacy and acceptability of mindfulness-based interventions for military veterans: A systematic review and meta-analysis

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This systematic review and meta-analysis was registered through the Open Science Framework (https://osf.io/e7w85/). Study data are included in supplemental materials. This research was supported by the National Center for Complementary and Integrative Health Grant

K23AT010879 (Simon B. Goldberg) and the National Institute of Mental Health T32MH078788 (Shufang Sun). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Conflicts of Interest

The authors declare no conflicts of interest.

Recommended citation: Goldberg, S. B., Riordan, K., Sun, S., Kearney, D. J., & Simpson, T. L. (in press). Efficacy and acceptability of mindfulness-based interventions for military veterans: A systematic review and meta-analysis. *Journal of Psychosomatic Research*.

Abstract

Background: Military veterans report high rates of psychiatric and physical health symptoms that may be amenable to mindfulness-based interventions (MBIs). Inconsistent prior findings and questions of fit between MBIs and military culture highlight the need for a systematic evaluation of this literature. **Objective:** To quantify the efficacy and acceptability of MBIs for military veterans. **Data sources:** We searched five databases (MEDLINE/PubMed, CINAHL, Scopus, Web of Science, PsycINFO) from inception to October 16th, 2019. **Study selection:** Randomized controlled trials (RCTs) testing MBIs in military veterans. **Results:** Twenty studies (k=16 unique comparisons, N=898) were included. At post-treatment, MBIs were superior to non-specific controls (e.g., waitlist, attentional placebos) on measures of posttraumatic stress disorder (PTSD), depression, general psychological symptoms (i.e., aggregated across symptom domains), quality of life / functioning, and mindfulness (Hedges' gs=0.32 to 0.80), but not physical health. At follow-up (mean length=3.19 months), MBIs continued to outperform non-specific controls on general psychological symptoms, but not PTSD. MBIs were superior to specific active controls (i.e., other therapies) at post-treatment on measures of PTSD and general psychological symptoms (gs=0.19 to 0.25). Participants randomized to MBIs showed higher rates of attrition than those randomized to control interventions (odds ratio=1.98). Several models were not robust to tests of publication bias. Study quality and risk of bias assessment indicated several areas of concern. **Conclusions:** MBIs may improve psychological symptoms and quality of life / functioning in veterans. Questionable acceptability and few high-quality studies support the need for rigorous RCTs, potentially adapted to veterans.

Keywords: mindfulness; military veterans; PTSD; depression; acceptability; meta-analysis

Highlights

- Mindfulness-based interventions (MBIs) produce psychological benefits in veterans
- MBIs may slightly outperform other active interventions
- Veterans are more likely to drop out of MBIs than active control conditions
- Large-scale randomized trials with follow-up assessment are needed

Efficacy and acceptability of mindfulness-based interventions for military veterans:

A systematic review and meta-analysis

Over the past two decades, accumulating evidence has demonstrated links between military service and health. Veterans, particularly those deployed to combat theaters, frequently show rates of psychiatric conditions including post-traumatic stress disorder (PTSD), depression, anxiety, and substance use above the civilian population and are more likely than civilians to die by suicide (1–10). Veterans also have high rates of some physical health conditions, including chronic pain (11,12). As in the general population, psychiatric and physical health conditions commonly co-occur among veterans (13–15). The prevalence and comorbidity of psychiatric and physical health conditions among veterans has motivated the Veterans Health Administration (VHA) and other organizations that serve veterans to disseminate evidence-based treatments that target specific conditions (16), with a particular emphasis on mental health treatments (e.g., prolonged exposure and cognitive processing therapy for PTSD) (17,18). Although those who complete evidence-based treatments may benefit, the impact of the available treatments on veteran health at the population level may be limited due to low rates of utilization and high rates of dropout (19). While pharmacological treatment approaches are commonly used (e.g., antidepressants, benzodiazepines, opioids) (12,20,21), there is documented interest among veterans in non-pharmacological approaches to address common psychiatric and physical health concerns (e.g., chronic pain) (22).

Mindfulness-based interventions (MBIs) are a non-pharmacological treatment approach that has been used to address many of the psychiatric and physical health conditions experienced by veterans (23). Standardized MBIs such as mindfulness-based stress reduction (MBSR) (24)

and mindfulness-based cognitive therapy (MBCT) (25) emphasize training in mindfulness meditation techniques and have been used to treat specific health conditions including recurrent depression (26) and chronic pain (27). Randomized controlled trials (RCTs) testing MBIs have shown promising effects on depression, anxiety, substance use, and chronic pain, typically outperforming waitlist controls and performing on par or better than other active therapies and evidence-based treatments (28–31). MBIs have also shown promising effects on PTSD (32), although recent conceptual work has highlighted the need for trauma-sensitive mindfulness training (33).

Despite promising results in the general population, fewer RCTs have examined MBIs among veterans and the available studies have yielded mixed findings. For example, Polusny et al. (34) compared MBSR with an evidence-based treatment for PTSD (present-centered therapy) (35), with MBSR producing larger reductions in clinician-rated PTSD symptoms at two-month follow-up. In contrast, Kearney et al. (36) found no reliable differences in PTSD symptoms at four-month follow-up between combined MBSR and treatment-as-usual (TAU) with TAU alone. These discrepancies in the literature make it difficult for those serving veterans (e.g., VHA leadership and health care providers) to determine when, if ever, MBIs should be recommended.

In addition to mixed efficacy findings, there are also questions regarding the degree to which MBIs may be acceptable to military veterans. Certain aspects of military culture (e.g., emphasis on "toughness," self-reliance, and other traditional male gender norms such as avoiding expression of vulnerable emotions) (37–39) may, in theory, conflict with the attitudinal stance and group norms commonly adopted in MBIs (e.g., acceptance, non-striving, vulnerability, self-disclosure) (24). Thus, in addition to evaluating efficacy, it would be valuable to examine the degree to which veterans find MBIs acceptable. Treatment acceptability is a multifaceted

construct (40). Treatment dropout is one objective indicator of acceptability that has been linked to poorer outcomes in psychotherapy (41,42). Several systematic reviews and meta-analyses have examined attrition in MBI studies, reporting rates ranging from 15.5% to 29% (43–46), which is similar to rates found in psychotherapy generally and cognitive behavioral therapy specifically (47,48). However, to our knowledge, no meta-analysis has quantified rates of attrition between MBIs and control conditions using data drawn from the same randomized controlled trial (i.e., likelihood of attrition from MBI versus alternative intervention arm), although such an analysis would provide a valuable indicator of acceptability.

Given mixed findings from RCTs and uncertain cultural fit, we conducted a meta-analysis to clarify the efficacy and acceptability of MBIs for military veterans. As MBIs have been applied to various psychiatric and physical health conditions common among veterans, we examined efficacy across a range of mental and physical health symptoms as well as non-symptom outcomes (e.g., quality of life, mindfulness). In addition, we assessed study characteristics that may account for discrepant findings (i.e., moderators). We restricted our analyses to RCTs and examined outcomes separately for comparisons with other therapies and with control conditions that were not intended to be therapeutic (e.g., waitlist, attentional placebo).

Method

Protocol and Registration

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed (49). This study was pre-registered through the Open Science Framework (https://osf.io/e7w85/). Four deviations were made from the protocol. First, we used meta-analysis to estimate the magnitude of differential attrition between MBIs and control

conditions, rather than simply reporting attrition rates descriptively. We restricted this analysis to control conditions that involved receiving an active intervention. Second, we included a category of physical health symptoms. Third, we did not conduct an overall omnibus analysis with all outcomes included, given the heterogeneity in measure types. Fourth, we added a sensitivity analysis with outliers excluded.

Eligibility Criteria

Eligible studies involved: (1) the delivery of an MBI (2) to military veterans (3) in a randomized controlled trial (RCT). To qualify as an MBI, an intervention had to include mindfulness meditation as a central treatment component and place an emphasis on home meditation practice (50). Consistent with prior meta-analyses focused on MBIs (28,44), interventions that emphasized the attitudinal component only (e.g., Acceptance and Commitment Therapy) (51) or informal mindfulness practice (e.g., Dialectical Behavior Therapy) (52) were excluded. Interventions that involved non-mindfulness mind-body practices (e.g., mantram repetition, yoga) (53) were excluded. Samples focused on active duty military or veterans' family members were excluded to allow generalization specifically to veterans. No restrictions were placed on type of control condition (e.g., waitlist or active controls were both eligible), publication status (e.g., dissertations were eligible), or language.

Information Sources

We searched five databases: MEDLINE/PubMed, CINAHL, PsycINFO, Web of Science, and Scopus. Databases were searched from inception to October 16th, 2019. In addition, recent reviews were hand searched (28,32,54).

Search

The following search terms were used for all five databases: mindful* AND (veteran* OR military) (see Supplemental Materials Table 1).

Study Selections

Two authors independently reviewed each title and/or abstract based on inclusion/exclusion criteria. For studies that passed initial screening, full texts were reviewed. Coding disagreements were discussed with the first author until reaching consensus. Inter-rater reliability was high (K = .76) (55).

Data Collection Process

Standardized spreadsheets were created for coding study- and effect size-level data. Data were independently extracted by the first and second authors.

Data Items

Data necessary for computing effect sizes (e.g., sample sizes, means, standard deviations) were extracted. We also extracted study inclusion criteria; sample age, gender composition, and percentage racial/ethnic minority; country of origin; type and length of MBI in weeks; type of control condition; post-treatment and follow-up timing; and intention-to-treat (ITT) and completer sample sizes.

Control conditions were coded on a two-tier system based on whether or not they were intended to be therapeutic (56,57). Non-specific controls included no treatment conditions (i.e., waitlist), treatment-as-usual (TAU) conditions in which both the MBI and non-MBI arm received the TAU (e.g., (36)), and conditions which controlled only for non-specific factors and which lacked purported active ingredients (e.g., support group) (58). Specific active controls were interventions that included specific treatment ingredients and specific mechanisms of change (i.e., cognitive behavioral therapy).

Outcomes were categorized into the following: PTSD, depression, anxiety, substance use, psychological symptoms, cognitive, mindfulness, quality of life / functioning, biological, and physical health outcomes. Measures of specific psychiatric symptoms (e.g., PTSD) were included in both the specific category (e.g., PTSD symptoms) as well as the more general psychological symptoms category. In other words, all measures of psychological symptoms contributed effect sizes to the broader psychological symptoms category. For studies that included multiple measures of psychological symptoms (e.g., PTSD and depression) (34), effect sizes were aggregated first within study as described below.

Data items were extracted for coding study quality based on modified Jadad (59)(1996) criteria that have been used to evaluate MBIs previously (60,61). A four-item study quality score was computed based on (1) whether a trial was randomized, (2) whether randomization was described and appropriate, (3) whether outcome assessment was blinded, and (4) whether reasons for withdrawal and dropouts were provided. Items coded as "yes" received a 1 and those coded as "no" or "unclear" received a 0, yielding a maximum total score of 4. Five additional aspects (e.g., use of ITT analysis) were coded but did not contribute to the total score (see Supplemental Materials Table 2).

Risk of Bias of Individual Studies

We evaluated risk of bias of individual studies using the Cochrane tool (62). We assessed bias in the domains of selection (random sequence generation, allocation concealment), performance (blinding of participants and personnel), detection (blinding of outcome assessors), attrition (incomplete outcome data), and reporting (selective reporting). Each study was assessed as low, high, or unclear risk of bias in each domain.

Summary Measures

We calculated standardized effect sizes using recommended meta-analytic methods (63). First, we computed within-group pre-post and pre-follow-up Cohen's (64) *d*s for the MBI and control conditions separately. For this computation, we assumed a correlation of $r_{xx} = .50$ between timepoints (lower than a typical test-retest correlation to account for potential intervention effects) (65). Then, we computed a between-group effect by subtracting the within-group effect for the control conditions from that of the MBI conditions (i.e., Becker's del) (66). In contrast to between-group effects based on post-treatment data alone, this effect size accounts for potential between-group differences at baseline. For outcomes that lacked baseline data (e.g., changes in diagnostic status) (34), post-treatment data were used (63).

To estimate differential attrition, we computed odds ratios representing the likelihood of dropout from the MBI conditions relative to the control group (63). We calculated differential attrition only for studies in which the control group received an intervention, as some control conditions did not include an intervention from which one could dropout (e.g., treatment-as-usual) (67). In this analysis we collapsed across control interventions that included specific ingredients (i.e., specific active controls) and those not intended to be therapeutic (i.e., non-specific controls).

Synthesis of Results

In keeping with recommended methods (63), effects were first aggregated within measure (e.g., subscales of the PTSD Checklist) (68) and then within study using the 'MAd' package (69) in R (70). In keeping with Fu et al.'s (71) recommendation, meta-analytic estimates were calculated when at least four studies were available for a particular outcome domain and control condition type (i.e., non-specific, specific active). Effects were converted from Cohen's *d* to Hedges' *g* to account for small sample bias (63). When necessary, the sign for each effect was

reversed so that a positive effect size always indicated improvement (e.g., decreased PTSD symptoms, increased mindfulness). Separate estimates were computed for post-treatment and follow-up timepoints. Heterogeneity was characterized using I^2 (i.e., proportion of heterogeneity that is between-study heterogeneity; Higgins et al., 2003) (72). Random effects models were used with weighting based on the inverse variance of each study's effect size through the 'metafor' package (73). For attrition, we used Peto's method (74) recommended in the Cochrane Handbook (62) implemented in the 'metafor' package which conducts a fixed effects meta-analysis.

Risk of Bias Across Studies

The potential impact of publication bias was assessed using trim-and-fill analyses and estimates of fail-safe N (FSN) in the 'metafor' package. Trim-and-fill analyses assessed funnel plot asymmetry to determine whether expected studies may be missing from the available literature (e.g., small studies with non-significant results). As trim-and-fill analyses can be underpowered, these tests were considered exploratory. FSN was calculated to estimate the number of non-significant results that would need to exist in order to nullify the observed effect (75). FSN was interpreted based Rosenberg's (76) recommendation (i.e., FSN is robust if $> 5*n + 10$, where n is the number of available studies).

Additional Analyses

We tested four study-level moderators, although, like trim-and-fill analyses, these were considered exploratory based on potentially low statistical power (77). We selected moderators theoretically or previously linked to MBI efficacy (78–80). These included study quality (based on modified Jadad criteria), PTSD inclusion criterion, gender (percentage female), and MBI treatment length in weeks.

Sensitivity analyses were conducted with outliers excluded. Several methods for identifying outliers in meta-analysis exist (81), and we used the 'find.outliers' function (82) which identifies outliers based on whether a study's confidence interval overlaps the omnibus effect confidence interval.

Results

Study Selection

Our search produced 1,484 citations. We removed 698 duplicates and evaluated 786 titles and/or abstracts for inclusion. After applying our inclusion/exclusion criteria (Figure 1), 20 studies were retained representing 16 unique comparisons and 898 participants (see Supplemental Materials Table 3 for a list of the included studies).

Study Characteristics

Study-level characteristics are reported in Table 1. All studies had a psychiatric or physical health-related inclusion criteria. The majority (68.8%) required a diagnosis of PTSD (or elevated PTSD symptoms) (83,84). The remainder required a specific physical health condition (pulmonary injury, chronic obstructive pulmonary disease, Gulf War illness) or other psychiatric condition (anxiety, substance use disorder, schizophrenia or schizoaffective disorder). Two studies required PTSD symptoms along with either depression (85) or substance use disorder symptoms (83). Participants were on average 49.27 years old (*SD* = 8.43), 6.1% female (*SD* = 7.57), and 24.0% racial/ethnic minorities (*SD* = 18.46). Most studies were conducted in the United States (81.3%), with the remainder occurring in Iran (18.8%).

MBIs were most commonly based on MBSR (68.8%), with 12.5% based on MBCT, 6.3% based on a combination of MBSR and MBCT, and 12.5% not explicitly based on MBSR or MBCT. MBIs lasted an average of 8.69 weeks (*SD* = 3.16, range = 4 to 16). The majority of the

comparisons (68.8%) involved non-specific controls with the remainder (31.3%) involving specific active controls. Non-specific controls included no treatment, TAU, and attentional placebo control conditions that lacked active ingredients and were not intended to be therapeutic (e.g., support group, psychoeducation). Specific active controls included treatments found on the American Psychological Association's Division 12 list of evidence-based treatment (cognitive behavioral therapy for anxiety, present-centered therapy for PTSD) (86) or biofeedback (RESPeRATE) (87). Half of the comparisons included a follow-up assessment which on average occurred 3.19 months post-treatment (*SD* = 1.96, range = 1 to 6). Average ITT sample size was 56.12 (*SD* = 30.54, range = 8 to 124). Average treatment completion rate was 76.4% (*SD* = 21.24) across all MBI conditions. For studies with control conditions that included an intervention (e.g., TAU controls were excluded), average MBI treatment completion was 69.3% (*SD* = 20.47) and control treatment completion was 80.5% (*SD* = 16.75).

Average Jadad study quality was 2.56 out of 4 (*SD* = 1.09). Only three studies received a 4 (Supplemental Materials Table 2). The area with the lowest average score was blind outcome assessment (mean = 0.44, *SD* = 0.51). Several studies did not report reasons for dropout (mean = 0.50, *SD* = 0.52).

Risk of Bias Within Studies

Risk of bias varied across domains (Figure 2; Supplemental Materials Table 4). Selective reporting bias was often high due to lack of pre-registration (e.g., through clinicaltrials.gov) or failing to clearly identify a pre-specified primary outcome. All studies were coded as high risk of bias for blinding of personnel and participants due to the nature of the intervention and lack of control conditions that obscured this fact (e.g., sham meditation) (88). Lack of blinding of outcome assessor and attrition bias were also common potential sources of bias.

Results of Individual Studies

All study-level effect size aggregates are reported in Supplemental Materials Table 5, separated by outcome domain and timepoint. A list of outcome measures associated with each domain is provided in Supplemental Materials Table 6.

Synthesis of Results

Efficacy. Meta-analytic estimates separated by comparison type (non-specific controls, specific active controls), timepoint (pre-post, pre-follow-up), and domains are reported in Table 2 and displayed in Figure 3.

Non-specific controls. At post-treatment, MBIs compared favorably with non-specific controls in the domains of PTSD (g = 0.64), depression (g = 0.80), psychological symptoms (g = 0.70), quality of life / functioning (g = 0.72), and mindfulness (g = 0.32). MBIs did not differ from non-specific controls at post-treatment on measures of physical health (g = 0.38, [-0.19, 0.95]). Heterogeneity for post-treatment comparisons was generally high and effect size estimates with low heterogeneity had wide confidence intervals.

At follow-up, MBIs continued to show superiority to non-specific controls on measures of psychological symptoms (g = 0.31) but no longer differed from non-specific controls for PTSD (g = 0.12). Heterogeneity was low, but again with wide confidence intervals.

Specific active controls. At post-treatment, MBIs compared favorably with specific active controls on measures of PTSD (g = 0.25) and psychological symptoms (g = 0.19). Heterogeneity for these comparisons was low. Insufficient studies were available for estimating effects at follow-up.

Attrition. Estimates of differential attrition were based on nine studies that included a control group that received an intervention (see Supplemental Materials Table 7). Participants

randomized to the MBI condition were significantly more likely to drop out than those randomized to the control group (log OR = 0.68, [0.27, 1.09]; Figure 4). Converting to odds ratio, this indicates that MBI participants were 98% more likely to drop out relative to participants in active control conditions (OR = 1.98).

Risk of Bias Across Studies

Asymmetric funnel plots were detected for three models (Table 2). In two cases, trim-and-fill adjusted effect sizes no longer differed from zero (the two post-treatment comparisons with specific active controls). Fail-safe Ns ranged from 0 to 222. Based on Rosenberg's (76)(2005) guidelines, three originally significant effects were not robust to publication bias (the two comparisons with specific active controls at post-treatment, comparison with non-specific active controls at post-treatment on mindfulness).

Additional Analyses

Although four study characteristics were tested as moderators (study quality, PTSD inclusion criterion, gender, MBI treatment length), no significant moderator effects were detected (Supplemental Materials Table 8). Models with outliers removed yielded results similar to the primary models, but with reduced effect in three models (change in *g*s = 0.18 to 0.27). Statistical significance tests did not change as a result of removing outliers (Supplemental Materials Table 9).

Discussion

Despite growing interest in the potential application of MBIs for the treatment of psychiatric and physical health conditions among veterans, no meta-analysis has examined the efficacy of this approach. This review, based on 16 comparisons and 898 participants, provides some support for this treatment approach within veteran populations, while also highlighting

important limitations of the available literature. At post-treatment, promising effects of MBIs were seen relative to non-specific controls (waitlist, attentional placebo) on measures of psychological symptoms and on quality of life / functioning. At follow-up, however, sustained effects were only seen on psychological symptoms with a small effect size. Nonetheless, the magnitude of the observed effects relative to non-specific controls are similar to those found in the broader MBI literature (e.g., *g*s = 0.55 to 0.59 for effects on PTSD, psychological symptoms, and quality of life versus waitlist controls) (28,32,89). MBIs compared favorably to specific active controls at post-treatment on measures of PTSD (g = 0.25) and psychological symptoms (g = 0.19). While small in magnitude, these effects also mirror prior reviews of the MBI literature which have found that MBIs yield larger reductions in psychological symptoms than specific active controls (e.g., d = 0.26, g = 0.23) (28,78). However, comparisons with specific active controls were not robust to tests of publication bias and a lack of follow-up assessment weakens the strength of this evidence. In order to clarify whether MBIs should be recommended for veterans, it is crucial that future RCTs compare MBIs with available therapies and assess outcomes at follow-up.

To our knowledge, no previous meta-analysis has quantified the acceptability of MBIs relative to other interventions. Dropout is an important objective metric of acceptability and high rates of attrition from psychotherapy have been reported for veterans (19) and from RCTs of PTSD treatments generally (90). Results indicated that participants assigned to MBI conditions were 98% more likely to dropout than those assigned to a control intervention. This suggests that MBIs may be perceived as less acceptable than attentional placebos or alternative treatments. Examination of the rates of differential attrition across studies indicated rates were highest in two studies comparing MBIs to present-centered therapy for PTSD (34,91). We were underpowered

to properly test whether this particular comparison condition and/or a PTSD inclusion criterion was associated with higher retention. However, this pattern is consistent with a previous meta-analysis indicating that present-centered therapy (a "trauma-avoidant" treatment that proscribes trauma-related discussion) showed lower dropout than trauma-focused treatments for PTSD (90). While MBIs are not explicitly trauma-focused, it has long been theorized that exposure and desensitization may be one the underlying mechanisms (92,93). Recent theoretical and qualitative research has also highlighted the need for trauma sensitivity in meditation training (33,94). A lack of trauma sensitivity may contribute to higher attrition in MBIs.

Regardless of the specific cause, higher attrition within MBIs treatment arms raises questions regarding the degree to which veterans find these treatment approaches acceptable. Prior work among veterans has highlighted difficulties in MBI treatment initiation and difficulties understanding and engaging with mindfulness practices (95,96), while other work indicates high self-reported interest in mindfulness meditation (97). Future research should continue to explicitly examine MBI acceptability among veterans and consider the possibility of adaptations for this population that are culturally relevant and diagnostically appropriate (as has been done to beneficial effect for racial/ethnic minorities) (98,99).

This study has important limitations, several of which are related to the meta-analytic sample itself. The relatively small number of comparisons reduced statistical power for testing efficacy. The relatively small number of participants per study puts effect size estimates at risk for small sample bias (100). There were insufficient studies to estimate effects in some important outcome domains (e.g., anxiety, substance use). Our choice of requiring four studies per estimate (71), while increasing confidence in the reported effects, reduced the number of domains covered. We chose to combine passive controls and active controls that were not intended to be

therapeutic (i.e., attentional placebos) into a single category (non-specific controls), anticipating insufficient studies to examine these separately and not wanting to combine attentional placebos with actual therapies. While justified on theoretical grounds (56,57), this may have produced an overly conservative estimate of MBIs' efficacy relative to passive controls. The number of studies likely limited our ability to properly test moderators. The very low number of female participants reduces generalizability, which is a particularly important limitation as gender diversity in the military grows (101).

Additionally, several aspects of our results make conclusions tenuous, including indications of publication bias, high or unclear risk of bias in several domains, and moderate to high heterogeneity within some analyses. This degree of heterogeneity suggests that meaningful differences between studies may exist, although we were unable to determine the cause of these differences. To reduce risk of bias, it is essential that future studies properly account for attrition, particularly given evidence of higher dropout within MBIs. Including non-self-report outcome measures and pre-specifying primary outcome measures (e.g., through Open Science Framework) (102) will also increase confidence in this literature. One important potential source of bias is researcher allegiance, which has been defined as a researcher's belief in the superiority of a particular treatment approach (103). Research allegiance has been shown to predict treatment differences in psychotherapy generally (104) and MBIs specifically (105), but has rarely been explicitly discussed in the MBI literature. Unfortunately, we were unable to test effects associated with researcher allegiance in the current study due to the small number of studies with specific active controls. Future meta-analyses should assess the impact of this potentially important source of bias.

These limitations notwithstanding, the overall pattern of findings suggests that MBIs may be a promising treatment option for reducing psychological symptoms and increasing quality of life / functioning in veterans. Benefits of MBIs beyond other therapies, at follow-up, and on physical health outcomes are less clear. The possibility that MBIs may results in higher rates of attrition is an important limitation to address in future studies and could support the adaptation of MBIs for veterans specifically. Efforts to match veterans with their preferred treatment approach is a promising route for decreasing attrition (106). Evidence that MBIs effectively reduce common psychiatric symptoms and chronic pain in the general population (28) coupled with promising effects of MBIs in several domains in the current meta-analysis supports future RCTs testing this approach for military veterans. As there are at least four million veterans from the recent wars in Afghanistan and Iraq and the VHA remains one of the largest healthcare providers in the world (107), clarifying the potential of MBIs for this population is warranted.

References

1. Fuehrlein BS, Mota N, Arias AJ, Trevisan LA, Kachadourian LK, Krystal JH, et al. The burden of alcohol use disorders in US military veterans: results from the National Health and Resilience in Veterans Study. Addiction. 2016;111(10):1786–94.

2. Bryan CJ, Griffith JE, Pace BT, Hinkson K, Bryan AO, Clemans TA, et al. Combat Exposure and Risk for Suicidal Thoughts and Behaviors Among Military Personnel and Veterans: A Systematic Review and Meta-Analysis. Suicide Life Threat Behav. 2015;45(5):633–49.

3. Fortney JC, Curran GM, Hunt JB, Cheney AM, Lu L, Valenstein M, et al. Prevalence of probable mental disorders and help-seeking behaviors among veteran and non-veteran community college students. Gen Hosp Psychiatry. 2016 Jan 1;38:99–104.

4. Hoerster KD, Lehavot K, Simpson T, McFall M, Reiber G, Nelson KM. Health and Health Behavior Differences: U.S. Military, Veteran, and Civilian Men. Am J Prev Med. 2012 Nov 1;43(5):483–9.

5. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care. N Engl J Med. 2004 Jul 1;351(1):13–22.

6. Kang HK, Bullman TA, Smolenski DJ, Skopp NA, Gahm GA, Reger MA. Suicide risk among 1.3 million veterans who were on active duty during the Iraq and Afghanistan wars. Ann Epidemiol. 2015 Feb 1;25(2):96–100.

7. Milliken CS, Auchterlonie JL, Hoge CW. Longitudinal Assessment of Mental Health Problems Among Active and Reserve Component Soldiers Returning From the Iraq War. JAMA. 2007 Nov 14;298(18):2141–8.

8. Ramchand R, Rudavsky R, Grant S, Tanielian T, Jaycox L. Prevalence of, Risk Factors for, and Consequences of Posttraumatic Stress Disorder and Other Mental Health Problems in Military Populations Deployed to Iraq and Afghanistan. Curr Psychiatry Rep. 2015 Apr 16;17(5):37.

9. Rudd MD, Goulding J, Bryan CJ. Student veterans: A national survey exploring psychological symptoms and suicide risk. Prof Psychol Res Pract. 2011 Oct;42(5):354–60.

10. Thomas JL, Wilk JE, Riviere LA, McGurk D, Castro CA, Hoge CW. Prevalence of Mental Health Problems and Functional Impairment Among Active Component and National Guard Soldiers 3 and 12 Months Following Combat in Iraq. Arch Gen Psychiatry. 2010 Jun 1;67(6):614–23.

11. Helmer DA, Chandler HK, Quigley KS, Blatt M, Teichman R, Lange G. Chronic Widespread Pain, Mental Health, and Physical Role Function in OEF/OIF Veterans. Pain Med. 2009 Oct 1;10(7):1174–82.

12. Sellinger JJ, Sofuoglu M, Kerns RD, Rosenheck RA. Combined Use of Opioids and Antidepressants in the Treatment of Pain: A Review of Veterans Health Administration Data for Patients with Pain Both With and Without Co-morbid Depression. Psychiatr Q. 2016 Dec 1;87(4):585–93.

13. Hoerster KD, Campbell S, Dolan M, Stappenbeck CA, Yard S, Simpson T, et al. PTSD is associated with poor health behavior and greater Body Mass Index through depression, increasing cardiovascular disease and diabetes risk among U.S. veterans. Prev Med Rep. 2019 Sep 1;15:100930.

14. Scherrer JF, Chrusciel T, Zeringue A, Garfield LD, Hauptman PJ, Lustman PJ, et al. Anxiety disorders increase risk for incident myocardial infarction in depressed and nondepressed Veterans Administration patients. Am Heart J. 2010 May 1;159(5):772–9.

15. Shipherd JC, Keyes M, Jovanovic T, Ready DJ, Baltzell D, Worley V, et al. Veterans seeking treatment for posttraumatic stress disorder: What about comorbid chronic pain? J Rehabil Res Dev. 2007 Mar;44(2):153–65.

16. Administration UD of VA Veterans Health. Evidence-based Practice Program - Organizational Excellence [Internet]. [cited 2020 Jun 24]. Available from: https://www.va.gov/HEALTHCAREEXCELLENCE/about/organization/examples/evidence-based-practice-program.asp

17. Karlin BE, Ruzek JI, Chard KM, Eftekhari A, Monson CM, Hembree EA, et al. Dissemination of evidence-based psychological treatments for posttraumatic stress disorder in the Veterans Health Administration. J Trauma Stress. 2010;23(6):663–73.

18. McHugh RK, Barlow DH. The dissemination and implementation of evidence-based psychological treatments: A review of current efforts. Am Psychol. 2010 Feb;65(2):73–84.

19. Seal KH, Maguen S, Cohen B, Gima KS, Metzler TJ, Ren L, et al. VA mental health services utilization in Iraq and Afghanistan veterans in the first year of receiving new mental health diagnoses. J Trauma Stress. 2010;23(1):5–16.

20. Hawkins EJ, Goldberg SB, Malte CA, Saxon AJ. New Coprescription of Opioids and Benzodiazepines and Mortality Among Veterans Affairs Patients With Posttraumatic Stress Disorder. J Clin Psychiatry. 2019 Jul 9;80(4):0–0.

21. Seal KH, Shi Y, Cohen G, Cohen BE, Maguen S, Krebs EE, et al. Association of Mental Health Disorders With Prescription Opioids and High-Risk Opioid Use in US Veterans of Iraq and Afghanistan. JAMA. 2012 Mar 7;307(9):940–7.

22. Taylor P, Dorstyn DS, Prior E. Stress management interventions for multiple sclerosis: A meta-analysis of randomized controlled trials. J Health Psychol. 2019 Jul 12;1359105319860185.

23. Goyal M, Singh S, Sibinga EMS, Gould NF, Rowland-Seymour A, Sharma R, et al. Meditation Programs for Psychological Stress and Well-being: A Systematic Review and Meta-analysis. JAMA Intern Med. 2014 Mar 1;174(3):357–68.

24. Kabat-Zinn J. Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness (Revised ed.). New York: Random House; 2013.

25. Segal ZV, Williams JMG, Teasdale JD. Mindfulness-based cognitive therapy for depression (2nd. ed). New York: Guilford Press; 2013.

26. Kuyken W, Hayes R, Barrett B, Byng R, Dalgleish T, Kessler D, et al. Effectiveness and cost-effectiveness of mindfulness-based cognitive therapy compared with maintenance antidepressant treatment in the prevention of depressive relapse or recurrence (PREVENT): a randomised controlled trial. The Lancet. 2015 Jul 4;386(9988):63–73.

27. Cherkin DC, Sherman KJ, Balderson BH, Cook AJ, Anderson ML, Hawkes RJ, et al. Effect of Mindfulness-Based Stress Reduction vs Cognitive Behavioral Therapy or Usual Care on Back Pain and Functional Limitations in Adults With Chronic Low Back Pain: A Randomized Clinical Trial. JAMA. 2016 Mar 22;315(12):1240–9.

28. Goldberg SB, Tucker RP, Greene PA, Davidson RJ, Wampold BE, Kearney DJ, et al. Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis. Clin Psychol Rev. 2018 Feb 1;59:52–60.

29. Li W, Howard MO, Garland EL, McGovern P, Lazar M. Mindfulness treatment for substance misuse: A systematic review and meta-analysis. J Subst Abuse Treat. 2017;75:62–96.

30. Khoo E-L, Small R, Cheng W, Hatchard T, Glynn B, Rice DB, et al. Comparative evaluation of group-based mindfulness-based stress reduction and cognitive behavioural therapy for the treatment and management of chronic pain: A systematic review and network meta-analysis. Evid Based Ment Health. 2019;22(1):26–35.

31. Kuyken W, Warren FC, Taylor RS, Whalley B, Crane C, Bondolfi G, et al. Efficacy of mindfulness-based cognitive therapy in prevention of depressive relapse: an individual patient data meta-analysis from randomized trials. JAMA Psychiatry. 2016 Jun 1;73(6):565–74.

32. Hopwood TL, Schutte NS. A meta-analytic investigation of the impact of mindfulness-based interventions on post traumatic stress. Clin Psychol Rev. 2017 Nov;57:12–20.

33. Treleaven DA. Trauma-sensitive mindfulness: Practices for safe and transformative healing. New York: W. W. Norton & Company;

34. Polusny MA, Erbes CR, Thuras P, Moran A, Lamberty GJ, Collins RC, et al. Mindfulness-Based Stress Reduction for Posttraumatic Stress Disorder Among Veterans: A Randomized Clinical Trial. JAMA. 2015 Aug 4;314(5):456–65.

35. Frost ND, Laska KM, Wampold BE. The Evidence for Present-Centered Therapy as a Treatment for Posttraumatic Stress Disorder. J Trauma Stress. 2014;27(1):1–8.

36. Kearney DJ, McDermott K, Malte C, Martinez M, Simpson TL. Effects of Participation in a Mindfulness Program for Veterans With Posttraumatic Stress Disorder: A Randomized Controlled Pilot Study. J Clin Psychol. 2013;69(1):14–27.

37. THOMPSON EH, PLECK JH. The Structure of Male Role Norms. Am Behav Sci. 1986 May 1;29(5):531–43.

38. Jakupcak M, Blais RK, Grossbard J, Garcia H, Okiishi J. "Toughness" in association with mental health symptoms among Iraq and Afghanistan war veterans seeking Veterans Affairs health care. Psychol Men Masculinity. 2014;15(1):100–4.

39. Bruyea S. Mindfulness and Minefields: Walking the Challenging Path of Awareness for Soldiers and Veterans. In: Practitioner's Guide to Ethics and Mindfulness-Based Interventions. Cham, Switzerland: Springer; 2017.

40. Hunsley J. Development of the Treatment Acceptability Questionnaire. J Psychopathol Behav Assess. 1992 Mar 1;14(1):55–64.

41. Swift JK, Callahan J, Levine JC. Using clinically significant change to identify premature termination. Psychother Theory Res Pract Train. 2009 Sep;46(3):328–35.

42. Swift TC, Belser AB, Agin-Liebes G, Devenot N, Terrana S, Friedman HL, et al. Cancer at the dinner table: Experiences of psilocybin-assisted psychotherapy for the treatment of cancer-related distress. J Humanist Psychol. 2017;57(5):488–519.

43. Nam S, Toneatto T. The Influence of Attrition in Evaluating the Efficacy and Effectiveness of Mindfulness-Based Interventions. Int J Ment Health Addict. 2016 Dec 1;14(6):969–81.

44. Khoury B, Lecomte T, Fortin G, Masse M, Therien P, Bouchard V, et al. Mindfulness-based therapy: A comprehensive meta-analysis. Clin Psychol Rev. 2013 Aug 1;33(6):763–71.

45. Khoury B, Sharma M, Rush SE, Fournier C. Mindfulness-based stress reduction for healthy individuals: A meta-analysis. J Psychosom Res. 2015 Jun 1;78(6):519–28.

46. Strauss C, Cavanagh K, Oliver A, Pettman D. Mindfulness-based interventions for people diagnosed with a current episode of an anxiety or depressive disorder: a meta-analysis of randomised controlled trials. PloS One. 2014;9(4):e96110.

47. Swift JK, Greenberg RP, Tompkins KA, Parkin SR. Treatment refusal and premature termination in psychotherapy, pharmacotherapy, and their combination: A meta-analysis of head-to-head comparisons. Psychotherapy. 2017;54(1):47–57.

48. Fernandez E, Salem D, Swift JK, Ramtahal N. Meta-analysis of dropout from cognitive behavioral therapy: Magnitude, timing, and moderators. J Consult Clin Psychol. 2015 Dec;83(6):1108–22.

49. Moher D, Liberati A, Tetzlaff J, Altman DG, Group TP. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLOS Med. 2009 Jul 21;6(7):e1000097.

50. Crane RS, Brewer J, Feldman C, Kabat-Zinn J, Santorelli S, Williams JMG, et al. What defines mindfulness-based programs? The warp and the weft. Psychol Med. 2017 Apr;47(6):990–9.

51. Hayes SC, Strosahl K, Wilson K. Acceptance and commitment therapy: An experiential approach to behavior change. New York: Guilford Press; 1999.

52. Linehan MM. Cognitive-behavioral treatment of borderline personality disorder. New York: Guilford Press; 1993.

53. Nidich S, Mills PJ, Rainforth M, Heppner P, Schneider RH, Rosenthal NE, et al. Non-trauma-focused meditation versus exposure therapy in veterans with post-traumatic stress disorder: a randomised controlled trial. Lancet Psychiatry. 2018 Dec 1;5(12):975–86.

54. Elwy AR, Johnston JM, Bormann JE, Hull A, Taylor SL. A Systematic Scoping Review of Complementary and Alternative Medicine Mind and Body Practices to Improve the Health of Veterans and Military Personnel. Med Care. 2014;52(12):S70–82.

55. Cicchetti DV. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychol Assess. 1994 Dec;6(4):284–90.

56. Wampold BE, Mondin GW, Moody M, Stich F, Benson K, Ahn H. A meta-analysis of outcome studies comparing bona fide psychotherapies: Empiricially, “all must have prizes.” Psychol Bull. 1997;122(3):203–15.

57. Wampold BE, Imel ZE. The great psychotherapy debate: The evidence for what makes psychotherapy work (2nd ed.). New York: Routledge; 2015.

58. Mularski RA, Munjas BA, Lorenz KA, Sun S, Robertson SJ, Schmelzer W, et al. Randomized Controlled Trial of Mindfulness-Based Therapy for Dyspnea in Chronic Obstructive Lung Disease. J Altern Complement Med. 2009 Oct 1;15(10):1083–90.

59. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJM, Gavaghan DJ, et al. Assessing the quality of reports of randomized clinical trials: Is blinding necessary? Control Clin Trials. 1996 Feb 1;17(1):1–12.

60. Piet J, Hougaard E. The effect of mindfulness-based cognitive therapy for prevention of relapse in recurrent major depressive disorder: a systematic review and meta-analysis. Clin Psychol Rev. 2011 Aug;31(6):1032–40.

61. Goldberg SB, Tucker RP, Greene PA, Davidson RJ, Kearney DJ, Simpson TL. Mindfulness-based cognitive therapy for the treatment of current depressive symptoms: a meta-analysis. Cogn Behav Ther. 2019 Feb 8;1–18.

62. Higgins JPT, Green S. Cochrane Handbook for Systematic Reviews of Interventions. London: Wiley & Sons; 2008.

63. Cooper HM, Hedges LV, Valentine JC. The handbook of research synthesis and meta-analysis (2nd ed.). New York: Russell Sage Foundation; 2009.

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

65. Hoyt WT, Re ACD. Effect size calculation in meta-analyses of psychotherapy outcome research. Psychother Res. 2018 May 4;28(3):379–88.

66. Becker BJ. Synthesizing standardized mean-change measures. Br J Math Stat Psychol. 1988;41(2):257–78.

67. Kearney DJ, Simpson TL, Malte CA, Felleman B, Martinez ME, Hunt SC. Mindfulness-based Stress Reduction in Addition to Usual Care Is Associated with Improvements in Pain, Fatigue, and Cognitive Failures Among Veterans with Gulf War Illness. Am J Med. 2016 Feb 1;129(2):204–14.

68. Weathers FW, Litz BT, Keane TM, Palmieri PA, Marx BP, Schnurr PP. The PTSD Checklist for DSM-5 (PCL-5) [Internet]. National Center for PTSD; 2013. Available from: www.ptsd.va.gov

69. Del Re AC, Hoyt WT. MAd: Meta-analysis with mean differences [Internet]. 2014. Available from: http://CRAN.R-project.org/package=MAd

70. R Core Team. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2018.

71. Fu R, Gartlehner G, Grant M, Shamliyan T, Sedrakyan A, Wilt TJ, et al. Conducting quantitative synthesis when comparing medical interventions: AHRQ and the Effective Health Care Program. J Clin Epidemiol. 2011 Nov 1;64(11):1187–97.

72. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003 Sep 4;327(7414):557–60.

73. Viechtbauer W. Conducting meta-analyses in R with the metafor package. J Stat Softw. 2010 Aug;36(3):1–48.

74. Yusuf S, Peto R, Lewis J, Collins R, Sleight P. Beta blockade during and after myocardial infarction: An overview of the randomized trials. Prog Cardiovasc Dis. 1985 Mar 1;27(5):335–71.

75. Rosenthal R. The file drawer problem and tolerance for null results. Psychol Bull. 1979;86(3):638–41.

76. Rosenberg MS. The File-Drawer Problem Revisited: A General Weighted Method for Calculating Fail-Safe Numbers in Meta-Analysis. Evolution. 2005;59(2):464–8.

77. Sterne JAC, Egger M. Funnel plots for detecting bias in meta-analysis: Guidelines on choice of axis. J Clin Epidemiol. 2001 Oct 1;54(10):1046–55.

78. Dunning DL, Griffiths K, Kuyken W, Crane C, Foulkes L, Parker J, et al. Research Review: The effects of mindfulness-based interventions on cognition and mental health in children and adolescents - a meta-analysis of randomized controlled trials. J Child Psychol Psychiatry. 2019 Mar;60(3):244–58.

79. Halladay JE, Dawdy JL, McNamara IF, Chen AJ, Vitoroulis I, McInnes N, et al. Mindfulness for the mental health and well-being of post-secondary students: A systematic review and meta-analysis. Mindfulness [Internet]. 2018 Jun 28; Available from: http://search.proquest.com.ezproxy.library.wisc.edu/docview/2062876426?accountid=465

80. de Abreu Costa M, D'Alò de Oliveira GS, Tatton-Ramos T, Manfro GG, Salum GA. Anxiety and Stress-Related Disorders and Mindfulness-Based Interventions: a Systematic Review and Multilevel Meta-analysis and Meta-Regression of Multiple Outcomes. Mindfulness. 2019;10(6):996–1005.

81. Viechtbauer W, Cheung MW-L. Outlier and influence diagnostics for meta-analysis. Res Synth Methods. 2010;1(2):112–25.

82. M.Sc.1 MH, Cuijpers2 PDP, Furukawa3 PDTA, Ebert2 APDDD. Doing Meta-Analysis in R [Internet]. [cited 2020 Jun 24]. Available from: https://bookdown.org/MathiasHarrer/Doing_Meta_Analysis_in_R/

83. Bein Z. A Pilot Study of an 8-Week Mindfulness-Based Intervention for Veterans with Posttraumatic Symptoms and Co-Occurring Substance Use Disorders. Alliant International University: ProQuest Dissertations Publishing; 2014.

84. Possemato K, Bergen-Cico D, Treatman S, Allen C, Wade M, Pigeon W. A Randomized Clinical Trial of Primary Care Brief Mindfulness Training for Veterans With PTSD. J Clin Psychol. 2016;72(3):179–93.

85. Omidi A, Mohammadi A, Zargar F, Akbari H. Efficacy of Mindfulness-Based Stress Reduction on Mood States of Veterans With Post-Traumatic Stress Disorder. Arch Trauma Res. 2013;1(4):151–4.

86. Present-Centered Therapy for Post-Traumatic Stress Disorder | Society of Clinical Psychology [Internet]. [cited 2020 Jun 24]. Available from: https://www.div12.org/treatment/present-centered-therapy-for-post-traumatic-stress-disorder/

87. Wahbeh H, Goodrich E, Goy E, Oken BS. Mechanistic Pathways of Mindfulness Meditation in Combat Veterans With Posttraumatic Stress Disorder. J Clin Psychol. 2016;72(4):365–83.

88. Zeidan F, Johnson SK, Gordon NS, Goolkasian P. Effects of Brief and Sham Mindfulness Meditation on Mood and Cardiovascular Variables. J Altern Complement Med. 2010 Jul 28;16(8):867–73.

89. Vibe M de, Bjørndal A, Tipton E, Hammerstrøm K, Kowalski K. Mindfulness Based Stress Reduction (MBSR) for Improving Health, Quality of Life, and Social Functioning in Adults. Campbell Syst Rev. 2012;8(1):1–127.

90. Imel ZE, Laska K, Jakupcak M, Simpson TL. Meta-analysis of dropout in treatments for posttraumatic stress disorder. J Consult Clin Psychol. 2013;81(3):394–404.

91. Bremner JD, Mishra S, Campanella C, Shah M, Kasher N, Evans S, et al. A Pilot Study of the Effects of Mindfulness-Based Stress Reduction on Post-traumatic Stress Disorder Symptoms and Brain Response to Traumatic Reminders of Combat in Operation Enduring Freedom/Operation Iraqi Freedom Combat Veterans with Post-traumatic Stress Disorder. Front Psychiatry [Internet]. 2017 [cited 2020 Jun 24];8. Available from: https://www.frontiersin.org/articles/10.3389/fpsyt.2017.00157/full

92. Kabat-Zinn J. An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. Gen Hosp Psychiatry. 1982 Apr 1;4(1):33–47.

93. Baer RA. Mindfulness Training as a Clinical Intervention: A Conceptual and Empirical Review. Clin Psychol Sci Pract. 2003;10(2):125–43.

94. Lindahl JR, Fisher NE, Cooper DJ, Rosen RK, Britton WB. The varieties of contemplative experience: A mixed-methods study of meditation-related challenges in Western Buddhists. PLOS ONE. 2017;12(5):e0176239.

95. Martinez ME, Kearney DJ, Simpson T, Felleman BI, Bernardi N, Sayre G. Challenges to Enrollment and Participation in Mindfulness-Based Stress Reduction Among Veterans: A Qualitative Study. J Altern Complement Med. 2015 May 28;21(7):409–21.

96. Pigeon W, Allen C, Possemato K, Bergen-Cico D, Treatman S. Feasibility and Acceptability of a Brief Mindfulness Program for Veterans in Primary Care with Posttraumatic Stress Disorder. Mindfulness. 2015 Oct 1;6(5):986–95.

97. Goldberg SB, Zeliadt SB, Hoggatt KJ, Simpson TL, Fortney JC, Taylor SL. Utilization and Perceived Effectiveness of Mindfulness Meditation in Veterans: Results from a National Survey. Mindfulness. 2019 Dec 1;10(12):2596–605.

98. Benish SG, Quintana S, Wampold BE. Culturally adapted psychotherapy and the legitimacy of myth: A direct-comparison meta-analysis. J Couns Psychol. 2011;58(3):279–89.

99. Griner D, Smith TB. Culturally adapted mental health intervention: A meta-analytic review. Psychother Theory Res Pract Train. 2006 Win;43(4):531–48.

100. Button KS, Ioannidis JPA, Mokrysz C, Nosek BA, Flint J, Robinson ESJ, et al. Power failure: why small sample size undermines the reliability of neuroscience. Nat Rev Neurosci. 2013 May;14(5):365–76.

101. Yano EM, Hayes P, Wright S, Schnurr PP, Lipson L, Bean-Mayberry B, et al. Integration of Women Veterans into VA Quality Improvement Research Efforts: What Researchers Need to Know. J Gen Intern Med. 2010 Jan 1;25(1):56–61.

102. Collaboration OS. Estimating the reproducibility of psychological science. Science [Internet]. 2015 Aug 28 [cited 2020 Jun 24];349(6251). Available from: https://science.sciencemag.org/content/349/6251/aac4716

103. Leykin Y, DeRubeis RJ. Allegiance in Psychotherapy Outcome Research: Separating Association From Bias. Clin Psychol Sci Pract. 2009;16(1):54–65.

104. Munder T, Brütsch O, Leonhart R, Gerger H, Barth J. Researcher allegiance in psychotherapy outcome research: An overview of reviews. Clin Psychol Rev. 2013 Jun 1;33(4):501–11.

105. Goldberg SB, Tucker RP. Allegiance effects in mindfulness-based interventions for psychiatric disorders: A meta-re-analysis. Psychother Res. 2020 Aug 17;30(6):753–62.

106. Swift JK, Callahan JL. The impact of client treatment preferences on outcome: a meta-analysis. J Clin Psychol. 2009;65(4):368–81.

107. National Academies of Sciences, Engineering, and Medicine. Evaluation of the Department of Veterans Affairs Mental Health Services. Washington (DC): National Academies Press (US); 2018.

108. Arch JJ, Ayers CR, Baker A, Almklov E, Dean DJ, Craske MG. Randomized clinical trial of adapted mindfulness-based stress reduction versus group cognitive behavioral therapy for heterogeneous anxiety disorders. Behav Res Ther. 2013 May 1;51(4):185–96.

109. AREFNASAB Z, GHANEI M, NOORBALA AA, ALIPOUR A, BABAMAHMOODI F, BABAMAHMOODI A, et al. Effect of Mindfulness Based Stress Reduction on Quality of Life (SF-36) and Spirometry Parameters, in Chemically Pulmonary Injured Veterans. Iran J Public Health. 2013 Sep;42(9):1026–33.

110. Davis LW, Lysaker PH, Kristeller JL, Salyers MP, Kovach AC, Woller S. Effect of mindfulness on vocational rehabilitation outcomes in stable phase schizophrenia. Psychol Serv. 2015;12(3):303–12.

111. Jasbi M, Sadeghi Bahmani D, Karami G, Omidbeygi M, Peyravi M, Panahi A, et al. Influence of adjuvant mindfulness-based cognitive therapy (MBCT) on symptoms of post-

traumatic stress disorder (PTSD) in veterans - results from a randomized control study. Cogn Behav Ther. 2018 Sep;47(5):431–46.

112. King AP, Block SR, Sripada RK, Rauch S, Giardino N, Favorite T, et al. Altered Default Mode Network (dmn) Resting State Functional Connectivity Following a Mindfulness-Based Exposure Therapy for Posttraumatic Stress Disorder (ptsd) in Combat Veterans of Afghanistan and Iraq. Depress Anxiety. 2016;33(4):289–99.

113. Niles BL, Klunk-Gillis J, Ryngala DJ, Silberbogen AK, Paysnick A, Wolf EJ. Comparing mindfulness and psychoeducation treatments for combat-related PTSD using a telehealth approach. Psychol Trauma Theory Res Pract Policy. 2012;4(5):538–47.

114. Arefnasab Z, Babamahmoodi A, Babamahmoodi F, Noorbala AA, Alipour A, Panahi Y, et al. Mindfulness-based Stress Reduction (MBSR) and Its Effects on Psychoimmunological Factors of Chemically Pulmonary Injured Veterans. Iran J Allergy Asthma Immunol. 2016;476–86.

115. Niles BL, Vujanovic AA, Silberbogen AK, Seligowski AV, Potter CM. Changes in Mindfulness Following a Mindfulness Telehealth Intervention. Mindfulness. 2013 Dec 1;4(4):301–10.

116. Omidi A, Hamidian S. Effectiveness of a combined mindfulness-based cognitive therapy and mindfulness-based stress reduction intervention on depression symptoms and quality of life in a group of Iranian veterans with posttraumatic stress disorder. Iran J Psychiatry Behav Sci. 2018;12(4):e55945.

117. Bergen-Cico D, Possemato K, Pigeon W. Reductions in Cortisol Associated With Primary Care Brief Mindfulness Program for Veterans With PTSD. Med Care. 2014;52(12):S25–31.

118. Colgan DD, Christopher M, Michael P, Wahbeh H. The Body Scan and Mindful Breathing Among Veterans with PTSD: Type of Intervention Moderates the Relationship Between Changes in Mindfulness and Post-treatment Depression. Mindfulness. 2016 Apr 1;7(2):372–83.

Table 1. Study-level characteristics

Study	Inclusion	N_{mind}	N_{cont}	Age	Female	REM	Country	$Name_{mind}$	$Type_{mind}$	Weeks	$Name_{cont}$	$Type_{cont}$	FU
Arch 2013(108)	anxiety	45	60	45.91	17	30	US	Modified MBSR	MBSR	10	CBT	specific	3
Arefnasab 2013(109)	pulmonary injury	20	20	49.4	0	0	Iran	MBSR	MBSR	8	waitlist	non-specific	NA
Bein 2014(83)	PTSD, SUD	4	4	50.13	0	37.5	US	Mindfulness for PTSD / GAD	None	8	TAU	non-specific	NA
Bremner 2017(91)	PTSD	17	9	34.47	0	41.18	US	MBSR	MBSR	9	PCT	specific	6
Davis 2015(110)	schizophrenia/ schizoaffective dx	18	16	51.74	3	61.76	US	MIRRORS	MBSR	16	Intensive Support	non-specific	2
Jasbi 2018(111)	PTSD	24	24	52.97	0	0	Iran	MBCT	MBCT	8	Socio-therapeutic activities	non-specific	NA
Kearney 2013(36)	PTSD	25	22	52	21.28	31.91	US	MBSR	MBSR	8	TAU	non-specific	4
Kearney 2016(67)	Gulf War illness	26	29	49.88	14.55	38.18	US	MBSR	MBSR	8	TAU	non-specific	6
King 2016(112)	PTSD	26	17	32.13	0	8.7	US	MB exposure therapy	MBCT	16	PCT	specific	NA
Mularski 2009(58)	COPD	44	42	67.4	1.16	49	US	MB breathing therapy	MBSR	8	Support group	non-specific	NA
Niles 2012(113)	PTSD	17	16	52	0	24	US	Mindfulness handbook	None	8	Psychoeducation	non-specific	1.5
Omidi 2013(85)	PTSD, depression	31	31	41.11	0	0	Iran	MBSR/MBCT	MBSR/MBCT	8	TAU	non-specific	NA
Polusny 2015(34)	PTSD	58	58	58.5	16	16	US	MBSR	MBSR	8	PCT	specific	2
Possemato 2016(84)	PTSD	36	26	46.4	12.9	17.7	US	Primary care brief mindfulness training	MBSR	4	TAU	non-specific	1
Wahbeh 2016a(87)	PTSD	28	28	51.1	6	12	US	Mindful breathing	MBSR	6	Biofeedback	specific	NA
Wahbeh 2016b(87)	PTSD	30	28	53.16	5.56	15.48	US	Mindful body scan	MBSR	6	Sitting quietly	non-specific	NA

Note: $N_{mind/cont}$ = intention-to-treat sample size for mindfulness and control conditions; Female = percentage female; REM = percentage racial/ethnic minority; Country = country of origin; $Name_{mind}$ = name of mindfulness condition; $Type_{mind}$ = standardized mindfulness-based intervention upon which mindfulness condition is based; $Weeks_{mind}$ = length of mindfulness intervention in weeks; $Name_{cont}$ = name of control condition; $Type_{cont}$ = control condition type; FU = length of follow-up in months; PTSD = posttraumatic stress disorder; COPD = chronic obstructive pulmonary disease; SUD = substance use disorder; US = United States; MBSR = mindfulness-based stress reduction; MBCT = mindfulness-based cognitive therapy; MB = mindfulness-based; GAD = generalized anxiety disorder; CBT = cognitive behavioral therapy; TAU = treatment-as-usual; PCT = present-centered therapy; non-specific = non-specific control condition not intended to be therapeutic; specific = specific active control condition.

Table 2. Meta-analytic results across outcome domains

Domain	Comparison	Timepoint	N	K	ES	I^2	k_{imp}	ES_{adj}	FSN
PTSD	non-specific	post	298	7	0.64 [0.16, 1.12]	76.93 [40.49, 95.67]	0	0.64 [0.16, 1.12]	61
PTSD	non-specific	fu	187	4	0.12 [-0.17, 0.41]	0.00 [0.00, 88.25]	0	0.12 [-0.17, 0.41]	0
PTSD	specific	post	206	4	0.25 [0.01, 0.50]	0.00 [0.00, 68.25]	2	0.22 [-0.01, 0.45]	3[a]
Depression	non-specific	post	333	7	0.80 [0.42, 1.19]	62.53 [0.00, 95.25]	0	0.80 [0.42, 1.19]	111
Psych Sx	non-specific	post	449	10	0.70 [0.38, 1.02]	72.68 [38.95, 92.75]	0	0.70 [0.38, 1.02]	222
Psych Sx	non-specific	fu	187	4	0.31 [0.04, 0.57]	10.89 [0.00, 92.30]	0	0.31 [0.04, 0.57]	5[a]
Psych Sx	specific	post	311	5	0.19 [0.00, 0.38]	0.00 [0.00, 62.30]	2	0.17 [-0.01, 0.35]	4
QOL/Function	non-specific	post	240	5	0.72 [0.47, 0.97]	0.00 [0.00, 82.25]	0	0.72 [0.47, 0.97]	57
Mindfulness	non-specific	post	281	7	0.32 [0.11, 0.54]	0.00 [0.00, 90.01]	1	0.30 [0.09, 0.51]	22[a]
Phys Health	non-specific	post	196	4	0.38 [-0.19, 0.95]	80.22 [34.10, 98.76]	0	0.38 [-0.19, 0.95]	6

Note: N = sample size, K = number of comparisons, ES = effect size in Hedges' *g* units; I^2 = heterogeneity; k_{imp} = number of imputed studies necessary for funnel plot symmetry; ES_{adj} = trim-and-fill adjusted effect size; FSN = fail-safe N; [a] = statistically significant effect that is not robust to FSN based on Rosenberg's (2005) guidelines; PTSD = posttraumatic stress disorder; Psych Sx = psychological symptoms; QOL/Function = quality of life or measures of functioning; Phys Health = physical health outcomes; non-specific = non-specific control conditions not intended to be therapeutic; specific = specific active control conditions; post = pre-post effect; fu = pre-follow-up effect. Values in brackets represent 95% confidence interval.

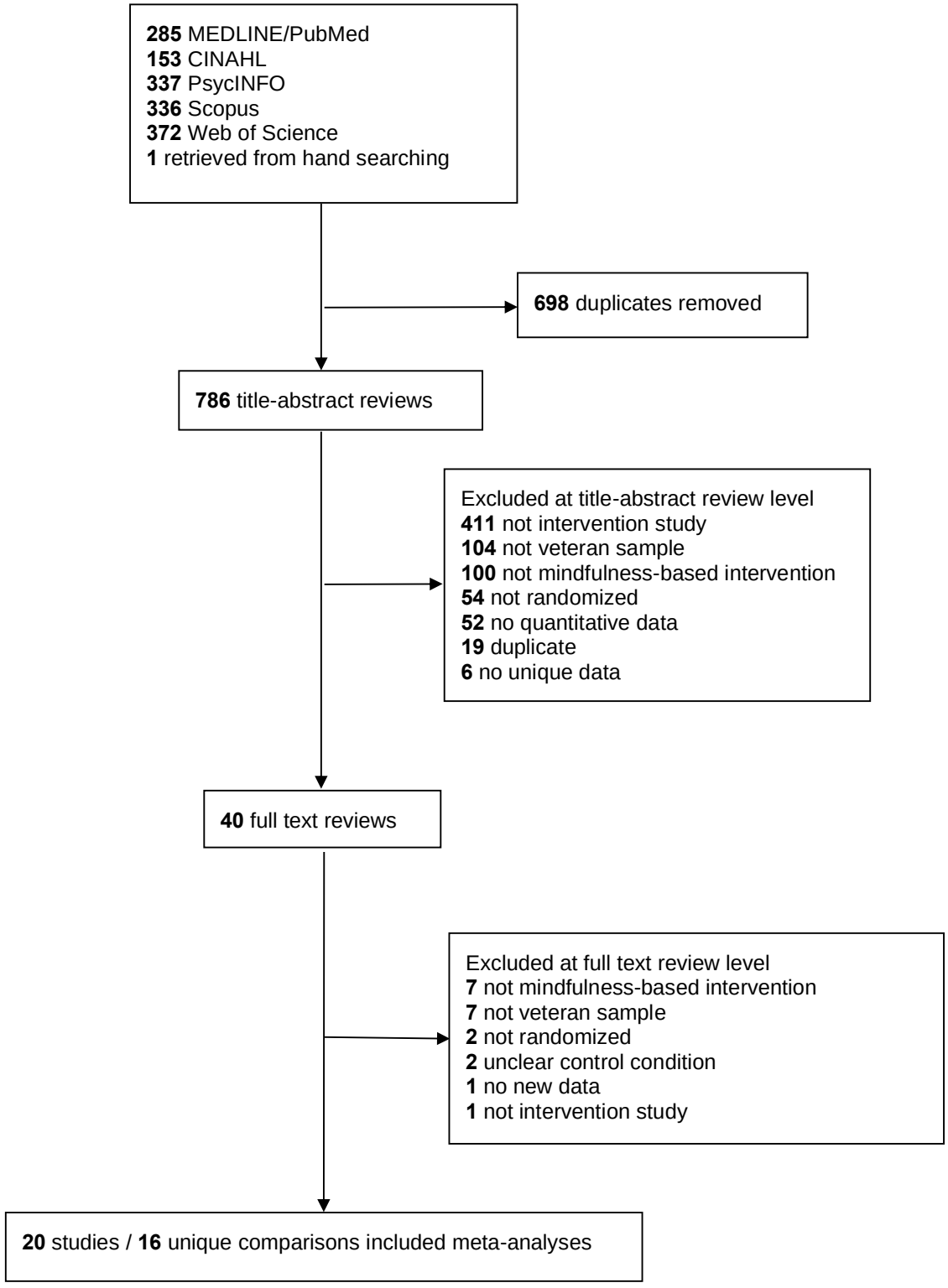

Figure 1. PRISMA flow diagram

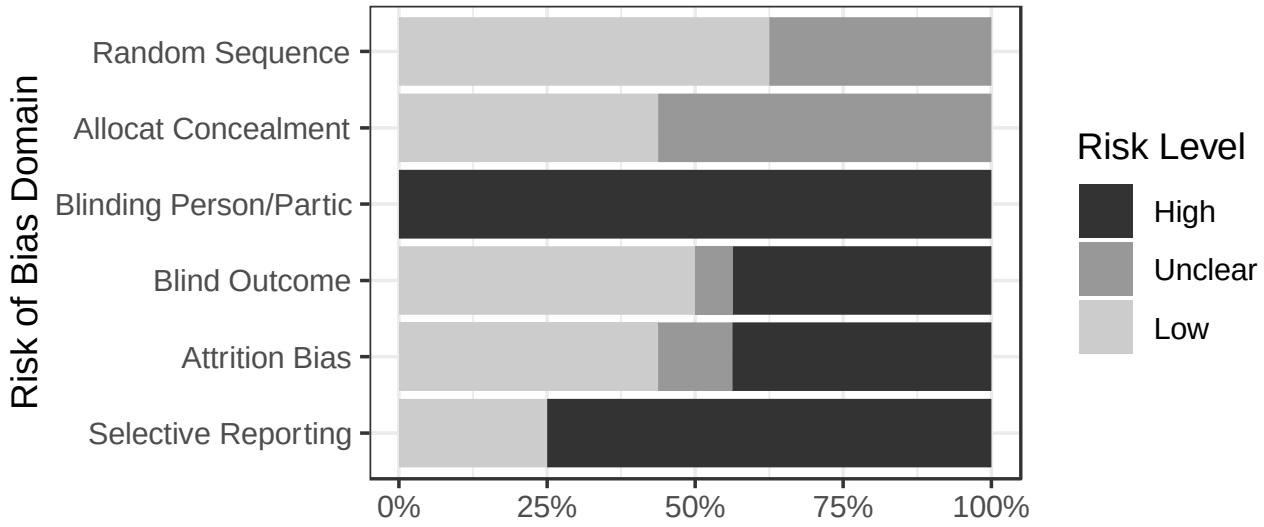

Figure 2. Cochrane risk of bias coding. Random sequence = random sequence generation; Allocat Concealment = allocation concealment; Blinding Person/Partic = blinding of personnel and participants; Blind Outcome = blinding of outcome assessor.

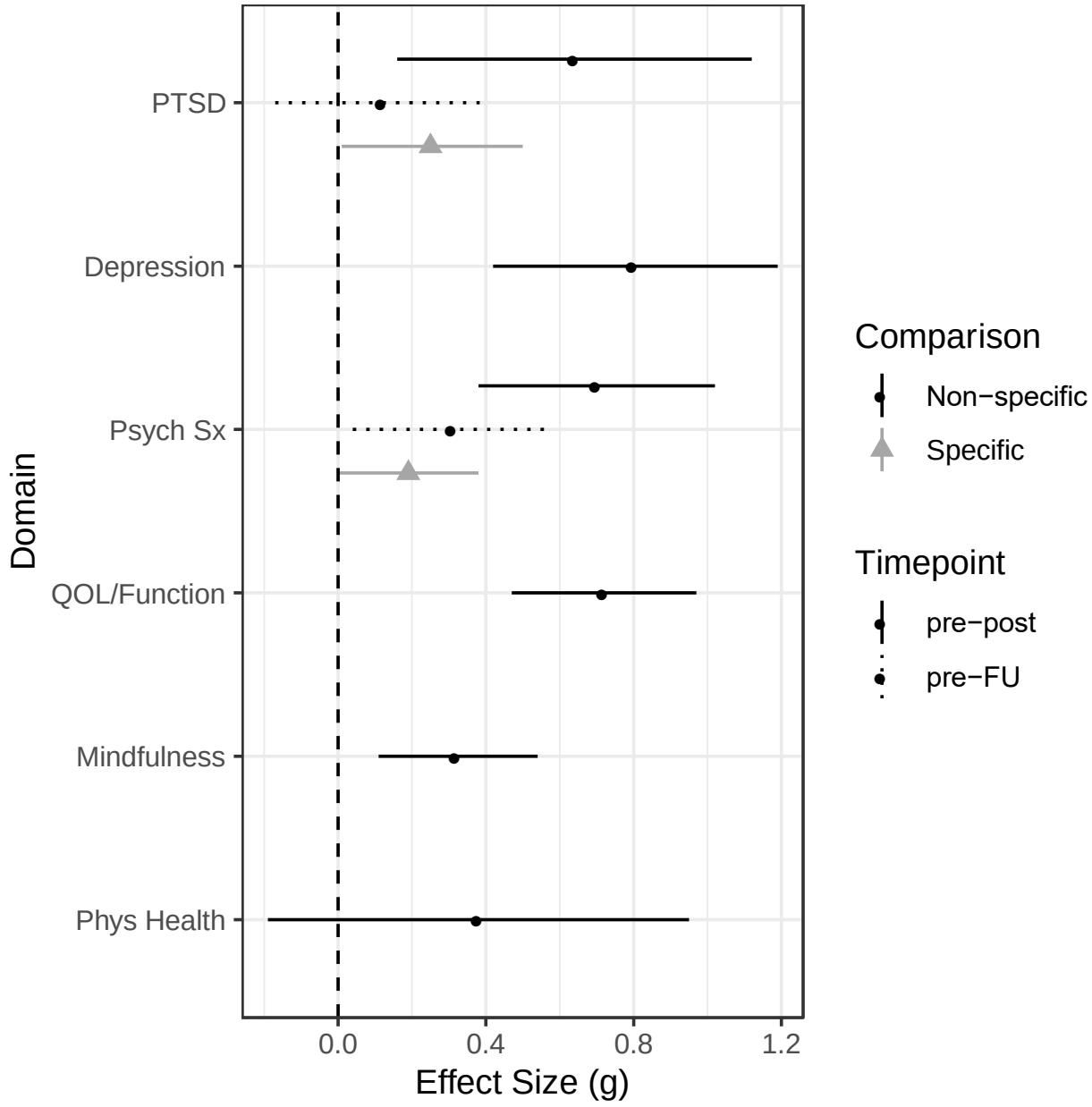

Figure 3. Forest plot displaying meta-analytic estimates in Hedges' *g* units when four or more studies were available for a given comparison. Error bars represent 95% confidence intervals.

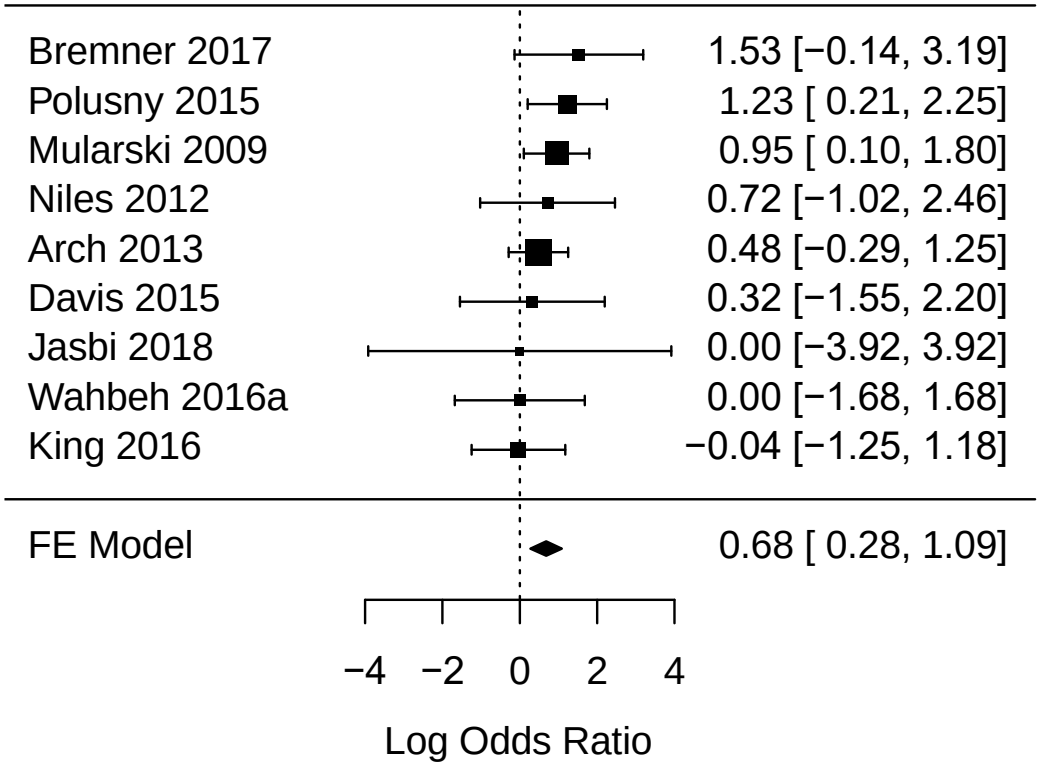

Figure 4. Forest plot depicting differential attrition for mindfulness-based intervention conditions relative to control intervention conditions. Effect sizes are displayed in log odds ratio units, with larger effect sizes indicating higher attrition in the mindfulness arm.

Supplemental Materials Table 1. Databases and search terms

Database	Search terms	Search/filter settings
MEDLINE/PubMed	mindful* AND (veteran* OR military)	"All Fields" + no filters
CINAHL	mindful* AND (veteran* OR military)	"Select a field (optional)" + no filters
PsycINFO	mindful* AND (veteran* OR military)	"Select a field (optional)" + no filters
Scopus	mindful* AND (veteran* OR military)	Document search + "Article title, Abstract, Keywords" + no filters
Web of Science	mindful* AND (veteran* OR military)	All databases + Topic ("Searches title, abstract, author keywords, and more.") + no filters

Supplemental Materials Table 2. Jadad study quality coding

Study	Random	Random described	Allocation concealed	Similar baseline	Blind outcome	Dropouts mentioned	Dropout reasons given	ITT	Power calculation	Jadad score (max = 4)
Arch 2013	**yes**	**yes**	yes	no	**yes**	yes	**yes**	yes	yes	4
Arefnasab 2013	**yes**	**yes**	unclear	yes	**no**	unclear	**no**	unclear	no	2
Bein 2014	**yes**	**no**	unclear	unclear	**no**	unclear	**unclear**	unclear	no	1
Bremner 2017	**yes**	**yes**	unclear	yes	**unclear**	yes	**yes**	no	no	3
Davis 2015	**yes**	**no**	unclear	yes	**no**	yes	**no**	no	no	1
Jasbi 2018	**yes**	**yes**	unclear	yes	**no**	yes	**yes**	yes	no	3
Kearney 2013	**yes**	**no**	yes	yes	**no**	yes	**no**	yes	no	1
Kearney 2016	**yes**	**no**	yes	yes	**no**	yes	**no**	yes	no	1
King 2016	**yes**	**no**	unclear	yes	**yes**	yes	**no**	no	no	2
Mularski 2009	**yes**	**yes**	yes	no	**yes**	yes	**yes**	no	yes	4
Niles 2012	**yes**	**yes**	yes	no	**no**	yes	**yes**	no	no	3
Omidi 2013	**yes**	**yes**	unclear	yes	**no**	yes	**yes**	yes	yes	3
Polusny 2015	**yes**	**yes**	no	no	**yes**	yes	**yes**	yes	yes	4
Possemato 2016	**yes**	**no**	unclear	yes	**yes**	yes	**yes**	yes	yes	3
Wahbeh 2016a	**yes**	**yes**	unclear	yes	**yes**	yes	**no**	no	yes	3
Wahbeh 2016b	**yes**	**yes**	unclear	yes	**yes**	yes	**no**	no	yes	3

Note: Random = was the trial randomized; Random described = was the randomization procedure described and appropriate; Allocation concealed = was the treatment allocation concealed; Similar baseline = were groups similar at baseline on prognostic indicators; Blind outcome = was blind outcome assessment conducted; Dropouts mentioned = was the number of withdrawals/dropouts in each group mentioned; Dropout reasons given = in addition to stating the number of withdrawals/dropouts, were reasons given for each group; Power calculation = was a power calculation described; Jadad score = modified Jadad study quality score based on Piet and Hougaard (60). Bolded columns contributed to Jadad score with yes = 1, unclear/no = 0.

Supplemental Materials Table 3. Primary and secondary studies included in meta-analysis

Primary study	Secondary study
Arch 2013	
Arefnasab 2013	Arefnasab 2016(114)
Bein 2014	
Bremner 2017	
Davis 2015	
Jasbi 2018	
Kearney 2013	
Kearney 2016	
King 2016	
Mularski 2009	
Niles 2012	Niles 2013(115)
Omidi 2013	Omidi 2018(116)
Polusny 2015	
Possemato 2016	Bergen-Cico 2014(117)
Wahbeh 2016a	Wahbeh 2016b, Colgan 2016(118)

Note: Wahbeh 2016a and Wahbeh 2016b reflect two sets of comparisons included in the same primary study (Wahbeh et al., 2016).

Supplemental Materials Table 4. Cochrane risk of bias coding

Study	Random sequence	Allocation Concealment	Blind participants/ personnel	Blind outcome assessment	Attrition bias	Selective reporting
Arch 2013	Low	Low	High	Low	High	Low
Arefnasab 2013	Low	Unclear	High	High	High	Unclear
Bein 2014	Unclear	Unclear	High	High	High	Unclear
Bremner 2017	Low	Unclear	High	Unclear	High	High
Davis 2015	Unclear	Unclear	High	High	High	High
Jasbi 2018	Low	Unclear	High	High	High	Low
Kearney 2013	Unclear	Low	High	High	Low	Low
Kearney 2016	Unclear	Low	High	Low	Low	Low
King 2016	Unclear	Unclear	High	Low	High	High
Mularski 2009	Low	Low	High	Low	Low	High
Niles 2012	Low	Low	High	High	High	High
Omidi 2013	Low	Unclear	High	High	High	Low
Polusny 2015	Low	Unclear	High	Low	Low	Low
Possemato 2016	Unclear	Unclear	High	Low	High	Low
Wahbeh 2016a	Low	Low	High	Low	High	High
Wahbeh 2016b	Low	Low	High	Low	High	High

Note: Risk of bias coded based on Higgins and Green (2008). Low = low risk of bias; High = high risk of bias; Unclea = unclear risk of bias.

Supplemental Materials Table 5. Study-level effect size estimates by domain and time point

Study	Domain	Comparison	Timepoint	ES	Variance
Jasbi 2018	Anxiety	non-spec	post	1.38	0.16
Arch 2013	Anxiety	spec	post	0.1	0.03
Arch 2013	Anxiety	spec	fu	0.16	0.04
Arefnasab 2013	Biological	non-spec	post	0.48	0.06
Possemato 2016	Biological	non-spec	post	0.39	0.07
Wahbeh 2016b	Biological	non-spec	post	-0.47	0.06
Wahbeh 2016a	Biological	spec	post	0.42	0.06
Wahbeh 2016b	Cognitive	non-spec	post	-0.16	0.07
Wahbeh 2016a	Cognitive	spec	post	0.45	0.08
Bein 2014	Depression	non-spec	post	0.88	0.38
Jasbi 2018	Depression	non-spec	post	2.34	0.21
Kearney 2013	Depression	non-spec	post	0.46	0.07
Kearney 2016	Depression	non-spec	post	0.63	0.08
Omidi 2013	Depression	non-spec	post	0.83	0.07
Possemato 2016	Depression	non-spec	post	0.57	0.07
Wahbeh 2016b	Depression	non-spec	post	0.55	0.08
Kearney 2013	Depression	non-spec	fu	0.43	0.07
Kearney 2016	Depression	non-spec	fu	0.85	0.09
Possemato 2016	Depression	non-spec	fu	0.26	0.06
Arch 2013	Depression	spec	post	0.12	0.04
Polusny 2015	Depression	spec	post	0.19	0.03
Wahbeh 2016a	Depression	spec	post	0.26	0.08
Arch 2013	Depression	spec	fu	-0.01	0.04
Polusny 2015	Depression	spec	fu	0.22	0.03
Bein 2014	Mindfulness	non-spec	post	1.45	0.56
Kearney 2013	Mindfulness	non-spec	post	0.54	0.09
Kearney 2016	Mindfulness	non-spec	post	0.52	0.07
Mularski 2009	Mindfulness	non-spec	post	-0.05	0.09
Niles 2012	Mindfulness	non-spec	post	0.37	0.08
Possemato 2016	Mindfulness	non-spec	post	0.05	0.05
Wahbeh 2016b	Mindfulness	non-spec	post	0.46	0.08
Kearney 2013	Mindfulness	non-spec	fu	0.55	0.09
Kearney 2016	Mindfulness	non-spec	fu	0.69	0.08
Niles 2012	Mindfulness	non-spec	fu	0.27	0.09
Bremner 2017	Mindfulness	spec	post	0.68	0.24
Polusny 2015	Mindfulness	spec	post	0.52	0.04
Wahbeh 2016a	Mindfulness	spec	post	0.07	0.08

Polusny 2015	Mindfulness	spec	fu	0.54	0.04
Arefnasab 2013	Phys Health	non-spec	post	1.25	0.14
Kearney 2016	Phys Health	non-spec	post	0.42	0.05
Mularski 2009	Phys Health	non-spec	post	-0.24	0.04
Wahbeh 2016b	Phys Health	non-spec	post	0.28	0.08
Kearney 2016	Phys Health	non-spec	fu	0.54	0.05
Wahbeh 2016a	Phys Health	spec	post	0.04	0.08
Wahbeh 2016b	Pos Affect	non-spec	post	0.46	0.09
Wahbeh 2016a	Pos Affect	spec	post	0.07	0.09
Arefnasab 2013	Psych Sx	non-spec	post	1.39	0.14
Bein 2014	Psych Sx	non-spec	post	0.69	0.26
Jasbi 2018	Psych Sx	non-spec	post	1.98	0.11
Kearney 2013	Psych Sx	non-spec	post	0.38	0.06
Kearney 2016	Psych Sx	non-spec	post	0.64	0.06
Mularski 2009	Psych Sx	non-spec	post	0.39	0.06
Niles 2012	Psych Sx	non-spec	post	0.75	0.10
Omidi 2013	Psych Sx	non-spec	post	0.63	0.04
Possemato 2016	Psych Sx	non-spec	post	0.26	0.05
Wahbeh 2016b	Psych Sx	non-spec	post	0.31	0.05
Kearney 2013	Psych Sx	non-spec	fu	0.35	0.06
Kearney 2016	Psych Sx	non-spec	fu	0.63	0.06
Niles 2012	Psych Sx	non-spec	fu	0.17	0.11
Possemato 2016	Psych Sx	non-spec	fu	0.06	0.05
Arch 2013	Psych Sx	spec	post	0.11	0.03
Bremner 2017	Psych Sx	spec	post	0.53	0.26
King 2016	Psych Sx	spec	post	0.38	0.18
Polusny 2015	Psych Sx	spec	post	0.17	0.02
Wahbeh 2016a	Psych Sx	spec	post	0.26	0.05
Arch 2013	Psych Sx	spec	fu	0.12	0.03
Bremner 2017	Psych Sx	spec	fu	1.48	0.26
Polusny 2015	Psych Sx	spec	fu	0.31	0.02
Bein 2014	PTSD	non-spec	post	0.50	0.31
Jasbi 2018	PTSD	non-spec	post	2.10	0.15
Kearney 2013	PTSD	non-spec	post	0.21	0.09
Kearney 2016	PTSD	non-spec	post	0.65	0.08
Niles 2012	PTSD	non-spec	post	0.82	0.12
Possemato 2016	PTSD	non-spec	post	0.11	0.05
Wahbeh 2016b	PTSD	non-spec	post	0.33	0.06
Kearney 2013	PTSD	non-spec	fu	0.18	0.09
Kearney 2016	PTSD	non-spec	fu	0.41	0.08

Niles 2012	PTSD	non-spec	fu	0.01	0.15
Possemato 2016	PTSD	non-spec	fu	-0.13	0.07
Bremner 2017	PTSD	spec	post	0.53	0.26
King 2016	PTSD	spec	post	0.38	0.18
Polusny 2015	PTSD	spec	post	0.17	0.03
Wahbeh 2016a	PTSD	spec	post	0.32	0.06
Bremner 2017	PTSD	spec	fu	1.48	0.26
Polusny 2015	PTSD	spec	fu	0.35	0.03
Arefnasab 2013	QOL/Function	non-spec	post	1.17	0.13
Davis 2015	QOL/Function	non-spec	post	0.59	0.10
Kearney 2016	QOL/Function	non-spec	post	0.73	0.08
Omidi 2013	QOL/Function	non-spec	post	0.74	0.07
Wahbeh 2016b	QOL/Function	non-spec	post	0.57	0.06
Kearney 2016	QOL/Function	non-spec	fu	0.98	0.08
Bremner 2017	QOL/Function	spec	post	0.40	0.21
Polusny 2015	QOL/Function	spec	post	0.19	0.03
Wahbeh 2016a	QOL/Function	spec	post	0.46	0.06
Polusny 2015	QOL/Function	spec	fu	0.32	0.03
Bein 2014	SUD	non-spec	post	0.77	0.38

Note: ES = effect size in Hedges' g units; PTSD = posttraumatic stress disorder; Psych Sx = psychological symptoms; QOL/Function = quality of life or measures of functioning; Phys Health = physical health outcomes; SUD = substance use disorder-related outcome; non-specific = non-specific control conditions not intended to be therapeutic; specific = specific active control conditions; post = pre-post effect; fu = pre-follow-up effect.

Supplemental Materials Table 6. Outcome measures with corresponding outcome domain

Domain	Outcome Measure
Anxiety	Clinician Anxiety Rating
Anxiety	Penn State Worry Questionnaire
Anxiety	Mood and Anxiety Symptom Questionnaire anxious arousal scale
Anxiety	Depression Anxiety and Stress Scale-21 anxiety subscale
Biological	Forced expiratory volume in one second ((FEV1)
Biological	Forced vital capacity (FVC)
Biological	FEV1/FVC
Biological	Lymphocyte concanavalin
Biological	Lymphocyte phytohaemagglutinin
Biological	Interleukin-17
Biological	CD4+ percentage
Biological	CD8+ percentage
Biological	Natural Killer cell percentage
Biological	Cortisol area under the curve with respect to ground
Biological	Cortisol area under the curve with respect to increase from baseline
Biological	Cortisol awakening response
Biological	Heart rate
Biological	Heart rate variability
Cognitive	Conflict effect score
Depression	Beck Depression Inventory
Depression	Patient Health Questionnaire 9
Depression	Depression Anxiety and Stress Scale-21 depression subscale
Depression	Behavioral Activation for Depression Scale
Depression	Beck Depression Inventory -II
Mindfulness	Five Facet Mindfulness Questionnaire total score
Mindfulness	Mindful Attention Awareness Scale
Mindfulness	Five Facet Mindfulness Questionnaire observe subscale
Mindfulness	Five Facet Mindfulness Questionnaire describe subscale
Mindfulness	Five Facet Mindfulness Questionnaire acting with awareness subscale
Mindfulness	Five Facet Mindfulness Questionnaire non-judging subscale
Mindfulness	Five Facet Mindfulness Questionnaire non-reactivity subscale
Phys Health	St George's Respiratory Questionnaire
Phys Health	Short-form McGill Pain Questionnaire
Phys Health	General Fatigue subscale of the Multidimensional Fatigue Inventory
Phys Health	Patient Reported Outcome Measurement Information System fatigue
Phys Health	Post six-minute walk test Borg Dyspnea Scale
Phys Health	Six-minute walk test distance

Phys Health	Memorial Symptom Assessment Scale
Phys Health	Veterans Rand -36 Physical Summary
Phys Health	Pittsburgh Sleep Quality Index
Phys Health	Dyspnea rest visual analog scale
Phys Health	Dyspnea activity visual analog scale
Phys Health	Self-report dyspnea exacerbations
Pos Affect	Positive and Negative Affect Schedule positive mood
Psych Sx	Beck Depression Inventory
Psych Sx	Clinician Anxiety Rating
Psych Sx	Penn State Worry Questionnaire
Psych Sx	Mood and Anxiety Symptom Questionnaire anxious arousal scale
Psych Sx	General Health Questionnaire
Psych Sx	PTSD Checklist - Military
Psych Sx	Patient Health Questionnaire 9
Psych Sx	Clinician Administered PTSD Scale
Psych Sx	PTSD Checklist-5 Re-experiencing
Psych Sx	PTSD Checklist-5 Avoidance
Psych Sx	PTSD Checklist-5 Negative mood/cognition
Psych Sx	PTSD Checklist-5 Hyperarousal
Psych Sx	Depression Anxiety and Stress Scale-21 depression subscale
Psych Sx	Depression Anxiety and Stress Scale-21 anxiety subscale
Psych Sx	Behavioral Activation for Depression Scale
Psych Sx	Posttraumatic Stress Disorder Symptom Scale-Interview
Psych Sx	Veterans Rand-36 Mental Summary
Psych Sx	Perceived Stress Scale
Psych Sx	White Bear Suppression Inventory
Psych Sx	Brunel Mood Scale Anger
Psych Sx	Brunel Mood Scale Dizziness
Psych Sx	Brunel Mood Scale Depression
Psych Sx	Brunel Mood Scale Fatigue
Psych Sx	Brunel Mood Scale Tension
Psych Sx	Brunel Mood Scale Vitality
Psych Sx	Beck Depression Inventory-II
Psych Sx	Positive and Negative Affect Scale negative mood
Psych Sx	Intrusive Thoughts Scale
Psych Sx	Loss of PTSD diagnosis
PTSD	PTSD Checklist - Military
PTSD	Clinician Administered PTSD Scale
PTSD	PTSD Checklist-5 Re-experiencing
PTSD	PTSD Checklist-5 Avoidance

PTSD	PTSD Checklist-5 Negative mood/cognition
PTSD	PTSD Checklist-5 Hyperarousal
PTSD	Posttraumatic Stress Disorder Symptom Scale-Interview
PTSD	Clinician Administered PTSD Scale
PTSD	PTSD Checklist
PTSD	Intrusive Thoughts Scale
PTSD	Loss of PTSD diagnosis
QOL/Function	Short Form 36
QOL/Function	FACIT – Spiritual Well-Being Scale
QOL/Function	Hours of work
QOL/Function	Cognitive Failures Questionnaire
QOL/Function	Short Form Health Survey (SF-12)
QOL/Function	World Health Organization Quality of Life-BREF
QOL/Function	General Perceived Self-Efficacy Scale
QOL/Function	Weeks of work
QOL/Function	Global Impression of Change
SUD	UPPS-P Impulsivity Scale

Note: FACIT = Functional Assessment of Chronic Illness Therapy; Pos affect = positive affect-related measures; Psych Sx = psychological symptoms; Phys Health = physical health outcomes; PTSD = posttraumatic stress disorder; QOL/Function = quality of life or measures of functioning; SUD = substance use disorder-related outcome.

Supplemental Materials Table 7. Intervention completers and dropouts from mindfulness and control interventions

Study	$Comp_{mind}$	$Drop_{mind}$	$Comp_{cont}$	$Drop_{cont}$
Arch 2013	20	25	34	26
Bremner 2017	9	8	8	1
Davis 2015	15	3	14	2
Jasbi 2018	24	0	24	0
King 2016	14	12	9	8
Mularski 2009	20	24	29	13
Niles 2012	13	4	14	2
Polusny 2015	45	13	54	4
Wahbeh 2016a	25	3	25	3

Note: Comp = completers, Drop = dropout. Completer and dropout sample sizes only included from comparisons with interventions (i.e., treatment-as-usual control conditions were excluded).

Supplemental Materials Table 8. Results of moderator tests

Domain	Comparison	Timepoint	$Jadad_b$	$Jadad_p$	$PTSD_b$	$PTSD_p$	$Female_b$	$Female_p$	$Weeks_b$	$Week_p$
PTSD	non-specific	post	0.17	0.541	0.00	.999	-0.05	0.100	0.19	0.201
PTSD	non-specific	fu	-0.19	0.193	-0.40	0.228	0.01	0.617	0.09	0.251
PTSD	specific	post	-0.14	0.476	NA	NA	-0.02	0.416	0.01	0.845
Depression	non-specific	post	0.18	0.422	0.23	0.713	-0.04	0.086	0.11	0.458
Psych Sx	non-specific	post	-0.01	0.975	-0.08	0.824	-0.03	0.129	0.16	0.169
Psych Sx	non-specific	fu	-0.19	0.127	-0.44	0.129	0.01	0.610	0.09	0.191
Psych Sx	specific	post	-0.13	0.433	0.12	0.551	-0.01	0.375	0.00	0.965
QOL/Function	non-specific	post	-0.02	0.869	-0.15	0.542	-0.01	0.674	-0.01	0.852
Mindfulness	non-specific	post	-0.19	0.060	0.11	0.676	0.01	0.687	0.07	0.252
Phys Health	non-specific	post	-0.28	0.236	-0.15	0.860	-0.01	0.906	0.07	0.860

Note: $Jadad_{b/p}$ = meta-regression coefficient and *p*-value for Jadad study quality score; $PTSD_{b/p}$ = meta-regression coefficient and *p*-value for PTSD sample; $Female_{b/p}$ = meta-regression coefficient and *p*-value for percentage female; $Weeks_{b/p}$ = meta-regression coefficient and *p*-value for treatment length in weeks; PTSD = posttraumatic stress disorder; Psych Sx = psychological symptoms; QOL/Function = quality of life or measures of functioning; Phys Health = physical health outcomes; SUD = substance use disorder-related outcome; non-specific = non-specific control conditions not intended to be therapeutic; specific = specific active control conditions; post = pre-post; fu = pre-follow-up.

Supplemental Materials Table 9. Models re-estimated with outliers excluded

Domain	Comparison	Timepoint	ES	ES_{adj}	ES_{change}
PTSD	non-specific	post	0.64 [0.16, 1.12]	0.37 [0.14, 0.61]	0.27
PTSD	non-specific	fu	0.12 [-0.17, 0.41]	0.12 [-0.17, 0.41]	0
PTSD	specific	post	0.25 [0.01, 0.50]	0.25 [0.01, 0.50]	0
Depression	non-specific	post	0.80 [0.42, 1.19]	0.62 [0.39, 0.85]	0.18
Psych Sx	non-specific	post	0.70 [0.38, 1.02]	0.52 [0.35, 0.68]	0.18
Psych Sx	non-specific	fu	0.31 [0.04, 0.57]	0.31 [0.04, 0.57]	0
Psych Sx	specific	post	0.19 [0.00, 0.38]	0.19 [0.00, 0.38]	0
QOL/Function	non-specific	post	0.72 [0.47, 0.97]	0.72 [0.47, 0.97]	0
Mindfulness	non-specific	post	0.32 [0.11, 0.54]	0.32 [0.11, 0.54]	0
Phys Health	non-specific	post	0.38 [-0.19, 0.95]	0.38 [-0.19, 0.95]	0

Note: ES = effect size in Hedges' *g* units; ES_{adj} = adjusted effect size estimate with outliers removed; ES_{change} = change in effect size with outliers removed; PTSD = posttraumatic stress disorder; Psych Sx = psychological symptoms; QOL/Function = quality of life or measures of functioning; Phys Health = physical health outcomes; non-specific = non-specific control conditions not intended to be therapeutic; specific = specific active control conditions; post = pre-post effect; fu = pre-follow-up effect. Values in brackets represent 95% confidence interval.