Received: 17 March 2017 | Revised: 21 March 2018 | Accepted: 28 March 2018

DOI: 10.1002/jclp.22634

WILEY

RESEARCH ARTICLE

A systematic review of randomized trials of mind-body interventions for PTSD

Barbara L. Niles[1] | DeAnna L. Mori[2] | Craig Polizzi[3] | Anica Pless Kaiser[1] | Elizabeth S. Weinstein[3] | Marina Gershkovich[4] | Chenchen Wang[5]

[1]National Center for PTSD and Boston University School of Medicine

[2]VA Boston Healthcare System and Boston University School of Medicine

[3]National Center for PTSD

[4]VA Boston Healthcare System

[5]Center for Complementary and Integrative Medicine at Tufts University School of Medicine

Correspondence
Barbara L. Niles, Ph.D., National Center for PTSD–Behavioral Science Division, VA Boston Healthcare System, 150 South Huntington Avenue (116-B-2), Boston, MA 02130.
Email: barbara.niles@va.gov

This study was supported by the Veterans Administration Clinical Science Research and Development (SPLD-004-15S, Drs. Niles and Mori) and the National Center for Complementary and Integrative Health (NCCIH; K24AT007323, Dr. Wang). The investigators are solely responsible for the contents of the manuscript and they do not represent official views of the U.S. Department of Veterans Affairs, the NCCIH, or the United States Government.

Abstract

Objective To systematically review outcomes from randomized controlled trials (RCTs) of mind–body treatments for PTSD.

Methods Inclusion criteria based on guidelines for assessing risk of bias were used to evaluate articles identified through electronic literature searches.

Results Twenty-two RCTs met inclusion standards. In most of the nine mindfulness and six yoga studies, significant between-group effects were found indicating moderate to large effect size advantages for these treatments. In all seven relaxation RCT's, relaxation was used as a control condition and five studies reported significant between-group differences on relevant PTSD outcomes in favor of the target treatments. However, there were large within-group symptom improvements in the relaxation condition for the majority of studies.

Conclusions Although many studies are limited by methodologic weaknesses, recent studies have increased rigor and, in aggregate, the results for mindfulness, yoga, and relaxation are promising. Recommendations for design of future mind–body trials are offered.

KEYWORDS
mind-body, PTSD, randomized controlled trial, systematic review

1 | INTRODUCTION

Interest in alternatives to conventional medical approaches for psychological and physical maladies has been growing rapidly in recent years. Complementary and integrative (CI) interventions, defined as a set of diverse practices that are not considered a part of conventional medicine (National Center for Complementary and Integrative Health, 2015), may be used in conjunction with or instead of conventional treatment. Furthermore, over one third of U.S. adults

use some form of CI therapy and "mind-body" practices, including deep breathing exercises, meditation, and yoga, to improve their health and wellbeing (Barnes, Bloom, & Nahin, 2008).

PTSD is a debilitating psychological disorder that affects 6% of U.S. adults in their lifetimes (Kessler, Chiu, Demler & Walters, 2005). Within the Veterans Health Administration (VHA), PTSD is the third most prevalent psychiatric diagnosis (Stecker, Fortney, Owen, McGovern, & Williams, 2010). Many individuals with PTSD do not seek conventional mental health services due to stigma and accessibility (Hoge et al., 2004). Moreover, a substantial proportion of those who do seek treatment do not experience relief (Steenkamp, Litz, Hoge, & Marmar, 2015). Empirically supported treatments for PTSD that direct individuals to recall traumatic events in a controlled fashion have been shown to be clinically effective in ameliorating symptoms (Foa, Hembree, & Rothbaum, 2007; Resick, Monson, & Chard, 2007), but a high proportion of individuals with PTSD either drop out of these standard therapies or are not substantially helped by them (Niles et al., 2017; Schottenbauer, Glass, Arnkoff, Tendick, & Gray, 2008; Steenkamp et al., 2015). Thus, other empirically supported treatments are needed to address PTSD symptoms for those who cannot or choose not to engage in the treatments currently available and for those whose symptoms remain after completing treatment.

Feasibility and acceptability of CI interventions for PTSD symptoms have been established by multiple well-conducted nonrandomized pilot studies over the past two decades (e.g., Carter & Byrne, 2004; Dutton, Bermudez, Matas, Majid, & Myers, 2013; Gordon, Staples, Blyta, & Bytyqi, 2004; Kimbrough, Magyari, Langenberg, Chesney, & Berman, 2010; Kearney, McDermott, Malte, Martinez, & Simpson, 2012; Kearney, McDermott, Malte, Martinez, & Simpson, 2013; Rosenthal, Grosswald, Ross, & Rosenthal, 2011; Staples, Hamilton, & Uddo, 2013). These studies also suggested that CI interventions could impact symptoms of PTSD. For example, Kimbrough and colleagues (2010) found that an 8-week mindfulness-based stress reduction (MBSR) program was not only safe and acceptable, but also efficacious in reducing PTSD symptoms for adult survivors of childhood sexual abuse. The participants were highly compliant with both class attendance and home practice and the significant reductions in PTSD symptoms were maintained through the 24-week follow-up.

CI approaches to alleviate symptoms of PTSD appear to be gaining popularity and surveys indicate that 20% of those diagnosed with PTSD and up to 46% of veterans and military personnel use CI modalities to address symptoms (Bystritsky et al., 2012; Davis, Mulvaney-Day, Larson, Hoover, & Mauch, 2014; Libby, Pilver, & Desai, 2013). In VHA, where up to 25% of returning Veterans seeking medical treatment suffer from PTSD (Schell & Marshall, 2008), over 90% of VA specialized PTSD treatment programs offer CI treatments (Libby, Pilver, & Desai, 2012). Stress management/relaxation, progressive muscle relaxation, and guided imagery are the most commonly used treatments in these programs (VA Healthcare Analysis and Information Group, 2011).

Although CI interventions for PTSD have been widely utilized and attracted great interest in recent years, empirical support for these interventions has lagged behind the clinical use. In 2012, the Institute of Medicine called for more research to evaluate the efficacy of these treatments (Institute of Medicine, 2012) and several published reviews of the scientific evidence soon followed (e.g., Banks, Newman, & Saleem, 2015; Kim, Schneider, Kravitz, Mermier, & Burge, 2013; Khusid & Vythilingam, 2016; Wahbeh, Senders, Neuendorf, & Cayton, 2014; Duan-Porter et al. 2016). As a whole these reviews demonstrated encouraging findings, but underscored the scant extant literature to support CI interventions for PTSD.

Given the strong interest in mind–body interventions for PTSD and the proliferation of relevant studies, frequent reviews of the accumulating literature are valuable for guiding treatment offerings and identifying directions for future research. Mindfulness, relaxation, yoga, and tai chi are CI therapies of particular interest due to the ease with which they can be utilized in clinical settings. These four therapies (see Figure 1) require active involvement from the participant, are highly "portable," and have great potential for dissemination because they are typically delivered in group settings with minimal need for equipment. Passive mind–body interventions, such as massage or acupuncture, are a qualitatively distinct group of treatments that require one-on-one attention from a practitioner and may require specialized equipment (e.g., massage table, acupuncture needles).

Meta-analyses are able to combine findings from a number of studies to generate estimates of effect size of the trials as a whole. Three reviews published in the past year examined randomized controlled trials (RCTs) of meditation

Mindfulness is frequently defined as a focused attention on present experiences without judgment (Kabat-Zinn, 1994). Interventions encouraging mindfulness and meditation have been considered the "third wave of behavior therapy" and current research examines the roles state and trait mindfulness may play in the generation and maintenance of symptoms of PTSD (Vujanovic, Youngwirth, Johnson & Zvolensky, 2009; Walser & Westrup, 2007).

Yoga is an integrative practice consisting of physical postures, breathing, and meditation. Yoga has been increasingly used by the public and in clinical settings for a variety of conditions and for general wellbeing (NCCIH, 2013). It may be used to increase present-focused attention and awareness, and cultivate mindfulness and acceptance. Additionally, the breath work component can be used to manage the hyperarousal symptoms of PTSD by improving the regulation of the autonomic nervous system (Moore, Brown, Money & Bates, 2011).

Relaxation therapy includes a variety of techniques including biofeedback training, imagery and visualization, and progressive muscle relaxation (NCCIH, 2016). Relaxation therapy has been well utilized in addressing the arousal symptoms of PTSD for decades and has been included as a key component of several empirically supported treatments for PTSD (Meichenbaum, 1975; Foa & Rothbaum, 2001). Use of relaxation as a stand-alone treatment for PTSD is somewhat rare, however, and relaxation has not received much attention in the clinical research on PTSD.

Tai Chi is a form of martial arts involving the practice of various motion routines and incorporates mindfulness, breathing, active relaxation, and slow movement (NCCIH, 2015). The characteristic slow movement makes it accessible for individuals of all physical health and fitness levels. In addition to physical improvements in flexibility, strength and pain management, Tai Chi has been shown to reduce tension, depression, and anger (Jin, 1989; Wang et al., 2010). Although, Tai Chi has been associated with physiological and psychological benefits, it is often overlooked as an intervention for psychological conditions including PTSD.

FIGURE 1 Definitions of mind–body interventions searched for to include in this review

interventions for PTSD and conducted random effect meta-analyses that included both mindfulness and yoga. The results of these three studies were comparable, indicating effect sizes in the small to medium range for these mind–body interventions. Hopwood and Schutte (2017) included 18 studies in their meta-analysis. The mean weighted Hedges' *g* effect size for this study was –0.44 (95% CI [0.61, –0.27]), which is considered a medium effect (Fritz, Morris, & Richler, 2012).

Gallegos and colleagues (Gallegos, Crean, Pigeon, & Heffner, 2017) examined 19 studies and found a mean weighted Hedges' *g* effect size of –0.39, (95% CI [–0.57, –0.22]), an effect in the small to medium range. After the authors removed one of the studies to reduce heterogeneity, the effect size was slightly diminished but similar and significant (–0.33, 95% CI [–0.45, –0.20]). Using more restrictive inclusion criteria, Hilton and colleagues (2017) examined eight RCTs of meditation focusing on PTSD outcomes: three trials assessed MBSR (either standard or brief), three assessed yoga interventions, and two assessed mantram repetition. The meditation interventions showed significantly greater reductions in PTSD symptoms than the comparison conditions, with a medium effect (standardized mean difference = –0.4, 95% CI [–0.81, –0.01]; Fritz et al., 2012). The authors noted that given the substantial heterogeneity in effect sizes and the mixed quality of the studies, the quality of the evidence for this finding was determined to be low. They concluded that more high quality studies with large samples are needed to fully support these findings.

Another recent meta-analysis focused on the comparison of cognitive-behavioral treatments (CBT) to relaxation across anxiety disorders, and examined whether the relative efficacy of the two types of treatments differed by anxiety disorder (Montero-Marin, Garcia-Campayo, López-Montoyo, Zabaleta-del-Olmo, & Cuijpers, 2017). The overall effect found was small (Hedges' $g = -0.25$, 95% CI [–0.38, –0.13]) and in favor of CBT. There were also some overall differences based on characteristics of relaxation, such as type (e.g., progressive muscle relaxation vs. applied relaxation)

and method of application (self-applied vs. therapist-applied). The authors concluded that CBT had a small advantage overall when compared with relaxation. This review included four studies of PTSD, each of which used relaxation as an active control to compare against a target treatment. The subgroup analysis of the PTSD studies indicated that CBT evidenced significantly greater reductions in symptoms than relaxation, with a medium effect size (Hedges' $g = -0.60$, 95% CI [−0.94, −0.27]). The authors caution that the small number of studies limits the conclusions that can be drawn from these PTSD findings.

The methodologies utilized in published RCTs of mind-body treatments for PTSD are varied in ways that can greatly impact calculations of effect sizes. For example, greater frequency and intensity of treatment (vs. lower dose), completer analyses (vs. intention to treat), and waitlist control groups (vs. active treatment controls) are likely to generate larger effects (Schnurr, 2007). When studies with methodological heterogeneity are combined in meta-analyses, the influences of these factors on overall effect size are unclear. Although subgroup analyses can be used to examine the contributions of these methodological factors, when there are few high quality studies, subgroups may be very small and the subgroup analyses less reliable. Therefore, it can be useful to consider the specific methodologies and characteristics of individual studies.

The current study offers a qualitative review of published mind–body trials may provide a complement to the meta-analyses described above. Each of the RCTs of mindfulness, yoga, tai chi, and relaxation that addressed PTSD symptoms and met a standard for quality and relevance are described and notable study characteristics and findings are highlighted. Additionally, we offer considerations and recommendations for future studies.

2 | METHODS

2.1 | Literature search and eligibility criteria

Electronic literature searches were conducted using PubMed, Published International Literature on Traumatic Stress (PILOTS) and four EBSCO databases (Psychology and Behavioral Sciences Collection, PsycINFO, PsycARTICLES, and SocINDEX). In order to capture all randomized controlled trials that were related to mindfulness, yoga, tai chi, and relaxation, the following mind–body therapy search terms were used: mindfulness, yoga, qigong, qi gong, chi kung, chikung, tai ji, tai chi, relaxation, relaxation therapy, progressive muscle relaxation, breathing exercises, meditation, transcendental meditation, mental healing, faith healing, spiritual healing, prayer, imagery, and guided imagery. The PTSD search terms were as follows: posttraumatic, post traumatic, PTSD, combat stress, soldier, warrior, veteran, and combat. The randomized controlled trial search terms were as follows: randomized controlled trial, randomized, and controlled clinical trial. RCTs conducted on adult populations and published in English between January 1985 and January 2018 were selected. Studies that examined mindfulness, yoga, tai chi, or relaxation as an intervention for PTSD and compared outcomes to an intervention or control group were eligible.

Mind–body interventions are often multi-dimensional and can differ widely. As there can be substantial similarities across categories and substantial variability within a given category, delineation of categories is difficult and definitions and groupings in the mind–body literature have been inconsistent. Many cognitive and behavioral therapies include components of breathing retraining, mindfulness, or relaxation. In order to narrow the focus of this review to treatments based primarily on mind–body components, treatments that utilized mind–body techniques in conjunction with or as a part of other more traditional "talk" psychotherapies were excluded from this review (e.g., relaxation used in Prolonged Exposure Therapy, mindfulness used in Mindfulness Based Cognitive Therapy or Mindfulness Based Exposure Therapy).

For the current review, we used the following decision rules to determine categories: (1) Interventions were considered to be mindfulness if the treatment included some type of meditation and focus on the present moment but were not labeled as yoga or tai chi; (2) Interventions were considered to be yoga if the study investigators labeled them as yoga and the majority of the intervention could be classified under at least one of Patanjali's eight limbs of yoga (Iyengar, 1979); (3) The relaxation category was limited to interventions that focused on encouraging relaxation of the mind and/or body with no explicit focus on present-moment awareness, stretching, or postures.

2.2 | Risk of bias assessment

Based on PRISMA guidelines (Liberati et al., 2009), the following "risk of bias" inclusion criteria were chosen to determine the quality and relevance of the identified articles: (1) study aims that include evaluation of treatment efficacy for PTSD outcomes; (2) eligibility criteria explicitly included a minimal level of symptoms of PTSD or a diagnosis of PTSD; (3) random assignment of individuals to groups; (4) interventions adequately developed and described; (5) valid quantitative outcome measurements; (6) appropriate statistical methods; (7) dropout rates reported; and (8) conclusions supported by findings. For each study included in the systematic review (see Table 1), two investigators independently determined that the eight criteria described above were met. Additional study characteristics that were considered and used to highlight studies of highest quality include: sample size, use of a credible control intervention, use of blinded assessors, evaluation of treatment fidelity, use of intent to treat (ITT) analyses, reporting of within- and between-group effect sizes, and inclusion of follow-up assessments.

3 | RESULTS

Twenty-two full-text articles met inclusion criteria and were included for critical review. No RCTs examining tai chi or qi gong for PTSD met the above inclusion criteria. Table 1 provides findings from the studies that met criteria for inclusion and each study is reviewed in text below. Figure 2 illustrates the study flow, number of studies screened, and reasons for exclusion.

3.1 | Mindfulness

Two of the nine mindfulness studies identified evaluated mantram repetition with veteran participants (Bormann, Thorp, Wetherell, & Golshan, 2008; Bormann, Thorp, Wetherell, Golshan, & Lang, 2013). This meditation-based group treatment teaches tools for training attention and regulating emotion, including the silent repetition of a word or phrase called a mantram. The initial feasibility study (Bormann et al., 2008) used a delayed treatment control and found large between-group effects. The second, larger trial (Bormann et al., 2013) used a treatment-as-usual control. Between-group effect sizes on both clinician-assessed and self-reported PTSD symptoms were small in the second trial, although it is notable that the mantram repetition group showed additional reductions in clinician-assessed symptoms during the 6-week follow-up period, suggesting continued improvement following the intervention. Furthermore, the proportion of participants who showed clinically meaningful change in clinician-assessed PTSD symptoms was significantly higher in the mantram repetition group (24%) than in the control (12%).

MBSR was compared to treatment as usual in a study of veterans with PTSD (Kearney et al., 2013). No reliable between-groups effects on PTSD symptoms were found using ITT or completer analyses and there were no differences in the proportion of participants who achieved clinically significant changes in PTSD symptoms. However, a large within-group effect on PTSD symptoms was reported in the mindfulness condition.

In contrast, in a small study of veterans with PTSD that examined changes in brain regions associated with PTSD, Bremner and colleagues (2017) found MBSR was superior to present-centered group therapy in reducing symptoms of PTSD. In addition, the robust changes persisted through the 6-month follow-up. However, the study utilized completer analyses and dropout was high; only 52% of the participants assigned to MBSR completed the treatment, compared to 89% assigned to present centered therapy.

Kim, Schneider, Bevans et al. (2013) delivered 16 sessions of mindfulness-based stretching and deep breathing to Intensive Care Unit nurses with sub-clinical symptoms of PTSD. In this small study, between-groups ITT analyses indicated that those randomized to the mindfulness condition showed a greater decline in self-reported PTSD symptoms than those in the waitlist control; symptom reductions were maintained at the 8-week follow-up.

A study with veteran participants examined a very brief (3.5 hours total) mindfulness intervention that was partially delivered via telephone and compared to a psychoeducation intervention of equal length (Niles et al., 2012). Completer analyses found large between-group effects on both clinician-assessed and self-reported PTSD symptoms as well as a

TABLE 1 Randomized controlled trials of mindfulness, yoga, and relaxation for posttraumatic stress disorder

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
MINDFULNESS (9 ARTICLES)					
Bormann et al. (2008)	Veterans with PTSD *N* = 33 Mean age = 56 (0% women)	Mantram Repetition (MR) Randomized: *n* = 14 Completed: *n* = 14 (6 weekly 90-min group sessions)	Delayed-Intervention Control Group (DI) Randomized: *n* = 15 Completed: *n* = 15	CAPS; PCL (BSI-I8; FACIT-SpEx4; MAAS; Q-LES-Q: SF; STAXI-2)	Between Groups: CAPS: MR vs DI ($d = 0.33$) PCL: MR vs DI ($d = 0.72$) Within Group: CAPS (NR) PCL ($d = 0.70$)
Bormann et al. (2013)	Veterans with PTSD *N* = 146 Mean age = 57 (3% women)	Mantram Repetition Program (MR) + Treatment-As-Usual Randomized: *n* = 71 Completed: *n* = 66 (6 weekly 90-min group sessions)	Treatment-As-Usual (TAU) Randomized: *n* = 75 Completed: *n* = 70	CAPS; PCL (BSI-18; FACIT-Sp;SF-12)	Between Groups: CAPS: MR vs TAU ($\eta_p^2 = 0.03^b$) PCL: MR vs TAU ($\eta_p^2 = 0.03^b$) Within Group: CAPS (NR) PCL (NR)
Bremner et al. (2017)	Veterans with PTSD *N* = 26 Mean age = 34 (0% women)	Mindfulness-Based Stress Reduction (MBSR) (8 weekly 2.5-hr group sessions plus 6-hr group session) Randomized: *n* = 17 Completed: *n* = 9	Present-Centered Group Therapy (PCGT) Randomized: *n* = 9 Completed: *n* = 8	CAPS (SCID-IV; FFMQ; FACIT-Sp)	Between Groups: CAPS (NR) MBSR vs PCGT Within Group: CAPS (NR)
Kearney et al. (2013)	Veterans with PTSD *N* = 47 Mean age = 52 (21.3% women)	Mindfulness-Based Stress Reduction + Treatment-As-Usual (MBSR) Randomized: *n* = 25 Completed: *n* = 21 (8 weekly 2.5-hr group sessions plus 7-hr group session)	Treatment-As-Usual (TAU) Randomized: *n* = 22 Completed: *n* = 21	PCL-C (BADS; FFMQ; PHQ-9; SF-8)	Between Groups: PCL-C: MBSR vs TAU ($d = 0.51$) Within Group: PCL-C ($d = 0.63$)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
Kelly and Garland (2016)	Female Survivors of IPV *N* = 45 Mean age = 41.5 (100% women)	Trauma Informed-Mindfulness-Based Stress Reduction (TI-MBSR) Randomized: *n* = 24 Completed: *n* = 20 (8 weekly 2-2.5-hr group sessions)	Wait-List Control Group (WL) Randomized: *n* = 21 Completed: *n* = 19	PCL-C (BDI-II; RSQ)	Between Groups: PCL-C: TI-MBSR vs WL ($d = 0.94$)[b] Within Group: PCL-C (NR)
Kim, Schneider, Bevans et al. (2013)	Intensive care unit nurses *N* = 29 Mean age = 45.7 (96.6% women)	Mindfulness-Based Stretching and Deep Breathing Randomized: *n* = 11 Completed: *n* = 11 (16 twice-weekly 60-min group sessions)	Wait-List Control Group Randomized: *n* = 11 Completed: *n* = 10 Non-PTSD Group Randomized: *n* = 7 Completed: *n* = 7	PCL-C (Plasma ACTH; Serum Cortisol; Serum DHEAS)	Between Groups: PCL-C (NR) Within Group: PCL-C (NR)
Niles et al. (2012)	Veterans with PTSD *N* = 33 Age range = 52.0 (0% women)	Telehealth Mindfulness (TM) Randomized: *n* = 17 Completed: *n* = 16 (2 in-person 45-min sessions and 6 weekly 20-min telephone sessions)	Telehealth Psychoeducation (TP) Randomized: *n* = 16 Completed: *n* = 14 (2 in-person 45-minute sessions and 6 weekly 20-min telephone sessions)	CAPS; PCL-M	Between Groups: CAPS: TM vs TP ($\eta_p^2 = 0.183$[b]) PCL-M: TM vs TP ($\eta_p^2 = 0.303$[b]) Within Group: CAPS ($\eta_p^2 = 0.502$[b]) PCL-M ($\eta_p^2 = 0.556$[b])
Polusny et al. (2015)	Veterans with PTSD N = 116 Mean age = 58.5 (16% women)	Mindfulness-Based Stress Reduction (MBSR) Randomized: *n* = 58 Completed: *n* = 47 (8 weekly 2.5-hr group sessions and a 6.5-hr retreat)	Present-Centered Therapy (PCT) Randomized: *n* = 58 Completed: *n* = 57 (9 weekly 1.5-hr group sessions)	CAPS; PCL (CEQ; FFMQ; LEC; PHQ-9; WHOQoL-BRIEF)	Between Groups: CAPS: MBSR vs PCT ($d = 0.41$[b]) PCL: MBSR vs PCT ($d = 0.40$[b]) Within Group: CAPS (NR) PCL (NR)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
Possemato et al. (2016)	VA primary care patients with symptoms of PTSD *N* = 62 Mean age = 46.4 (12.9% women)	Primary Care Brief Mindfulness Training (PCBMT) Randomized: *n* = 36 Completed: *n* = 16 (4 weekly 1.5-hr group sessions)	Primary Care Treatment As Usual (PCTAU) Randomized: *n* = 26 Completed: *n* = 24	CAPS; PCL-S (PHQ-9; MAAS; FFMQ)	Between Groups: CAPS: PCBMT vs PCTAU ($d = 0.24$) PCL-S: PCBMT vs PCTAU ($d = 0.26$) Within Group: CAPS (NR) PCL-S (NR)
YOGA (6 ARTICLES)					
Carter et al. (2013)	Vietnam veterans with PTSD *N* = 50 Mean age = 58.5 (0% women)	Sudarshan Kriya Yoga (Y) Randomized: *n* = 16 Completed: *n* = 14 (22-hr group sessions over 5 days plus 9 2-hr follow-up sessions)	Delayed-Intervention Control Group (DI) Randomized: *n* = 15 Completed: *n* = 11	CAPS; PCL-M (AUDIT; CES-D; MINI-Plus; WHOQoL-BRIEF)	Between Groups: CAPS: Y vs DI ($\eta_p^2 = 0.17$[b]) PCL-M: Y vs DI ($\eta_p^2 = 0.41$[b]) Within Group: CAPS ($d = 0.90$[b]) PCL-M (NR) DI after intervention: CAPS ($d = 1.20$[b]) PCL-M (NR)
Jindani et al. (2015)	Individuals with PTSD *N* = 80 Median age = 41 (88.8% women)	Kundalini Yoga (Y) Randomized: *n* = 59 Completed: *n* = 29 (8 weekly 90-min group sessions)	Wait-List Control Group (WL) Randomized: *n* = 21 Completed: *n* = 21	PCL-17 (RS; PANAS; FFMQ; ISI; PSS; DASS 21)	Between Groups: PCL-17: Y vs WL ($\eta_p^2 = 0.25$[b]) Within Group: PCL-17 (NR)
Mitchell et al. (2014)	Individuals with PTSD (veterans and civilians) *N* = 38 Mean age = 44.4 (100% women)	Kripalu Yoga (Y) Randomized: *n* = 20 Completed: *n* = 14 (12 75-min group sessions option for weekly or twice-weekly)	Assessment Control Group (ACG) Randomized: *n* = 18 Completed: *n* = 12 (12 weeks)	PCL-C (PSS-I; TLEQ; CES-D; STAI)	Between Groups: PCL-C: Y vs ACG (0.20)[a] Within Group: PCL-C (NR)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
Reinhardt et al. (2017)	Active duty personnel and veterans with PTSD *N* = 51 Mean age = 47.76 (11.8% female)	Kripalu Yoga (Y) Randomized: *n* = 26 Completed: *n* = 10 (20 twice weekly 90-min group sessions)	Assessment Control Group (ACG) Randomized: *n* = 25 Completed: *n* = 21 (10 weeks)	CAPS; IES; PCL-M	Between Groups: CAPS past week: Y vs ACG (= 0.00) CAPS past month: Y vs ACG ($\eta^2 = 0.01$) IES: Y vs ACG ($\eta^2 = 0.01$) PCL-M: Y vs ACG ($\eta^2 = 0.02$)Within Groups: CAPS (NR) IES (NR) PCL-M (NR)
Seppala et al. (2014)	OEF/OIF Veterans with PTSD *N* = 21 Mean age = 28.65 (0% women)	Sudarshan Kriya Yoga (Y) Randomized: *n* = 11 Completed: *n* = 10 (7 daily 3-hr group sessions)	Wait-List Control Group (WL) Randomized: *n* = 10 Completed: *n* = 9	PCL-M (MASQ)	Between Groups: PCL-M: Y vs WL ($d = 1.16$) Within Group: PCL-M (NR)
Van der Kolk et al. (2014)	Individuals with chronic, treatment-resistant PTSD *N* = 64 Mean age = 42.9 (100% women)	Trauma-Informed Hatha Yoga (Y) Randomized: *n* = 32 Completed: *n* = 31 (10 weekly 60-min group sessions)	Supportive Women's Health Education (SWHE) Randomized: *n* = 32 Completed: *n* = 29 (10 weekly 60-min group sessions)	CAPS; DTS (SCID-IV; BDI; IASC)	Between Groups: CAPS: Y vs SWHE ($d = 0.41^b$) DTS: Y vs SWHE ($d = 0.34^b$) Within Group: CAPS ($d = 1.07^b$) DTS ($d = 0.52^b$)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
RELAXATION (7 ARTICLES)					
Carletto et al. (2016)	Patients with MS diagnosed with PTSD *N* = 50 Mean age = 40.1 (81% women)	Relaxation Therapy Randomized: *n* = 25 Completed: *n* = 22 (10 60-min sessions conducted over 12–15 weeks)	EMDR Randomized: *n* = 25 Completed: *n* = 20 (10 60-min sessions conducted over 12–15 weeks)	CAPS; IES-R; (SCID-IV; HADS; CMDI; FAMS; TAQ; FSS; EDSS)	Between Groups: CAPS: R vs. EMDR (NS and NR) IES-R: R vs. EMDR (NS) (η_p^2 = NR) Within Group: CAPS (NR) IES-R (NR)
Hinton et al. (2011)	Latino patients with treatment-resistant PTSD *N* = 24 Mean age = 49.5 (100% women)	Applied Muscle Relaxation Randomized: *n* = 12 Completed: *n* = 12 (14 weekly 60-min group sessions)	Culturally-Adapted Cognitive Behavioral Therapy Randomized: *n* = 12 Completed: *n* = 12 (14 weekly 60-min group sessions)	PCL-C (Emotion Regulation Scale; Nervios Scale; SCL-90-R)	Between Groups: PCL-C: AMR vs. <u>CA- CBT</u> (*d* = 1.6) Within Group:PCL-C (*d* = 0.80)
Markowitz et al. (2015)	Individuals with PTSD *N* = 110 Mean age = 40.10 (70% women)	Relaxation Therapy Randomized: *n* = 32 Completed: *n* = 21 (10 90-min group sessions over 14 weeks)	Prolonged Exposure Randomized: *n* = 38 Completed: *n* = 27 (10 90-min group sessions over 14 weeks) Interpersonal Psychotherapy Randomized: *n* = 40 Completed: *n* = 34 (14 weekly 50-min group sessions)	CAPS; PSS-SR (IIP; Q-LES-Q; SAS-SR; Self-initiated In Vivo Exposure Scale)	Between Groups: CAPS: RT vs <u>PE</u> (NR) RT vs IPT (NS) (NR) PSS-SR: RT vs <u>PE</u>, RT vs <u>IPT</u> (NR) Within Group: CAPS (*d* = 1.32) PSS-SR (*d* = 0.71)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
Marks et al. (1998)	Individuals with PTSD *N* = 87 Mean age = 38 (35.6% women)	Relaxation Randomized: *n* = 21 Completed: *n* = 20 (10 90-min sessions)	Prolonged Exposure Randomized: *n* = 23 Completed: *n* = 20 Cognitive Restructuring Randomized: *n* = 19 Completed: *n* = 18 (10 90-min individual sessions) Exposure + Cognitive Restructuring Randomized: *n* = 24 Completed: *n* = 19 (10 105-min sessions)	CAPS; IES; PTSDSS (BDI; Fear Questionnaire; GHQ; STAI)	Between Groups: CAPS: R vs. PE ± C ± EC (NR) IES: R vs. PE ± C ± EC (NR) PTSDSS R vs. PE ± C ± EC (NR) Within Group: CAPS (*d* = 0.60) IES (*d* = 0.08) PTSDSS (NR)
Taylor et al. (2003)	Individuals with PTSD *N* = 60 Mean age = 37 (75% women)	Relaxation Training Randomized: *n* = 19 Completed: *n* = 15 (8 1 hr sessions)	Prolonged Exposure Randomized: *n* = 22 Completed: *n* = 15 EMDR Randomized: *n* = 19 Completed: *n* = 15 (All interventions: 8 1.5 hr sessions)	CAPS; PTSDSS (SCID-IV; BDI; RTQ)	Between Groups: R vs. PE vs. EMDR (NS) CAPS (NR)PTSDSS (NR) Within Group: CAPS ($\eta^2 > 0.47^b$)PTSDSS (NR)
Vaughan et al. (1994)	Individuals with PTSD *N* = 36 Mean age = 32 (63.9% women)	Applied Muscle Relaxation Randomized: *n* = 11 Completed: *n* = 11 (3-5 50 min sessions over 2–3 weeks)	Waitlist Control Group Randomized: *n* = 17 Completed: *n* = 17 EMD Randomized: *n* = 12 Completed: *n* = 12 Image Habituation Training Randomized: *n* = 13 Completed: *n* = 13 (Both interventions: 3-5 50 min sessions over 2–3 weeks)	IES; SI-PTSD (ADIS-R; HRSD; STAI; BDI)	Between Groups: SI-PTSD: R vs. W vs. IHT (NS and NR) IES: R vs. W vs. IHT (NR) Within Group: SI-PTSD (NR) IES (NR)

(Continues)

TABLE 1 (Continued)

Source	Population *N* = enrolled Age (% women)	Mind–body intervention(s) *n* (frequency and duration)	Comparison intervention(s) *n* (frequency and duration)	PTSD outcome measures (additional measures)	Pre- to post-effect sizes (underlined treatment indicates greater symptom reductions)
Zucker et al. (2009)	Individuals in residential substance use treatment with PTSD symptoms *N* = 50 Age range = 18–60 (44.7% women)	Progressive Muscle Relaxation Randomized: *n* = NR Completed: *n* = 19 (At least 20-min daily for 4 weeks)	Respiratory Sinus Arrhythmia Biofeedback Randomized: *n* = NR Completed: *n* = 19 (At least 20-min daily for 4 weeks)	PCL-C; PTS-T scale from DAPS (BDI; ISI; SDNN; Substance Cravings Question)	Between Groups: PCL-C: PMR vs. RSA (NS and NR) PTS-T: PMR vs. RSA (NS and NR) Within Group: PCL-C (NR) PTS-T (NR)

Note. Cohen's *d* effect sizes: small = 0.1–0.3; moderate = 0.3–0.5; large ≥ 0.5.

Eta squared and partial eta squared effect sizes: small = 0.01–0.06; moderate = 0.06–0.15; large ≥ 0.15.

[a]Finegold's formula for effect size which is analogous to Cohen's *d*

[b]Indicates significance at $p < .05$

Key: ACG, assessment control group; AMR, applied muscle relaxation; C, cognitive restructuring; CA-CBT, culturally-adapted cognitive behavioral therapy; DI, delayed intervention; EC, prolonged exposure and cognitive restructuring; EMD, eye movement desensitization; EMDR, eye movement desensitization and reprocessing; IHT, image habituation training; IPV, interpersonal violence; MBSR, mindfulness-based stress reduction; MR, mantram repetition; MS, multiple sclerosis; NR, not reported; NS, not significant; OEF, Operation Enduring Freedom; OIF, Operation Iraqi Freedom; PCT, present-centered therapy; PCGT, present-centered group therapy; PCBMT, primary care brief mindfulness training; PCTAU, primary care treatment as usual; PE, prolonged exposure; PMR, progressive muscle relaxation; PTSD, posttraumatic stress disorder; RSA, respiratory sinus arrhythmia biofeedback; R/RT, relaxation/relaxation training; SWHE, Supportive Women's Health Education; TAU, treatment-as-usual; TM, telehealth mindfulness; TP, telehealth psychoeducation; VA, Veteran Affairs; WL, wait-list; Y, yoga;.

Measures: ADIS-R, Anxiety Disorders Interview Schedule-Revised; AUDIT, Alcohol Use Disorders Identification Test; BADS, Behavioral Activation for Depression Scale; BDI, Beck Depression Inventory; BSI, Brief Symptom Inventory; CAPS, Clinician Administered PTSD Scale; CEQ, Credibility/Expectancy Questionnaire; CES-D, Center for Epidemiological Studies-Depression Scale; CMDI, Chicago Multiscale Depression Inventory; DASS 21, Depression, Anxiety, and Stress Scale; DAPS, Detailed Assessment of Posttraumatic States; DTS, Davidson Trauma Scale; EDSS, Expanded Disability Status Scale; FACIT-Sp, Functional Assessment of Chronic Illness Therapy-Spiritual Well-being Scale; FACIT-SpEx4, Functional Assessment of Chronic Illness Therapy-Spirituality-Expanded; FAMS, Functional Assessment of Quality of Life in Multiple Sclerosis; FFMQ, Five Facet Mindfulness Questionnaire; FSS, Fatigue Severity Scale; GHQ, General Health Questionnaire; HADS, Hospital Anxiety and Depression Scale; IAS, Inventory of Altered Self-Capacities; IES, Impact of Events Scale; IES-R, Impact of Events Scale-Revised; IIP, Inventory of Interpersonal Problems; ISI, Insomnia Severity Index; LEC, Life Events Checklist; MAAS, Mindfulness Attention Awareness Scale; MASQ, Mood and Anxiety Symptoms Questionnaire; MINI, Mini International Neuropsychiatric Interview; PANAS, Positive and Negative Affect Schedule; PCL, PTSD Checklist; PCL-C, PTSD Checklist-Civilian; PCL-M, PSTD Checklist-Military; PCL-S, PTSD Checklist-Specific; PCL-17, PTSD Checklist 17 Item Self Report; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; PTSDSS, PTSD Symptoms Scale; PSS-I, PTSD Symptom Scale-Interview; PSS-SR, Posttraumatic Stress Scale-Self Report; PTS-T, Posttraumatic Stress-Total on the Detailed Assessment of Posttraumatic States; Q-LES-Q, Quality of Life Enjoyment and Satisfaction; Q-LES-Q: SF, Quality of Life Enjoyment and Satisfaction: Short Form; RS, Resilience Scale; RTQ, Reactions to Treatment Questionnaire; SAS-SR, Social Adjustment Scale-Self Report; SCID-IV, Structured Clinical Interview for DSM-IV; SCL, Symptom Checklist; SDNN, Standard Deviation of Normal-to Normal;SF, Health Survey Short Form; SI-PTSD, PTSD Structured Interview;STAI, State-Trait Anxiety Inventory; STAXI, State-Trait Anger Expression Inventory; TAQ, Trauma Antecedent Questionnaire;TLEQ, Traumatic Life Events Questionnaire; WHOQoL, World Health Organization's Quality of Life Inventory.

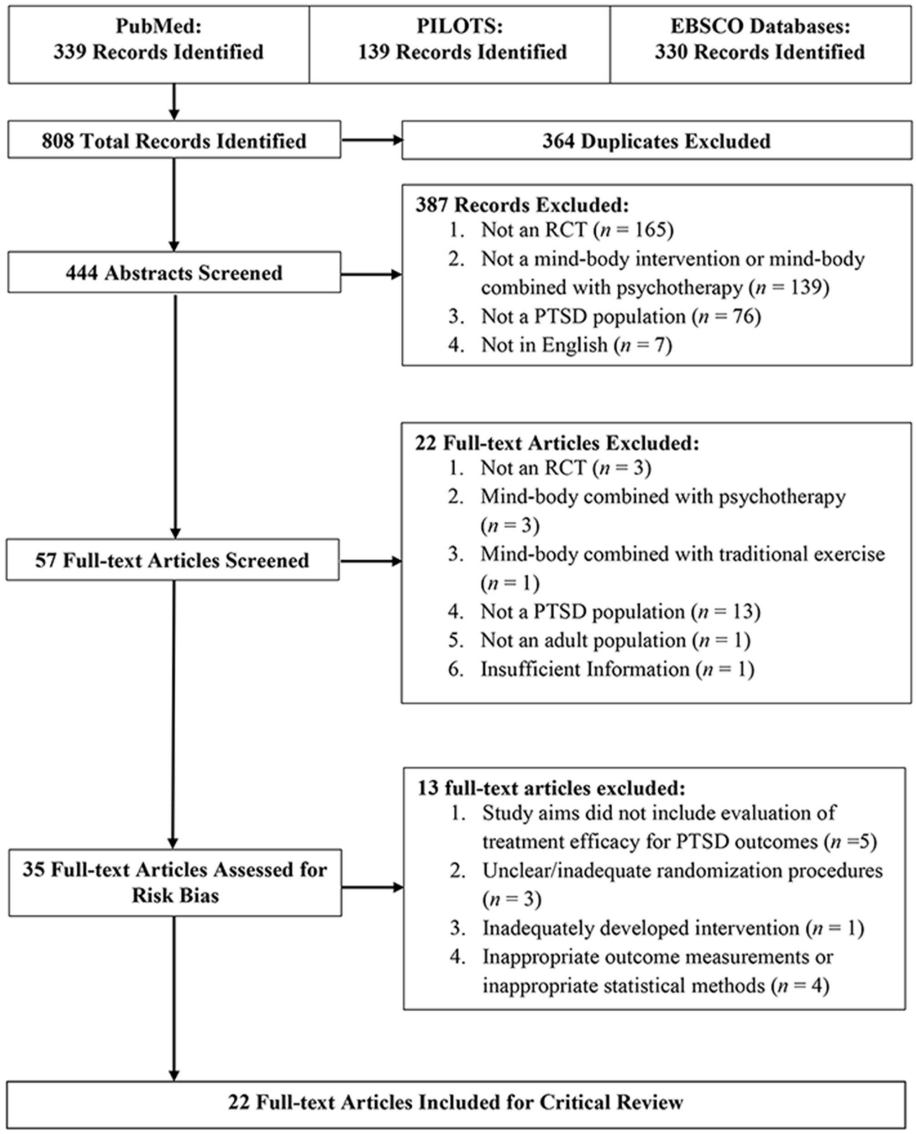

FIGURE 2 Article selection process

significant difference between groups in the proportion of participants who achieved clinically significant change in self-reported symptoms (54% for mindfulness and 8% for psychoeducation). However, symptoms returned to baseline and the two groups did not differ significantly at the 6-week follow-up.

Primary care was the setting for a recent trial comparing four-sessions of mindfulness training to treatment as usual for veterans with symptoms of PTSD (Possemato et al., 2016). The authors found no differences between the two groups using ITT analyses and attributed this to the large proportion of veterans who did not attend even one mindfulness session (44.44%). Of the completers, the authors reported significant difference between group effects and medium to large differences between group effect sizes; most of the participants who completed the mindfulness condition (75%) experienced a clinically significant change in symptoms in either clinician-assessed or self-reported PTSD. The effect size and clinically significant changes were maintained at the 8-week follow-up.

A study conducted by Kelly and Garland (2016) randomized 45 female survivors of Interpersonal Violence (IPV) into either an 8-week trauma informed MBSR (TI-MBSR) program or a waitlist control. Using ITT analyses, it was found

that participants in the TI-MBSR condition experienced a significant reduction in their self-reported posttraumatic stress symptoms when compared to the waitlist control. In addition, a large effect size was found for TI-MBSR on PTSD symptoms. Furthermore, at posttreatment there was a significant reduction in the proportion of participants whose PCL-C scores met the diagnostic cutoff for PTSD in the TI-MBSR group, but not in the waitlist control group. Treatment retention was also very high for TI-MBSR with 95% attending at least five of the eight sessions.

A recent trial by Polusny and colleagues (2015) compared MBSR to present-centered therapy (PCT) for veterans and found that both self-reported and clinician-assessed PTSD symptoms declined in both groups. Improvement in the MBSR group was significantly greater than in the present-centered group in both self-reported and clinician-assessed PTSD, and participants in the MBSR condition were more likely than those in PCT to experience clinically significant change in self-reported PTSD at the 2-month follow-up. However, there were no significant differences between the two groups in rates of diagnostic remission. Of note, the treatment dropout at follow-up was substantially higher in the MBSR group (22.4%) than in the present-centered group (6.9%). Some important strengths of this study are the large sample, use of an active control group, assessment of treatment fidelity, and use of ITT analyses. However, a significant limitation of this study is that there was a substantial difference in treatment dosage between those in the experimental MBSR (26.5 hours) and active control (13.5 hours). In addition, those in the MBSR condition were encouraged to engage in home practice, while those in the present centered therapy condition were not given assignments to do outside of group. This large difference in treatment exposure may have contributed to the results that favored the MBSR group.

The nine mindfulness studies differed substantially from one another in terms of methodology. Almost all examined predominantly male veteran outpatient populations, although two studied predominantly examined female populations (Kelly & Garland, 2016; Kim, Schneider, Bevans, et al., 2013). Three studies (Bremner et al., 2017; Niles et al., 2012; Polusny et al., 2015) utilized an active treatment control and the others used a waitlist or treatment-as-usual control condition. Most studies utilized rigorous ITT analyses, but three studies (Bormann et al., 2008; Bremner et al., 2017; Niles et al., 2012) conducted completer analyses only. All but two studies (Bormann et al., 2008; Kelly & Garland, 2016) included a follow-up assessment. The range of total treatment hours was very wide, from 3.5 hours (Niles et al., 2012) to 27 hours (Kearney et al., 2013; Polusny et al., 2015). Two studies used samples of over 100 participants (Bormann et al., 2013; Polusny et al., 2015), whereas the remainder used smaller samples of fewer than 65. Eight studies employed an in-person group session format whereas one (Niles et al., 2012) employed an individual telehealth format.

Seven of the mindfulness studies, (all but Kearney et al., 2013; Possemato et al., 2016), indicated reductions in PTSD symptoms from pre- to posttreatment for the mindfulness condition when compared to the control. The between-groups effect sizes ranged from small and nonsignificant (Bormann et al., 2013; Possemato et al., 2016) to large (Bormann et al., 2008; Niles et al., 2012). Within-group effect sizes, when reported, were uniformly large, (Bormann et al., 2008; Kearney et al., 2013; Niles et al., 2012) which suggests that mindfulness can have a considerable impact on PTSD symptoms. Although dropouts during treatment were below 25% for most studies, dropout was quite high in the small Bremner et al. (2017) study focused on brain changes (47.06%). In addition, nonattendance at the first session was high in the study conducted in a primary care setting (44.44%; Possemato et al., 2016). Five studies (Bormann et al., 2013; Bremner et al., 2017; Kim, Schneider, Bevans et al., 2013; Polusny et al., 2015; Possemato et al., 2016) reported that treatment gains were largely maintained or improved over the 6-week to 6-month follow-up period; the Niles et al. (2012) study reported that PTSD symptom reductions were not maintained and suggested this may be due to the low dose of 3.5 hours of the intervention. In general, mindfulness interventions are accessible and feasible, associated with reductions in PTSD symptoms, and can be delivered individually, in a group, through a telehealth format, in a primary care setting, or at a mental health clinic.

3.2 | Yoga

Six studies of yoga met the inclusion criteria. An Australian study by Carter and colleagues (2013) examined an intensive yoga intervention that consisted of 22 hours of guided group yoga instruction over 5 days followed by nine

2-hour follow-up sessions. Completer analyses showed significant decreases in both clinician-assessed and self-reported PTSD 6 weeks following intervention completion, whereas the waitlist group had no decline; the between-group effect sizes were large. Furthermore, following the delayed yoga intervention, the waitlist group also improved significantly on clinician-assessed PTSD with large within-group effect sizes.

Mitchell and colleagues (2014) completed a pilot study with women using a less intensive yoga intervention and a more active control condition. The 12-session yoga condition was compared to a 12-session assessment control condition in which the participants completed questionnaires in a group format. ITT analyses showed that there was a significant drop in self-reported PTSD symptoms over time, but that there was no significant difference between the groups indicating no advantage for yoga over group assessment. Within-group analyses indicated that PTSD symptoms decreased significantly for the yoga group. Improvements in self-reported PTSD symptoms were maintained at the 1 month follow-up assessment for both groups.

In another pilot study designed to investigate if yoga can reduce PTSD symptomology and improve overall wellness, a predominantly female (89%) group of participants were randomized to either 8 weekly sessions of Kundalini yoga or a waitlist control group (Jindani, Turner, & Khalsa, 2015). Using completer analyses, the posttreatment assessment indicated that those who received yoga had significantly greater reductions in self-reported PTSD than the waitlist control, with a small to moderate effect size. The differential dropout rate was notable as all participants in the control group completed the study while more than half (51%) dropped out of the yoga condition and did not complete the study.

Significant and lasting benefits were noted following a short period of time in a small study that examined Sudarshan Kriya yoga, a breathing-based meditation. Seppälä and colleagues (2014) provided 3-hour group sessions daily for 7 days to recently returning veterans and compared outcomes to a waitlist control. ITT analyses indicated that participants in the yoga group experienced a significant reduction in self-reported PTSD symptoms with large between-group effect sizes, with the strongest effect on the hyperarousal and reexperiencing symptoms. The symptom reductions were maintained at 1 month and 1 year follow-up.

Van der Kolk and colleagues (2014) compared a 10-week trauma-informed yoga intervention to a health education control group. ITT analyses indicated that both groups showed significant reductions in clinician-assessed PTSD, but the yoga group exhibited larger decreases than the control group with a moderate between-group effect size. Both groups also experienced significant decreases in self-reported PTSD symptoms mid-treatment; however, the gains were maintained in the yoga group at posttreatment whereas symptoms worsened in the control group. Within-group analyses of the yoga group indicated that the effect sizes were large for both clinician-assessed and self-reported PTSD symptom reductions. A significantly higher proportion of participants in the yoga group (53%) fell below the diagnostic cutoff for PTSD diagnosis after treatment compared to 21% in the control group.

Reinhardt and colleagues (2017) compared a 10-week Kripalu-based yoga intervention to an assessment-only control group in a recent study. Completer analyses indicated that both groups showed nonsignificant reductions in clinician-assessed PTSD symptoms. Self-reported PTSD symptoms decreased in the yoga group and increased in the control group, however, these findings were nonsignificant with small between-group effect sizes. Notably, treatment dropout was unusually high in this study, with 62% of participants in the yoga group withdrawing from the study.

Two of the yoga studies had only female participants (Mitchell et al., 2014; Van der Kolk et al., 2014), one had a mostly female group of participants (88.8%; Jindani et al., 2015), one had a mostly male sample (88.2%; Reinhardt et al., 2017), and the other two had only male participants (Carter et al., 2013; Seppälä et al., 2014). Treatment dropout was variable across studies, ranging from 1.6% (Van der Kolk et al., 2014) to 62% (Reinhardt et al., 2017). Three studies employed ITT analyses (Mitchell et al., 2014; Seppälä et al., 2014; Van der Kolk et al., 2014) and three used completer analyses (Carter et al., 2013; Jindani et al., 2015; Reinhardt et al., 2017). All but two studies (Reinhardt et al., 2017; Van der Kolk et al., 2014) included a follow-up assessment. Van der Kolk et al. (2014) utilized an active treatment control condition whereas the other five studies utilized a waitlist or assessment control condition. The total hours of treatment varied greatly across the six studies, from 10 (Van der Kolk et al., 2014) to 40 hours (Carter et al., 2013). Different types of yoga were investigated in the studies; Sudarshan Kriya yoga was utilized in Carter et al. (2013) and Seppälä et al. (2014), Kripalu yoga was used in Mitchell et al. (2014) and Reinhardt et al. (2017),

Kundalini yoga was examined in Jindani et al. (2015), and trauma-informed hatha yoga was employed in Van der Kolk et al. (2014).

Four of the six yoga studies (all but Mitchell et al., 2014 and Reinhardt et al., 2017) found significant between-group effects ranging from moderate to large effect sizes. All reported within-group effects were large. Two studies (Carter et al., 2013; Mitchell et al., 2014) reported that treatment gains were maintained over the 1 to 6 month follow-up period. Taken together, these studies indicate that yoga is an acceptable and feasible intervention that may be associated with PTSD symptom reductions. The van der Kolk study, in particular, with a moderately large sample size of 64 and an active comparison treatment, provides important preliminary support for yoga as an efficacious treatment for PTSD, although there were no follow-up assessments to determine the persistence of the improvements.

3.3 | Relaxation

All seven of the studies identified for review in this section examined relaxation as a control comparison for other treatments under study. Therefore, this section is focused on pre- to posttreatment within-group differences as well as differences between the relaxation condition and the target treatment(s) on primary outcome measures.

Applied muscle relaxation was compared to culturally-adapted CBT for PTSD in a small study with Latino patients by Hinton, Hofmann, Rivera, Otto, & Pollack, 2011. Large pre- to posttreatment effect sizes were reported for the participants in the relaxation condition on self-reported PTSD. The between groups analyses indicated a significantly greater effect for CBT with a large between-groups effect size. All participants in the CBT condition achieved clinically significant change (10 point decrease on the PCL) compared to one third of the participants in the relaxation condition.

A study that examined relaxation in comparison to three other active treatments (prolonged exposure, cognitive restructuring, and the two combined) found large treatment effects on both self-reported and clinician-assessed PTSD for all four treatments (Marks, Lovell, Noshirvani, Livanou, & Thrasher, 1998). Compared to the other active treatments, however, gains were modest for the relaxation group. Fifteen percent of the participants in the relaxation condition achieved clinically significant change (<2 SDs on the CAPS) compared with 47% to 53% for the other conditions. Notably, there were no significant differences between groups on how many met PTSD diagnostic criteria at posttreatment. The authors reported completer analyses but stated that ITT analyses yielded similar outcomes.

Taylor and colleagues compared relaxation to prolonged exposure and eye movement desensitization and reprocessing (EMDR; Taylor et al., 2003). Completer analyses indicated that all three treatments were efficacious in reducing clinician-assessed and self-reported PTSD. However, prolonged exposure showed an advantage over the other treatments on some measures, such as the proportion of individuals who no longer met diagnostic criteria for PTSD and the proportion who achieved clinically significant changes in symptom clusters at posttreatment and follow-up. Of note, the dosage for relaxation therapy was less than both EMDR and exposure by a third (i.e., 8 hours vs. 12 hours) and the pre- to posttreatment effect size for relaxation was large and significant. Despite the differences among the treatments, the authors also note that outcomes did not differ significantly at posttreatment or follow-up and ITT analyses for self-reported PTSD indicated no significant between-group effects.

Relaxation was compared to two active treatments (eye movement desensitization and image habituation training) as well as a waitlist control in a study by Vaughan and colleagues (Vaughan et al., 1994). Despite small group sizes and short treatment duration (three to five sessions total), all three active treatment groups improved significantly in clinician-assessed PTSD compared with waitlist and improvements were sustained at follow-up. No differences were found among the treatment groups in clinician-assessed PTSD or the proportion of individuals who qualified for a PTSD diagnosis following treatment.

A study focused on heart rate variability of individuals in residential treatment for substance use also examined PTSD outcomes in an RCT comparing progressive muscle relaxation and biofeedback for respiratory sinus arrhythmia (Zucker, Samuelson, Muench, Greenberg, & Gevirtz, 2009). The interventions were used as adjunctive interventions in the treatment program. Both groups showed significant reductions in self-reported PTSD and there were no significant differences between groups.

A recent study by Carletto and colleagues (2016) compared relaxation therapy to EMDR among patients with multiple sclerosis who were diagnosed with PTSD. Within-group analyses revealed large effect sizes for both conditions on clinician-assessed and self-reported PTSD symptoms and between-groups analyses revealed no differences by treatment condition. Completer analyses indicated that 100% of participants in the EMDR condition and 77% of participants in the relaxation therapy condition no longer met criteria for a PTSD diagnosis at the six-month follow-up, a statistically significant difference.

Markowitz and colleagues (2015) used relaxation therapy as an active control in a non-inferiority trial comparing interpersonal therapy to prolonged exposure for PTSD. This rigorous study used a large sample, an active control group, blinded assessment of outcomes, and assessment of treatment fidelity, as well as an ITT approach to analyses. The authors employed sophisticated longitudinal mixed-effects models using multiple imputations for missing values to evaluate efficacy. Within group pre-to-post analyses of all therapies revealed large effect sizes, and between-groups analyses found no significant differences among the three conditions in posttreatment clinician-assessed PTSD symptoms or remission rates. Compared to the relaxation group, participants in the prolonged exposure and interpersonal therapy groups reported significantly greater reductions in self-reported PTSD symptoms and showed higher rates of response (defined as improvement of >30% on CAPS). Nevertheless, the improvements seen in the relaxation group were substantial and there were no significant differences among the groups on many of the reported outcomes.

All seven of the relaxation studies focused primarily on the efficacy of the target interventions in the RCTs and in general provided limited detail about the procedures and results for the relaxation condition. There was substantial heterogeneity in study methodology regarding session length (20 minutes to 90 minutes), frequency of the sessions (daily to weekly), and duration of the intervention (2 weeks to 15 weeks). Importantly, the within-group effects were not uniformly reported and were based on small group sizes. Five of the studies had a participant pool that was predominantly or all female (64% to 100%), while both Marks et al. (1998) and Zucker et al. (2009), included more male participants (64% and 55%, respectively). Four of the studies used ITT analyses (Carletto et al., 2016; Hinton et al., 2011; Markowitz et al., 2015; Vaughan et al., 1994), while the remaining used completer analyses (Marks et al., 1998; Taylor et al., 2003; Zucker et al., 2009).

In four studies (Hinton et al., 2011; Markowitz et al., 2015; Marks et al., 1998; and Taylor et al., 2003) large pre-to post within-group effect sizes for relaxation were reported indicating that the relaxation treatment had a salutary effect on PTSD symptoms. The remaining three studies (Carletto et al., 2016; Vaughan et al., 1994; Zucker et al., 2009) did not report within-group effect sizes but both reported reduced PTSD severity for all treatment conditions, including relaxation. Three of the studies (Carletto et al., 2016; Hinton et al., 2011; Marks et al., 1998) reported greater treatment efficacy for the target treatments than relaxation on the primary PTSD outcome measures. Additionally, in two of the other four studies (Markowitz et al., 2015; Taylor et al., 2003), secondary analyses showed better outcomes for the experimental group on at least one PTSD metric, while the two remaining studies (Vaughan et al. 1994, Zucker et al., 2009) showed no advantage for the target treatments.

4 | DISCUSSION

The evidence provided by the mindfulness, yoga, and relaxation studies reviewed here offers support for mind-body treatments for PTSD. Although the literature base remains limited because many of the trials suffer from methodologic weaknesses, it is encouraging that there are increasing numbers of RCTs to draw on and that some larger, more rigorous studies have been added to the nascent evidence base. For example, the trial by Polusny and colleagues (2015) demonstrates superior outcomes for mindfulness compared to PCT, which is considered to be an empirically supported treatment for PTSD by Division 12 of the American Psychological Association (2013). Similarly, the study by Van der Kolk et al. (2014) provides important support for yoga as an efficacious treatment for PTSD compared to a health education control. These two studies used stronger research designs than most of the studies reviewed here in that they both included relatively large samples, used active and credible control groups (rather than treatment as usual or waitlist comparisons), utilized blinded assessors, and reported ITT analyses. Nevertheless, both studies also have

notable weaknesses, such as the large difference in treatment dosage for the Polusny et al. (2015) trial (Lee & Hoge, 2017) and the lack of follow-up assessment to evaluate the durability of treatment effects in the Van der Kolk et al. (2014) trial. While the accumulating findings on mind–body treatments for PTSD are promising, future research should utilize improved study designs and reduce methodological limitations to strengthen the evidence.

Stand-alone relaxation interventions as treatments for PTSD have seldom been included in previous reviews, presumably because relaxation has been examined in RCTs only as a control condition. The recent meta-analysis by Montero-Marin et al. (2017) indicates that, on the whole, CBT interventions are moderately more efficacious than relaxation for PTSD and the current findings do not contradict this. Five of the seven relaxation studies found significant between-group differences on PTSD or other relevant outcome measures in favor of the target treatments. In addition, the current review highlights the large within-group symptom improvements in the relaxation condition for the majority of the studies in this category. Thus, although relaxation may not perform as well as target treatments, the effects are sizable. Due to the heterogeneity of the study methodologies, conclusions about these studies as a whole should be cautiously interpreted. Nonetheless, given the ease with which stand-alone relaxation can be utilized in clinical settings, it may be a valuable treatment option for PTSD and additional research is needed to determine its relative efficacy.

4.1 | Strengths and limitations

A strength of this review is that we included a wide variety of interventions within each of the three categories of treatments. However, a drawback is that there are substantial dissimilarities among the treatments within each category. For example, within the Mindfulness category, Mantram Repetition, which emphasizes one-pointed attention on a spiritual word, may be fundamentally different from sitting-in-open-awareness meditation, as emphasized in MBSR. Most mind–body interventions are multidimensional and there is a great deal of heterogeneity among them. Interventions that include several components, especially those that include both yoga and mindfulness, are particularly difficult to categorize. In addition, many of the studies reviewed provided only minimal description of the interventions examined. Given these challenges, we elected to rely substantially on the investigators' label of the intervention to determine its category. However, investigators' labels are likely based more on the theoretical orientation of the designer of the intervention than on objective assessments of what is received by the trial participants, and this subjectivity may limit the conclusions that can be drawn from our findings.

As smaller trials tend to be analyzed with less methodological rigor (Coronado-Montoya et al., 2016), the small number of participants in many trials reviewed may have contributed to an exaggeration of positive outcomes. In addition, small trials that did not show PTSD symptom improvement may not have been published, and publication bias may have influenced the findings. Thus, despite the exclusion of single-arm studies from this review to reduce overestimation of results, our findings may still be biased in favor of mind–body treatments. On the other hand, differences among treatment conditions are more difficult to detect for studies with small samples. The absence of significant differences between groups for several of the studies reviewed should not be interpreted as confirmation that the groups are equivalent.

This review was restricted to PTSD outcomes. Examination of changes in other life domains that have been associated with mind–body practices, such as quality of life or physical functioning, would present a fuller picture of the potential benefits of these interventions. Some previous reviews of mind–body interventions for PTSD have examined comorbid issues (e.g., depression; Hilton et al., 2017). However, since there was little consistency in terms of which other domains of functioning were evaluated among the studies that met criteria to be included in this review (e.g., three of the nine mindfulness studies examined depression, two examined quality of life, etc.) we elected to limit the focus to PTSD symptoms as this was the outcome of interest for this systematic review.

The applicability of this review may be limited by the specific populations under study (e.g., seven of the nine mindfulness studies were conducted with Veterans) and the interventions could perform differently in other populations. Finally, our restriction to English-language publications may have excluded important studies that were published in other languages.

4.2 | Recommendations

Establishing methods to clearly define active ingredients and key components of mind–body interventions will be important to guide future research and clinical applications. To allow researchers and clinicians to reliably replicate interventions, we recommend that researchers develop treatment manuals with detailed descriptions and/or audio or video recordings of the components of interventions. Groessl and colleagues (2015) have begun to develop an objective measure to identify components of yoga interventions and such efforts are needed for other mind–body therapies as well. Examination of specific components and repeated measurement of constructs of hypothesized relevance in mind–body interventions (such as arousal, positive affect, distress tolerance, and positive reappraisal [Hanley, Garland, & Tedeschi, 2017; Talkovsky & Lang, 2017; Vujanovic, Niles, Pietrefesa, Schmertz, and Potter, 2013]) may elucidate mechanisms of change. As the literature grows and we gain clear definitions of the components of mind–body interventions, dismantling studies, such as those conducted on cognitive treatments for PTSD (i.e., Resick et al., 2008) should be performed to identify key elements that drive symptom change.

Going forward, it will be important to consider that a focus on remission of PTSD symptoms may be misaligned with the objectives of most mind-body interventions and that this may necessitate a shift in the methods used to evaluate outcomes. Interventions such as yoga or mindfulness are not directly aimed at reducing specific groups of symptoms; they may be most helpful in changing one's relation to one's mental state and physical sensations. These interventions encourage present moment awareness and aim to reduce struggle against distressing sensations. Mind–body interventions may encourage tolerance of negative physical and emotional states for individuals with PTSD and promote approach-oriented coping (Vujanovic et al., 2013) that can empower individuals to engage in healthy lifestyle habits. Furthermore, these interventions may reduce persistent hyperarousal symptoms (Wahbeh, Goodrich, Goy, & Oken, 2016) that perpetuate physical and psychological dysregulation and thus initiate a positive cycle of enhanced health. In order to facilitate comparisons and aggregation of findings across studies, researchers should include both between- and within-group effect sizes when presenting results and employ common tools that assess these broader issues. We recommend that investigators consider utilizing PROMIS measures (https://www.healthmeasures.net/explore-measurement-systems/promis) to evaluate more global health and mental health functioning.

Choice of comparison groups in RCTs is a study design element that deserves careful consideration as there are advantages and drawbacks associated with all comparison groups (Park et al., 2014). Unlike medication trials, there is no true placebo in mind–body or psychotherapy RCTs for PTSD (Schnurr, 2007). As was found to be the case with relaxation, control interventions sometimes prove to be efficacious so it is critical to specify the components of the comparisons as well as the target treatments. Similarly, as noted by Bradley and colleagues (2005), in many cases relaxation comparison treatments were not "intended (nor presumably perceived by the research therapists conducting them) to succeed" and therapist belief in efficacy of study treatments may affect the outcomes. Thus, study therapists should be adequately trained across conditions and should deliver each with a consistent level of enthusiasm to avoid potential bias. When choosing comparison interventions, it is, of course, necessary to attend to practical concerns, such as the feasibility of recruiting participants who will have a 50% chance of receiving a control intervention or requirements from funding agencies for active alternative treatments rather than waitlist controls. Theories about mechanisms of change also should guide choices; comparison interventions that omit a hypothesized key ingredient will provide valuable information to advance our understanding of how these interventions work.

Given that interventions with inadequate dose may generate false null results and that lengthy interventions may not be feasible to deliver, the length and intensity of treatments should be varied and empirically evaluated to determine optimal dose. Engagement in mind–body practices outside of the research setting is likely to enhance treatment effects both during and following study interventions. Future studies should attempt to measure home practice and conduct follow-up assessments to evaluate the impact of continued practice on symptoms over time. It will be useful to examine whether taking steps to encourage practice in the home and/or community (e.g., videos, providing referrals with free or low cost community classes) can maintain or boost treatment gains.

There is encouraging evidence that mind–body approaches may be effectively blended with other therapies in the treatment of PTSD. For example mindfulness has been combined with cognitive therapy (King et al., 2013) and with traditional exercise (Goldstein et al., 2018) to address PTSD with good preliminary results. Future research should evaluate the efficacy of mind–body interventions both alone and in combination with other treatments, particularly with current standard evidence-based trauma-focused psychotherapies. This may lead to matching treatments to individual patient characteristics to optimize outcomes. For example, mind–body treatments that focus on deep breathing and relaxation may work better for individuals with particularly high arousal symptoms, whereas CBT approaches may be optimal for those with greater elevations of negative mood and cognitions.

In addition to the need for further evidence to support mindfulness and yoga as treatments for PTSD, we encourage research on tai chi and additional studies on stand-alone relaxation. The active mind-body treatments reviewed here can be offered easily in venues that are not associated with the stigma of mental health care, such as in primary care practices and community settings, and these treatments may appeal to individuals with PTSD who are reluctant to engage in traditional psychotherapies. Although the current evidence is in its infancy, the accumulating research to support mind–body treatments for PTSD is promising.

ORCID

Barbara L. Niles http://orcid.org/0000-0002-2342-9737

REFERENCES

American Psychological Association (2013). Present-centered therapy for post-traumatic stress disorder. Retrieved from https://www.div12.org/PsychologicalTreatments/treatments/ptsd_present.html

Banks, K., Newman, E., & Saleem, J. (2015). An Overview of the research on mindfulness-based interventions for treating symptoms of posttraumatic stress disorder: A systematic review. *Journal of clinical psychology*, *71*(10), 935–963.

Barnes, P. M., Bloom, B., & Nahin, R. L. (2008). *Complementary and alternative medicine use among adults and children: United States, 2007*. National Health Statistics Reports; no 12. Hyattsville, MD: National Center for Health Statistics.

Bormann, J. E., Thorp, S., Wetherell, J. L., & Golshan, S. (2008). A spiritually based group intervention for combat veterans with posttraumatic stress disorder: Feasibility study. *Journal of Holistic Nursing*, *26*, 109–116. https://doi.org/10.1177/0898010107311276

Bormann, J. E., Thorp, S. R., Wetherell, J. L., Golshan, S., & Lang, A. J. (2013). Meditation-based mantram intervention for veterans with posttraumatic stress disorder: A randomized trial. *Psychological Trauma: Theory, Research, Practice, and Policy*, *5*(3), 259–267. https://doi.org/10.1037/a0027522

Bradley, R., Greene, J., Russ, E., Dutra, L., & Westen, D. (2005). A multidimensional meta-analysis of psychotherapy for PTSD. *American Journal of Psychiatry*, *162*(2), 214–227. https://doi.org/10.1176/appi.ajp.162.2.214

Bremner, J. D., Mishra, S., Campanella, C., Shah, M., Kasher, N., Evans, S., … Carmody, J. (2017). 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. *Frontiers in Psychiatry*, *8*, https://doi.org/10.3389/fpsyt.2017.00157

Bystritsky, A., Hovav, S., Sherbourne, C., Stein, M. B., Rose, R. D., Campbell-Sills, L., … Roy-Byrne, P. P. (2012). Use of complementary and alternative medicine in a large sample of anxiety patients. *Psychosomatics*, *53*(3), 266–272. https://doi.org/10.1016/j.psym.2011.11.009

Carletto, S., Borghi, M., Bertino, G., Oliva, F., Cavallo, M., Hofmann, A., … & Ostacoli, L. (2016). Treating Post-traumatic Stress Disorder in Patients with Multiple Sclerosis: A Randomized Controlled Trial Comparing the Efficacy of Eye Movement Desensitization and Reprocessing and Relaxation Therapy. *Frontiers in Psychology*, *7*, https://doi.org/10.3389/fpsyg.2016.00526

Carter, J., Gerbarg, P. L., Brown, R. P., Ware, R. S., D'Ambrosio, C., Anand, L., … Katzman, M. A. (2013). Multicomponent yoga breath program for Vietnam veteran post traumatic stress disorder: Randomized controlled trial. *Journal of Traumatic Stress Disorders and Treatment*, *2*(3). Retrieved from https://scitechnol.com/multicomponent-yoga-breath-program-for-vietnam-veteran-post-traumatic-stress-disorder-randomized controlled-trial-OPd.php?article_id = 1364 https://doi.org/10.4172/2324-8947.1000108

Carter, J., & Byrne, G. (2004). A two year study of the use of yoga in a series of pilot studies as an adjunct to ordinary psychiatric treatment in a group of Vietnam War veterans suffering from post traumatic stress disorder. Online document at: www.therapywithyoga.com Accessed November, 27

Coronado-Montoya, S., Levis, A. W., Kwakkenbos, L., Steele, R. J., Turner, E. H., & Thombs, B. D. (2016). Reporting of Positive Results in Randomized Controlled Trials of Mindfulness-Based Mental Health Interventions. *PLoS One*, *11*(4), e0153220. https://doi.org/10.1371/journal.pone.0153220

Davis, M. T., Mulvaney-Day, N., Larson, M. J., Hoover, R., & Mauch, D. (2014). Complementary and alternative medicine among veterans and military personnel: A synthesis of population surveys. *Medical care*, *52*, S83–S90. https://doi.org/10.1097/MLR.0000000000000227

Duan-Porter, W., Coeytaux, R. R., McDuffie, J. R., Goode, A. P., Sharma, P., Mennella, H., … Dept of Health Services Research and Development, Durham VA Medical Center, Durham, NC. (2016). Evidence map of yoga for depression, anxiety, and posttraumatic stress disorder. *Journal of Physical Activity & Health*, *13*(3), 281–288. https://doi.org/10.1123/jpah.2015-0027

Dutton, M. A., Bermudez, D., Matas, A., Majid, H., & Myers, N. L. (2013). Mindfulness-based stress reduction for low-income, predominantly african american women with PTSD and a history of intimate partner violence. *Cognitive and Behavioral Practice*, *20*(1), 23. https://doi.org/10.1016/j.cbpra.2011.08.003

Foa, E. B., Hembree, E. A., & Rothbaum, B. O. (2007). *Treatments that work. Prolonged exposure therapy for PTSD: Emotional processing of traumatic experiences: Therapist guide*. New York, NY: Oxford University Press.

Foa, E. B., & Rothbaum, B. O. (2001). *Treating the trauma of rape: Cognitive-behavioral therapy for PTSD*. New York, NY: Guilford Press.

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology. General*, *141*(1), 2–18. https://doi.org/10.1037/a0024338

Gallegos, A. M., Crean, H. F., Pigeon, W. R., & Heffner, K. L. (2017). Meditation and yoga for posttraumatic stress disorder: A meta-analytic review of randomized controlled trials. *Clinical Psychology Review*, *58*, 115–124. https://doi.org/10.1016/j.cpr.2017.10.004

Goldstein, L. A., Mehling, W. E., Metzler, T. J., Cohen, B. E., Barnes, D. E., Choucroun, G. J., … Neylan, T. C. (2018). Veterans Group Exercise: A randomized pilot trial of an Integrative Exercise program for veterans with posttraumatic stress. *Journal of Affective Disorders*, *227*, 345–352. https://doi.org/10.1016/j.jad.2017.11.002

Gordon, J. S., Staples, J. K., Blyta, A., & Bytyqi, M. (2004). Treatment of posttraumatic stress disorder in postwar kosovo high school students using mind–body skills groups: A pilot study. *Journal of Traumatic Stress*, *17*(2), 143–147. https://doi.org/10.1023/B:JOTS.0000022620.13209.a0

Groessl, E. J., Maiya, M., Elwy, A. R., Riley, K. E., Sarkin, A. J., Eisen, S. V., … Park, C. L. (2015). The essential properties of yoga questionnaire: Development and methods. *International journal of yoga therapy*, *25*(1), 51–59. https://doi.org/10.17761/1531-2054-25.1.51

Hanley, A. W., Garland, E. L., & Tedeschi, R. G. (2017). Relating dispositional mindfulness, contemplative practice, and positive reappraisal with posttraumatic cognitive coping, stress, and growth. *Psychological Trauma: Theory, Research, Practice, and Policy*, *9*(5), 526–536.https://doi.org/10.1037/tra0000208

Hilton, L., Maher, A. R., Colaiaco, B., Apaydin, E., Sorbero, M. E., Booth, M., ... Hempel, S. (2017). Meditation for posttraumatic stress: Systematic review and meta-analysis. *Psychological Trauma: Theory, Research, Practice, and Policy*, *9*(4), 453–460. https://doi.org/10.1037/tra0000180

Hinton, D. E., Hofmann, S. G., Rivera, E., Otto, M. W., & Pollack, M. H. (2011). Culturally adapted CBT (CA-CBT) for Latino women with treatment-resistant PTSD: A pilot study comparing CA-CBT to applied muscle relaxation. *Behaviour Research and Therapy*, *49*(4), 275–280. https://doi.org/10.1016/j.brat.2011.01.005

Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., & Koffman, Robert (2004). Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *The New England Journal of Medicine*, *351*(1), 13–22. https://doi.org/10.1056/NEJMoa040603

Hopwood, T. L., & Schutte, N. S. (2017). A meta-analytic investigation of the impact of mindfulness-based interventions on post traumatic stress. *Clinical Psychology Review*, *57*, 12–20. https://doi.org/10.1016/j.cpr.2017.08.002

Institute of Medicine (2012). *Treatment for posttraumatic stress disorder in military and veteran populations: Initial assessment*. Washington, DC: National Academy of Sciences.

Iyengar, B. K. S. (1979). *Light on yoga: Yoga Dipika* (revised ed.). New York, NY: Schocken Books.

Jin, P. (1989). Changes in heart rate, noradrenaline, cortisol and mood during Tai Chi. *Journal of Psychosomatic Research*, *33*(2), 197–206. https://doi.org/10.1016/0022-3999(89)90047-0

Jindani, F., Turner, N., & Khalsa, S. B. S. (2015). A yoga intervention for posttraumatic stress: A preliminary randomized control trial. *Evidence-Based Complementary and Alternative Medicine : ECAM*, *2015*, 351746. https://doi.org/10.1155/2015/351746

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life*. New York, NY: Hyperion.

Kearney, D. J., McDermott, K., Malte, C., Martinez, M., & Simpson, T. L. (2012). Association of participation in a mindfulness program with measures of PTSD, depression and quality of life in a veteran sample. *Journal of Clinical Psychology*, *68*(1), 101–116. https://doi.org/10.1002/jclp.20853

Kearney, D. J., McDermott, K., Malte, C., Martinez, M., & Simpson, T. L. (2013). Effects of participation in a mindfulness program for veterans with posttraumatic stress disorder: A randomized controlled pilot study. *Journal of Clinical Psychology*, *69*(1), 14–27. https://doi.org/10.1002/jclp.21911

Kelly, A., & Garland, E. L. (2016). Trauma-informed mindfulness-based stress reduction for female survivors of interpersonal violence: Results from a stage I RCT. *Journal of Clinical Psychology*, *72*(4), 311–328. https://doi.org/10.1002/jclp.22273

Kessler, R. C., Chiu, W. T., Demler, O., & Walters, E. E. (2005). Prevalence, Severity, and Comorbidity of Twelve-month DSM-IV Disorders in the National Comorbidity Survey Replication (NCS-R). *Archives of General Psychiatry*, *62*(6), 617–627. http://doi.org/10.1001/archpsyc.62.6.617

Khusid, M. A., & Vythilingam, M. (2016). The emerging role of mindfulness meditation as effective self-management strategy, part 1: Clinical implications for depression, post-traumatic stress disorder, and anxiety. *Military Medicine*, *181*(9), 961–968. https://doi.org/10.7205/MILMED-D-14-00677

Kim, S. H., Schneider, S. M., Bevans, M., Kravitz, L., Mermier, C., Qualls, C., & Burge, M. R. (2013). PTSD symptom reduction with mindfulness-based stretching and deep breathing exercise: Randomized controlled clinical trial of efficacy. *The Journal of Clinical Endocrinology & Metabolism*, *98*(7), 2984–2992. https://doi.org/10.1210/jc.2012-3742

Kim, S. H., Schneider, S. M., Kravitz, L., Mermier, C., & Burge, M. R. (2013). Mind-body practices for posttraumatic stress disorder. *Journal of Investigative Medicine*, *61*(5), 827–834. https://doi.org/10.231/JIM.0b013e3182906862

Kimbrough, E., Magyari, T., Langenberg, P., Chesney, M., & Berman, B. (2010). Mindfulness intervention for child abuse survivors. *Journal of Clinical Psychology*, *66*(1), 17–n/a. https://doi.org/10.1002/jclp.20624

King, A. P., Erickson, T. M., Giardino, N. D., Favorite, T., Rauch, S. A. M., Robinson, E., … Liberzon, I. (2013). A pilot study of group mindfulness-based cognitive therapy (MBCT) for combat veterans with posttraumatic stress disorder (PTSD). *Depression and Anxiety*, *30*(7), 638–645 https://doi.org/10.1002/da.22104

Lee, D. J., & Hoge, C. W. (2017). Significant methodological flaws limit conclusions drawn by authors of a recent PTSD mindfulness study. *Evidence-based mental health*, *20*(1), 30–30. https://doi.org/10.1136/eb-2016-102308

Libby, D. J., Pilver, C. E., & Desai, R. (2012). Complementary and alternative medicine in VA specialized PTSD treatment programs. *Psychiatric Services*, *63*(11), 1134–1136. https://doi.org/10.1176/appi.ps.201100456

Libby, D. J., Pilver, C. E., & Desai, R. (2013). Complementary and alternative medicine use among individuals with posttraumatic stress disorder. *Psychological Trauma: Theory, Research, Practice, and Policy*, *5*(3), 277–285. https://doi.org/10.1037/a0027082

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., … Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Annals of Internal Medicine*, *151*(4), W-65–W-94. https://doi.org/10.7326/0003-4819-151-4-200908180-00136

Marks, I., Lovell, K., Noshirvani, H., Livanou, M., & Thrasher, S. (1998). Treatment of posttraumatic stress disorder by exposure and/or cognitive restructuring: A controlled study. *Archives of General Psychiatry*, *55*(4), 317–325. https://doi.org/10.1001/archpsyc.55.4.317

Markowitz, J. C., Petkova, E., Neria, Y., Van Meter, P. E., Zhao, Y., Hembree, E., … & Marshall, R. D. (2015). Is exposure necessary? A randomized clinical trial of interpersonal psychotherapy for PTSD. *American Journal of Psychiatry*, *172*(5), 430–440. https://doi.org/10.1176/appi.ajp.2014.14070908

Meichenbaum, D. (1975). Self-instructional methods. In F. H. Kanfer & A. P. Goldstein (Eds.), *Helping people change* (pp. 357–391). Elmsford, NY: Pergamon Press.

Mitchell, K. S., Dick, A. M., DiMartino, D. M., Smith, B. N., Niles, B., Koenen, K. C., & Street, A. (2014). A pilot study of a randomized controlled trial of yoga as an intervention for PTSD symptoms in women. *Journal of Traumatic Stress*, *27*(2), 121–128. https://doi.org/10.1002/jts.21903

Montero-Marin, J., Garcia-Campayo, J., López-Montoyo, A., Zabaleta-del-Olmo, E., & Cuijpers, P. (2017). Is cognitive–behavioural therapy more effective than relaxation therapy in the treatment of anxiety disorders? A meta-analysis. *Psychological Medicine*, 1–12. https://doi.org/10.1017/S0033291717003099

Moore, M., Brown, D., Money, N., & Bates, M. (2011). *Mind-body skills for regulating the autonomic nervous system*. Arlington, VA: Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury.

National Center for Complementary and Integrative Health (2015, March). *Complementary, Alternative, or Integrative Health: What's In a Name?*. Retrieved from https://nccih.nih.gov/health/integrative-health.

National Center for Complementary and Integrative Health (2016, May). *Relaxation Techniques for Health*. Retrieved from https://nccih.nih.gov/health/stress/relaxation.htm

National Center for Complementary and Integrative Health (2015, August). *Tai Chi and Qi Gong: In Depth*. Retrieved from https://nccih.nih.gov/health/taichi/introduction.htm

National Center for Complementary and Integrative Health (2013, June). *Yoga: In Depth*. Retrieved from https://nccih.nih.gov/health/yoga/introduction.htm

Niles, B. L., Klunk-Gillis, J., Ryngala, D. J., Silberbogen, A. K., Paysnick, A., & Wolf, E. J. (2012). Comparing mindfulness and psychoeducation treatments for combat-related PTSD using a telehealth approach. *Psychological Trauma: Theory, Research, Practice, and Policy*, *4*, 538–547. https://doi.org/10.1037/a0026161

Niles, B. L., Polizzi, C. P., Voelkel, E., Weinstein, E. S., Smidt, K., & Fisher, L. M. (2017). Initiation, dropout, and outcome from evidence-based psychotherapies in a VA PTSD outpatient clinic. *Psychological Services*, https://doi.org/10.1037/ser0000175

Park, C. L., Groessl, E., Maiya, M., Sarkin, A., Eisen, S. V., Riley, K., & Elwy, A. R. (2014). Comparison groups in yoga research: A systematic review and critical evaluation of the literature. *Complementary therapies in medicine*, *22*(5), 920–929.

Polusny, M. A., Erbes, C. R., Thuras, P., Moran, A., Lamberty, G. J., Collins, R. C., … Lim, K. O. (2015). Mindfulness-based stress reduction for posttraumatic stress disorder among veterans: A randomized clinical trial. *JAMA*, *314*(5), 456–465. https://doi.org/10.1001/jama.2015.8361

Possemato, K., Bergen-Cico, D., Treatman, S., Allen, C., Wade, M., & Pigeon, W. (2016). A randomized clinical trial of primary care brief mindfulness training for veterans with PTSD. *Journal of Clinical Psychology*, *72*(3), 179–193. https://doi.org/10.1002/jclp.22241

Reinhardt, K. M., Noggle Taylor, J. J., Johnston, J., Zameer, A., Cheema, S., & Khalsa, S. B. S. (2017). Kripalu yoga for military veterans with PTSD: A Randomized Trial. *Journal of Clinical Psychology*, https://doi.org/10.1002/jclp.22483

Resick, P. A., Galovski, T. E., Uhlmansiek, M. O'B., Scher, C. D., Clum, G. A., & Young-Xu, Y. (2008). A randomized clinical trial to dismantle components of cognitive processing therapy for posttraumatic stress disorder in female victims of interpersonal violence. *Journal of Consulting and Clinical Psychology*, *76*(2), 243–258. https://doi.org/10.1037/0022-006X.76.2.243

Resick, P. A., Monson, C. M., & Chard, K. M. (2007). Cognitive processing therapy: Veteran/military version. *Washington, DC: Department of Veterans' Affairs*,

Rosenthal, J. Z., Grosswald, S., Ross, R., & Rosenthal, N. (2011). Effects of transcendental meditation in veterans of operation enduring freedom and operation iraqi freedom with posttraumatic stress disorder: A pilot study. *Military Medicine*, *176*(6), 626–630. https://doi.org/10.7205/MILMED-D-10-00254

Schell, T. L., & Marshall, G. N. (2008). Survey of individuals previously deployed for OEF/OIF. In T. T. and L. H. Jaycox, (Ed.), *Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery* (pp. 87–115). Santa Monica, CA: RAND Center for Military Health Policy Research.

Schnurr, P. P. (2007). The rocks and hard places in psychotherapy outcome research. *Journal of Traumatic Stress*, *20*, 779–792. https://doi.org/10.1002/jts.20292

Schottenbauer, M. A., Glass, C. R., Arnkoff, D. B., Tendick, V., & Gray, S. H. (2008). Nonresponse and dropout rates in outcome studies on PTSD: Review and methodological considerations. *Psychiatry*, *71*(2), 134–168. https://doi.org/10.1521/psyc.2008.71.2.134

Seppälä, E. M., Nitschke, J. B., Tudorascu, D. L., Hayes, A., Goldstein, M. R., Nguyen, D. T., … Davidson, R. J. (2014). Breathing-based meditation decreases posttraumatic stress disorder symptoms in US military veterans: A randomized controlled longitudinal study. *Journal of Traumatic Stress*, *27*(4), 397–405. https://doi.org/10.1002/jts.21936

Staples, J. K., Hamilton, M. F., & Uddo, M. (2013). A yoga program for the symptoms of post-traumatic stress disorder in veterans. *Military Medicine*, *178*(8), 854–860. https://doi.org/10.7205/MILMED-D-12-00536

Stecker, T., Fortney, J., Owen, R., McGovern, M. P., & Williams, S. (2010). Co-occurring medical, psychiatric, and alcohol-related disorders among veterans returning from Iraq and Afghanistan. *Psychosomatics*, *51*(6), 503–507. Retrieved from https://search.proquest.com/docview/805137181?accountid = 30093

Steenkamp, M. M., Litz, B. T., Hoge, C. W., & Marmar, C. R. (2015). Psychotherapy for military-related PTSD: A review of randomized clinical trials. *JAMA*, *314*(5), 489–500. https://doi.org/10.1001/jama.2015.8370

Talkovsky, M., & Lang, A. J. (2017). Meditation-based Approaches in the Treatment of PTSD. *PTSD Research Quarterly*, *28*(2), 1–10.

Taylor, S., Thordarson, D. S., Maxfield, L., Fedoroff, I. C., Lovell, K., & Ogrodniczuk, J. (2003). Comparative efficacy, speed, and adverse effects of three PTSD treatments: Exposure therapy, EMDR, and relaxation training. *Journal of Consulting and Clinical Psychology*, *71*(2), 330–338. https://doi.org/10.1037/0022-006X.71.2.330

VA Healthcare Analysis and Information Group (2011). *2011 Complementary and alternative medicine*. Washington, DC: Department of Veterans Affairs.

Van der Kolk, B., Stone, L., West, J., Rhodes, A., Emerson, D., Suvak, M., & Spinazzola, J. (2014). Yoga as an adjunctive treatment for posttraumatic stress disorder: A randomized controlled trial. *Journal of Clinical Psychiatry*, *75*(6), 559–565. https://doi.org/10.4088/JCP.13m08651

Vaughan, K., Armstrong, M. S., Gold, R., O'Connor, N., Jenneke, W., & Tarrier, N. (1994). A trial of eye movement desensitization compared to image habituation training and applied muscle relaxation in post-traumatic stress disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*(4), 283–291. https://doi.org/10.1016/0005-7916(94)90036-1

Vujanovic, A. A., Hart, A. S., Potter, C. M., Berenz, E. C., Niles, B., & Bernstein, A. (2013). Main and interactive effects of distress tolerance and negative affect intensity in relation to PTSD symptoms among trauma-exposed adults. *Journal of Psychopathology and Behavioral Assessment*, *35*(2), 235–243. https://doi.org/10.1007/s10862-012-9325-2

Vujanovic, A. A., Niles, B., Pietrefesa, A., Schmertz, S. K., & Potter, C. M. (2013). Mindfulness in the treatment of posttraumatic stress disorder among military veterans. *Spirituality in Clinical Practice*, *1*(S), 15–25. https://doi.org/10.1037/2326-4500.1.S.15

Vujanovic, A. A., Youngwirth, N. E., Johnson, K. A., & Zvolensky, M. J. (2009). Mindfulness-based acceptance and posttraumatic stress symptoms among trauma-exposed adults without axis I psychopathology. *Journal of Anxiety Disorders*, *23*(2), 297–303. https://doi.org/10.1016/j.janxdis.2008.08.005

Wahbeh, H., Goodrich, E., Goy, E., & Oken, B. S. (2016). Mechanistic pathways of mindfulness meditation in combat veterans with posttraumatic stress disorder: Mechanistic pathways of mindfulness meditation. *Journal of Clinical Psychology*, *72*(4), 365–383. https://doi.org/10.1002/jclp.22255

Wahbeh, H., Senders, A., Neuendorf, R., & Cayton, J. (2014). Complementary and alternative medicine for posttraumatic stress disorder symptoms: A systematic review. *Journal of Evidence-based Complementary & Alternative Medicine*, *19*(3), 161–175. https://doi.org/10.1177/2156587214525403

Walser, R., & Westrup, D. (2007). *Acceptance and commitment therapy for the treatment of post-traumatic stress disorder and trauma-related problems: A practitioner's guide to using mindfulness and acceptance strategies*. Oakland, CA: New Harbinger Publications.

Wang, C., Bannuru, R., Ramel, J., Kupelnick, B., Scott, T., & Schmid, C. H. (2010). Tai Chi on psychological well-being: Systematic review and meta-analysis. *BMC Complementary and Alternative Medicine*, *10*(23). Retrieved from https://www.biomedcentral.com/1472-6882/10/23 https://doi.org/10.1186/1472-6882-10-23

Zucker, T. L., Samuelson, K. W., Muench, F., Greenberg, M. A., & Gevirtz, R. N. (2009). The effects of respiratory sinus arrhythmia biofeedback on heart rate variability and posttraumatic stress disorder symptoms: A pilot study. *Applied Psychophysiology and Biofeedback*, *34*(2), 135–143. https://doi.org/10.1007/s10484-009-9085

How to cite this article: Niles BL, Mori DL, Polizzi C, et al. A systematic review of randomized trials of mind-body interventions for PTSD. *J Clin Psychol*. 2018;74:1485–1508. https://doi.org/10.1002/jclp.22634