Kripalu Yoga for Military Veterans With PTSD: A Randomized Trial

Kristen M. Reinhardt,[1] Jessica J. Noggle Taylor,[1,2] Jennifer Johnston,[3] Abida Zameer,[4] Seetal Cheema,[5] and Sat Bir S. Khalsa[1]

[1] *Brigham and Women's Hospital, Harvard Medical School*
[2] *Emory University*
[3] *Lowell Vet Center*
[4] *Northeastern University*
[5] *Kaiser Permanente*

Objectives: This randomized controlled trial of yoga for military veterans and active duty personnel with posttraumatic stress disorder (PTSD) evaluated the efficacy of a 10-week yoga intervention on PTSD. **Method:** Fifty-one participants were randomized into yoga or no-treatment assessment-only control groups. Primary outcome measures included questionnaires and the Clinician Administered PTSD Scale. **Results:** Both yoga ($n = 9$) and control ($n = 6$) participants showed significant decreases in reexperiencing symptoms, with no significant between-group differences. Secondary within-group analyses of a self-selected wait-list yoga group ($n = 7$) showed significant reductions in PTSD symptoms after yoga participation, in contrast to their control group participation. Consistent with current literature regarding high rates of PTSD treatment dropout for veterans, this study faced challenges retaining participants across conditions. **Conclusion:** These results are consistent with recent literature indicating that yoga may have potential as a PTSD therapy in a veteran or military population. However, additional larger sample size trials are necessary to confirm this conclusion. J. Clin. Psychol. 74:93–108, 2018.

Keywords: RCT; yoga; PTSD; military; veteran; trauma

The lifetime prevalence of posttraumatic stress disorder (PTSD) in the United State's general population is estimated to be 6.8% (Kessler et al., 2005). Perhaps unsurprisingly, the prevalence among military veterans is estimated to be much higher at 23% (Fulton et al., 2015; Magruder et al., 2015; Street, Gradus, Giasson, Vogt, & Resick, 2013). Military veterans experience a high rate of physical and psychological trauma including combat (Richardson, Frueh, & Acierno, 2010) and interpersonal conflicts, such as military sexual trauma (Surís & Lind, 2008). After these and other traumatic events, some veterans meet diagnostic criteria for PTSD (Clancy et al., 2006; Vasterling et al., 2010; American Psychiatric Association, 2013). Studies have demonstrated that not all trauma survivors benefit from conventional psychotherapy (Schottenbauer, Glass, Arnkoff, Tendick, & Gray, 2008) or medication (Hoskins et al., 2015). Hence, the scope of available treatments needs to broaden for veterans diagnosed with PTSD.

This study was supported by U.S. Department of Defense Awards W81XWH-08-2-0203 and W81XWH-10-1-1066 to S. B. S. Khalsa at Brigham and Women's Hospital from the Telemedicine & Advanced Technology Research Center of the US Army Medical Research and Material Command and by the Institute of Extraordinary Living of the Kripalu Center for Yoga & Health.

The investigators are solely responsible for the contents of the manuscript and they do not represent official views of the U.S. Department of Defense, the U.S. Department of Veterans Affairs, or the United States Government. Please contact the first author for further protocol and intervention details. This study is registered at www.clinicaltrials.gov, #NCT00962403.
Kristen Reinhardt is now at the University of Oregon Department of Psychology, Eugene, OR.

Please address correspondence to: Kristen Reinhardt, MS, Department of Psychology, University of Oregon, 1227 University of Oregon, Eugene, OR 97403. E-mail: kreinha5@uoregon.edu

Published online in Wiley Online Library (wileyonlinelibrary.com/journal/jclp). DOI: 10.1002/jclp.22483

Yoga as an Intervention for PTSD: Research and Theoretical Mechanisms

Integrative therapies have recently received an increased amount of attention through clinical practice and research (Polusny et al., 2015; Wynn, 2015; Strauss, Coeytaux, McDuffle, Nagi, & Williams, 2011). A recent review of 16 studies suggested that mind–body practices (e.g., yoga, mindfulness-based stress reduction, deep breathing, meditation, Tai Chi, and Qigong) are associated with decreases in trauma-related symptoms (especially intrusion and avoidance) and emotion dysregulation (Kim, Schneider, Kravitz, Mermier, & Burge, 2013). These studies were limited by small sample sizes, and some lacked randomized control comparison groups.

One of these mind–body interventions, yoga, is an ancient Eastern contemplative practice conceptualized by many as a moving meditation. In the West, the most common, explicitly taught yoga practices are breathing (*pranayama)*, physical postures (*asana*), and meditation. A meta-analysis investigated evidence for yoga as an adjunctive treatment for schizophrenia, depression, anxiety, and PTSD (Cabral, Meyer & Ames, 2011). Results from 10 studies included in Cabral and colleagues' meta-analysis indicated that yoga had a statistically significant effect on symptoms of mental illness, with a pooled effect size of –3.25, $p = 0.002$, 95% confidence interval [CI] [–5.36, –1.14]. Suggestions included fewer, unwanted side effects from yoga relative to pharmacotherapy, and that yoga may be effective for physical challenges that co-occur with PTSD (Rosenbaum et al., 2015).

Telles, Singh, and Balkrishna (2012) reviewed 12 studies (seven RCTs) on yoga for PTSD and associated symptoms (e.g., depression and anxiety), with results suggesting that yoga is helpful for mitigating trauma-related symptoms. Researchers (Macy, Jones, Graham, & Roach, 2015; Mitchell et al., 2014; Seppälä et al., 2014; van der Kolk et al., 2014; Jindani, Turner, & Khalsa, 2015; Quiñones, Maquet, Vélez, & López, 2015; Rhodes, Spinazzola, & van der Kolk, 2016) have reported conflicting results of randomized controlled trials (RCTs) for yoga as a treatment for PTSD. These mixed findings indicate a need for more research that addresses design limitations of extant studies.

Telles et al. (2012) and Macy et al. (2015) outline limitations of studies included in their reviews, and offer suggestions to enhance future research on yoga for PTSD. Telles et al. (2012) note that RCTs were limited by being underpowered and using nonvalidated assessments. Macy et al. (2015) suggest that researchers should use RCT designs (also noted in Metcalf et al., 2016), use established and well-validated outcome measures, include effect sizes in their reported statistics, and record the type of yoga that participants received and the yoga instructor's level of expertise. Both groups noted promising evidence supporting yoga as a treatment for trauma-related mental health symptoms, yet acknowledged that limitations of existing research hamper clear conclusions about yoga's efficacy. Thus, researchers need to improve upon existing research designs through implementing higher quality design RCTs, studying larger sample sizes, using established outcome measures, and more closely documenting their yoga interventions and interventionist qualifications.

Recent studies including veterans (Stankovic, 2011; Carter et al., 2013; Staples, Hamilton, & Uddo, 2013; Mitchell et al., 2014; Johnston et al., 2015) suggested that yoga is feasible and acceptable as a PTSD treatment for military veterans, although outcome results did not consistently show significant changes in PTSD symptoms. Mitchell and colleagues (2014) found that both civilian and veteran women randomized to yoga or assessment-only control groups experienced significant reductions in reexperiencing symptoms. Yoga participants experienced greater reductions in hyperarousal symptoms, and control participants experienced greater reductions in anxiety symptoms. They concluded that yoga might be a helpful adjunctive treatment for PTSD. Follow-up analyses (Reddy, Dick, Gerber, & Mitchell, 2014; Martin, Dick, Scioli-Salter, & Mitchell, 2014) indicated that the yoga intervention may have led to decreased alcohol and drug use and increased physical activity, although these changes were not significant similar to primary PTSD outcomes.

In addition to reporting main effects of yoga on PTSD and trauma-related symptoms, researchers have discussed potential mechanisms through which yoga practice may lead to symptom reduction. These include improvements in self-regulation, including cognitive, emotional, and behavioral regulation (Gard, Noggle, Park, Vago, & Wilson, 2014; Dick, Niles,

Street, DiMartino, & Mitchell, 2014); interoceptive awareness (van der Kolk, 2006; van der Kolk et al., 2014; Schmalzl, Crane-Godreau, & Payne, 2014); and stress physiology (Riley & Park, 2015; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012). Collectively through these mechanisms, yoga may reduce PTSD symptoms by decreasing physical tension, increasing relaxation, attenuating automatic thoughts (e.g., rumination) and behaviors (e.g., hyperarousal), and enhancing awareness and attitudes characterized by nonjudgment (Johnston et al., 2015). These changes may support trauma survivors' symptom management and negotiation of traumatic sequelae. Theoretical accounts and the few existing mechanistic investigations of yoga suggest that it is a multifaceted practice working through several mediating and moderating systems.

Immediately before the present study, we conducted a single-arm pilot study with a sample of female and male military veterans (n = 12) and investigated the effects of a 20-session, biweekly group yoga intervention on PTSD symptoms (Johnston et al., 2015). The results showed clinically and statistically significant decreases in PTSD total symptoms ($d = 0.77$) on the Clinician-Administered PTSD Scale (Blake et al., 2000) and specific significant decreases in PTSD symptom subscales (Reexperiencing, $d = 0.73$; Avoidance, $d = 0.57$; and Hyperarousal, $d = 0.98$). A research literature comparative benchmark analysis of eight RCTs of traditional therapies for PTSD symptoms showed a treatment effect that was significantly lower than the pooled effect size ($d = 1.07$). In contrast to studies with a wait-list (WL) control group, however, this study's effect size was significantly higher. Although findings from this study provided useful effect sizes, both through the primary outcome results and benchmark analysis, the clinical trial was limited by being nonrandomized and likely underpowered. Future studies ought to include randomized control designs as well as both clinician-administered and self-report outcome measures.

We designed the present study to build on the strengths and address the limitations of previous research. Our design addressed the limitations of previous research as follows: The present study used an RCT design, had a larger planned sample size, and employed well-validated clinician-administered and self-report outcome measures. We planned to report effect sizes and report the type of yoga we implemented and the level of experience of our interventionists. Last, to enhance generalizability and ecological validity, we formed a collaboration with our local VA Healthcare System, to recruit veterans through VA Hospitals and implement some yoga classes there.

The primary objective of this RCT was to evaluate the efficacy of 10 weeks of yoga on PTSD symptoms among a sample of military service members. We hypothesized that compared to a no-treatment assessment-only control group, PTSD symptoms would improve after a yoga intervention and that participants in the control group who self-select into subsequent yoga treatment (WL yoga group) would also see significant improvement in PTSD symptoms.

Method

Participants

The Institutional Review Boards at Partners Healthcare/Brigham and Women's Hospital, the Department of Defense, and the VA Boston Healthcare System approved the study protocol. Active duty military personnel and veterans ($n = 379$) were recruited in Boston through flyers posted in neighborhoods and Boston VA Hospitals and advertisements on public transit and Craigslist (Figure 1). Entry criteria were as follows: 18 years of age or older; PTSD diagnosis (per Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders* [*DSM-IV-TR*] Axis I Disorders, clinical trials version (SCID-CT; First, Williams, Spitzer, & Gibbon, 2007); no more than one hour of current weekly mind–body practice; and physical and psychological capability to undergo the yoga intervention. Ongoing medication or psychotherapy at enrollment was not exclusionary, and we requested notification of any changes to these regimens. Out of the 379 people who were assessed via phone, 78% were ineligible for the following reasons: not having a PTSD diagnosis (roughly 50%), having a current mind–body practice (roughly 30%), and having non-veteran status (roughly 8%).

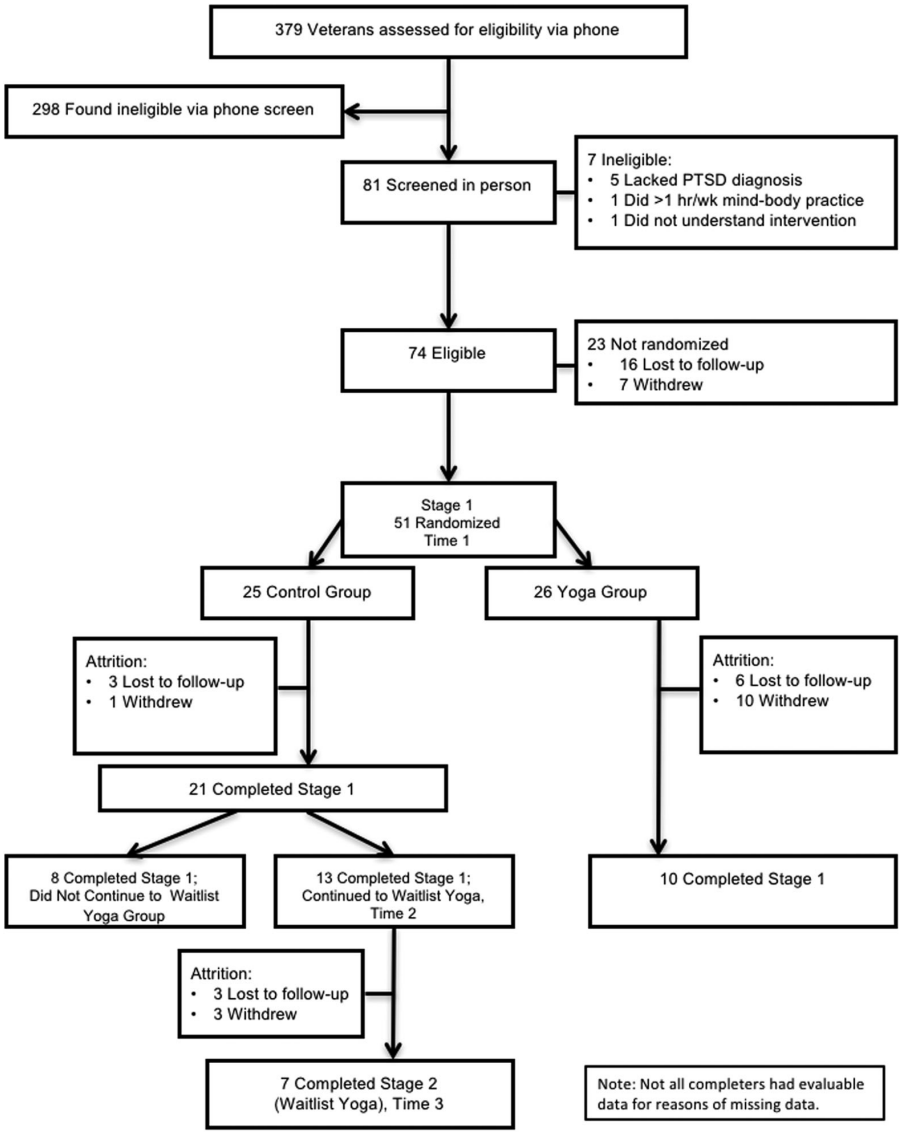

Figure 1. CONSORT diagram.

Participants screened by phone ($n = 81$) were consented and research study staff confirmed eligibility through conducting an in-person medical and personal history interview and the SCID-CT (First et al., 2007). Following the interviews, 74 participants (female = 8.1%, mean $[M]_{age} = 46.74$, standard deviation $[SD] = 13.58$) were eligible for the study. It is notable that only a small percentage of our participants were female, and that this is only slightly lower than the overall percentage of women in active duty service (14%; Office of the Deputy Assistant Secretary of Defense, 2014). Between the time that participants' eligibility was determined and randomization (1–3 months), 23 participants were not randomized for the following reasons: participants were lost to follow-up ($n = 16$) and participants withdrew ($n = 7$). Participant's reasons for withdrawing are as follows: schedule conflicts ($n = 4$), long-term hospitalization ($n = 1$), stressful family life ($n = 1$), and anticipating that the study would be too triggering of their PTSD symptoms ($n = 1$).

Table 1
Demographic Characteristics of Randomized Participants

Characteristics	Yoga group ($n = 26$)	Wait-list yoga group ($n = 13$)	Control group ($n = 12$)
Age	$M = 44.12$ ($SD = 13.97$)	M = 56.15 ($SD = 11.39$)	M = 46.58 ($SD = 12.66$)
Sex			
Male	24	11	10
Female	2	2	2
Race			
White/Caucasian	16	7	9
Black/African American	6	2	2
Asian American	1	0	0
Mixed/other	1	2	0
Not reported	2	2	1
Ethnicity			
Not Hispanic or Latino	17	10	9
Hispanic or Latino	2	1	1
Not reported	7	2	2
Completed	10	7	8
Withdrew	10	3	1
Lost to follow-up	6	3	3

Note. M = mean; SD = standard deviation. Wait-list yoga group participants who "completed" means that they completed both the control and yoga group phases.

In Stage 1 (see Figure 1), we randomly assigned a total of 51 participants (female = 11.8%, $M_{age} = 47.76$, $SD = 13.77$; Table 1) into one of the two study conditions: the intervention condition (yoga group) or the assessment-only control condition (control group). After participants completed baseline assessments, Author J. J. Noggle Taylor conducted a simple random assignment via a web-based random sampling service (www.randomizer.org; Urbaniak & Plous, 2015). Once we consented the minimum number of participants, we initiated baseline assessments and randomization to initiate a cohort. We determined a priori that a cohort would comprise at least 12 eligible participants, six participants in each group. Following randomization, participants were not blind to their group assignment. In the control group, some participants ($n = 8$) did not elect to participate in a subsequent yoga intervention. Other participants in the control group ($n = 13$) chose to complete the assessment period, the long-term follow-up, and then participate in the yoga intervention (WL yoga group). Of these participants, seven completed the yoga intervention, while three were lost to follow-up and three withdrew.

We gave control group participants the following participation options: complete outcome measures only during Stage 1 of study (compensation = $260); complete outcome measures during Stage 1 and then participate in the subsequent WL yoga group during Stage 2 (completing no additional outcome measures; compensation = $260); or complete outcome measures during Stage 1, participate in the subsequent WL yoga group during Stage 2, and complete outcome measures during Stage 2 (compensation = $335). The intent for our initial Stage 1 timeline was as follows: initial baseline assessments and randomization (2 weeks); yoga intervention (10 weeks); and 12 weeks of no contact, at the end of which participants would complete a battery of long term follow-up measures. We had intended this to take a total of 24 weeks in total, but because of recruitment challenges, the initial planned 2-week baseline and randomization period took anywhere from 4 to 12 weeks. Thus, the Stage 1 duration was between 26 and 34 weeks. In implementation, the Stage 2 timeline remained at 10 weeks (see Figure 1). Compensation for the yoga participants was up to $300 for attending the yoga classes and completing the outcome measures.

Materials and Procedures

Clinician-Administered PTSD Scale (Blake et al., 2000; CAPS). The CAPS is a 30-item semistructured interview to diagnose PTSD. Subscales confirm criteria of (a) trauma and (b) PTSD symptoms of intrusion, (c) avoidance, and (d) hyperarousal. Participants are asked about duration of symptoms, impact on social and occupational functioning, global severity, and validity. Interviewers rate participant's answers to individual questions on separate frequency and intensity scales (range = 0-4) and document symptoms experienced in the past week or month. For this study, two assessors (a female doctoral-level psychologist and a male psychiatry resident) conducted all CAPS interviews. They were both blinded to participant treatment condition. Symptom subscales have excellent inter-rater reliability for frequency and severity ($r > .92$) and good internal consistency (alpha = .87; Cicchetti, Fontana, & Showalter, 2009). Data from the CAPS were collected at pre and post.

PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1994). We used two versions of this survey: PCL-Military (PCL-M) and PCL-Civilian (PCL-C). The former assesses symptoms related to traumatic military experiences, while the latter assesses symptoms related to general trauma. These 17-item self-report questionnaires assess PTSD symptoms consistent with *DSM-IV-TR* diagnostic criteria. Participants rated bothersomeness in the past month on a 5-point Likert scale ranging from 1 (not at all) to 5 (extremely). Psychometric research has demonstrated strong internal consistency (*alpha* > 0.75; Wilkins, Lang, & Norman, 2011), reliability ($r > 0.70$; Weathers et al., 1993; Campbell et al., 1999), and strong convergent validity (*kappa* > 0.79; Keen, Kutter, Niles, & Krinsley, 2008). Data from the PCL were collected at pre, mid, and post.

Impact of Events Scale-Revised (IES-R; Weiss & Marmar, 1997). This 22-item self-report measure assesses distress precipitated by traumatic events. Participants responded to 14 items that directly corresponded to *DSM-IV* PTSD symptoms. Participants identified a stressful life event and then rated how "distressed or bothered" they were by it in the past 7 days on a 5-point Likert scale ranging from 0 (*not at all*) to 4 (*extremely*). Scoring is by total mean (range = 0-4) and subscale means for intrusion, avoidance, and hyperarousal. Among Vietnam veterans, data showed excellent internal consistency overall (alpha = 0.96) as well as for intrusion (alpha = 0.94), avoidance (alpha = 0.87), and hyperarousal (alpha = 0.91; Creamer, Bell, & Failla, 2003). Data from non-veteran trauma survivors suggest high reliability (Weiss & Marmar, 1997). Data were collected at pre, mid, and post.

Yoga Intervention (Yoga Group and WL Yoga Group)

The yoga intervention was identical to our pilot study (Johnston et al., 2015). Per Kripalu Yoga Teachers' Association and Yoga Alliance standards, all instructors (two female including author J. Johnston, and one male) had advanced training in Kripalu Yoga, which combines physical postures, breathing, and meditation, emphasizing moving meditation. Twice weekly 90-minute group yoga sessions over 10 consecutive weeks each included a brief check-in, centering and breathing exercises, 10–15 minutes of body warm-ups, 50–55 minutes of physical poses, breath work, and moving meditation, followed by 5–10 minutes of relaxation. Discussion themes were as follows: balancing the sleep-wake system; increasing flexibility and strength; reducing stress; developing a responsive (versus reactive or avoidant) relationship with the self, others, and environment; and developing mindful awareness throughout practice. Participants were also asked to practice yoga outside of class daily for 15-minutes with a provided audio recording.

Control Condition (Control Group)

Participants randomized into the no-treatment assessment-only control group were asked to complete all outcome measures as a group (excluding the CAPS interviews, which were

conducted individually for all participants). They were also offered the opportunity to be in the subsequent WL yoga group to participate in the yoga intervention after completing the 10-week assessment period and long-term follow-up.

Statistical Analysis and Data Collection

Since attrition varied between groups, completer analysis of baseline differences in the primary outcome (CAPS) were evaluated using a two-way analysis of variance (ANOVA) of completer status, group assignment, and interaction between the two. Changes were assessed for completers using within-subjects repeated measures analysis of variance (RM-ANOVA), including a between-subjects factor. The between-subjects model factor was group and within-subjects factors were time (pre and post) and interaction of group by time. Tukey's HSD post hoc tests were conducted as warranted at baseline, midtreatment, and posttreatment.

There may be inherent differences between those who do and do not self-select into a treatment. For example, those who self-select may experience worse symptoms than those who do not. WL yoga group self-selectors were control participants who decided to participate in the yoga intervention, whereas non-self-selectors decided to terminate their involvement in the study after their control group participation. To assess for differences between these two groups, they were compared using RM-ANOVA with a between-subjects factor of self-selection status and within-subjects factors of time (pre and post) and group by time interaction. The rationale for this comparison was to determine any differences in PTSD symptoms between groups. For example, perhaps self-selectors had less improvement, worsening symptoms, or overall greater symptom severity during the control condition (thus greater therapeutic need) than non-self-selectors when deciding whether or not to participate in the intervention. To evaluate longitudinal changes for the self-selecting WL yoga group, a RM-ANOVA over time (pre-, post-, and post-yoga) was also conducted.

Statistical significance was alpha $= 0.05$. Effect sizes used η^2 with Cohen's (1988) ranges of small ≤ 0.01, medium ≤ 0.06, and large ≤ 0.14. Data were collected at three hospitals within the Boston-area (preliminary, midpoint, post-, and postyoga data for some cohorts, all CAPS interviews) and at one Boston area yoga studio (mid-point, post-, and post-yoga data for some cohorts).

Results

Yoga Group in Comparison to Assessment-Only Control Group Analyses

Clinician-reported PTSD symptoms. At baseline, participants in the yoga and control groups met diagnostic criteria for PTSD with average scores in the severe range (Weathers, Keane, & Davidson, 2001; Table 2). Following the 10-week intervention period, yoga group participants' PTSD symptom levels dropped into the moderate PTSD/threshold range (CAPS moderate range 40–59; Weathers et al., 2001) for the past week ($M_{PastWeek} = 58.22$) but not for the past month ($M_{PastWeek} = 63.56$; Table 2). Participants in the control group remained in the severe PTSD symptom range (Table 2). For participants in the yoga group, there was a reduction in total CAPS scores by week ($M_{difference} = 12.11$) and month ($M_{difference} = 9.77$). Participants in the control group also demonstrated total CAPS reductions by week ($M_{difference} = 6.16$) and month ($M_{difference} = 1.34$; Table 2).

A two-way ANOVA comparing baseline differences in CAPS by completer status, group, and interaction showed no statistically significant differences in the overall model for any baseline CAPS outcomes (past-week lowest $p = 0.14$ [avoidance] and past-month lowest $p = 0.18$ [avoidance]). A RM-ANOVA compared the effect of group (yoga or control) on PTSD symptoms (measured by the CAPS) over time. The assumption of sphericity was not violated for any CAPS outcomes and thus no corrections were applied. Overall, both the yoga and control groups showed reductions in CAPS total and subscale scores (one significant reduction over time with the rest trends), which resulted in nonsignificant comparisons by group. There were

Table 2
CAPS Past Week and Past Month–Descriptive Statistics and RM-ANOVA Comparing Yoga and Control Groups

		Group				RM-ANOVA								
		Yoga ($n = 9$)		Control ($n = 6$)		Group			Time			Group* Time		
		Pre	Post	Pre	Post									
		Mean (SD)				F value	P value	η^2	F value	P value	η^2	F value	P value	η^2
CAPS past week	Total	70.33 (18.55)	58.22 (26.47)	67.33 (22.46)	61.17 (20.97)	$F_{1,13} = 0.00$	1.00	0.00	$F_{1,13} = 3.41$	0.09	0.04*	$F_{1,13} = 0.36$	0.56	0.00
	Reexperiencing	18.22 (6.82)	12.89 (9.31)	18.00 (8.10)	12.83 (8.38)	$F_{1,13} = 0.00$	0.97	0.00	$F_{1,13} = 6.66$	0.02***	0.10**	$F_{1,13} = 0.00$	0.96	0.00
	Avoidance	30.33 (7.73)	26.56 (10.32)	26.33 (7.26)	25.67 (14.53)	$F_{1,13} = 0.29$	0.60	0.02*	$F_{1,13} = 0.63$	0.44	0.01*	$F_{1,13} = 0.59$	0.31	0.00
	Hyperarousal	22.22 (7.16)	18.78 (9.15)	23.00 (8.67)	22.67 (4.63)	$F_{1,13} = 0.41$	0.53	0.02*	$F_{1,13} = 1.01$	0.37	0.02*	$F_{1,13} = 0.69$	0.42	0.01*
CAPS past month	Total	73.33 (18.28)	63.56 (25.70)	69.17 (23.91)	67.83 (23.04)	$F_{1,13} = 0.00$	1.00	0.00	$F_{1,13} = 0.93$	0.35	0.02*	$F_{1,13} = 0.54$	0.48	0.01*
	Reexperiencing	20.00 (7.16)	15.78 (8.20)	18.67 (8.16)	19.67 (8.50)	$F_{1,13} = 0.13$	0.72	0.01*	$F_{1,13} = 0.54$	0.47	0.01*	$F_{1,13} = 1.43$	0.25	0.03*
	Avoidance	30.22 (7.64)	26.89 (10.17)	26.50 (7.76)	25.50 (14.32)	$F_{1,13} = 0.32$	0.58	0.02*	$F_{1,13} = 0.62$	0.44	0.01*	$F_{1,13} = 0.18$	0.68	0.00
	Hyperarousal	23.56 (6.04)	20.89 (9.83)	23.83 (9.13)	22.67 (4.63)	$F_{1,13} = 0.09$	0.77	0.00	$F_{1,13} = 0.71$	0.41	0.02*	$F_{1,13} = 0.11$	0.75	0.00

Note. CAPS = Clinician Administered PTSD Scale; RM-ANOVA = repeated measures analysis of variance; SD = standard deviation.
η^2 = effect size. *Small effect size. **Medium effect size. ***Significant at $p < 0.05$.

no significant between-group differences on total PTSD symptoms, as measured by the CAPS past-week or past-month. There were nonsignificant trends with small effect sizes in pre- to postdifferences between groups for past-week hyperarousal symptoms and for past-week and past-month avoidance symptoms (Table 2).

Given these null results between groups with small effect sizes, post hoc power analyses were conducted using G*Power version 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2007). For $\alpha = 0.05$, N = 31 and Cohen's f = 0.1768 (past-week total CAPS), power = 0.16. For comparison, to achieve power = 0.80 at $\alpha = 0.05$ for the same Cohen's f, the sample size would have to be N = 256. Over time, most results demonstrated small effect sizes that were nonsignificant in the RM-ANOVA. The only analysis by time that showed significant reductions was CAPS reexperiencing symptoms (past-week): both the yoga ($M_{difference} = -5.33$) and control groups ($M_{difference} = -5.17$) improved, $F(1,13) = 6.66$, $p = 0.02$, with a medium effect size ($\eta^2 = 0.10$). Analyses did not show any significant group by time interactions. See Table 2 for full results and statistics.

Self-reported PTSD symptoms. A paired *t*-test demonstrated that there were no significant differences between PCL-M and PCL-C scores for data from eight participants in both groups across three time points ($t(23) = 1.12$, $p = 0.27$) and the means were highly correlated ($r = 0.87$). Thus, we will only report results from the PCL-M. For the PCL-M, self-reported PTSD symptoms were reduced in the yoga group ($M_{difference} = -8.5$), while symptoms increased marginally in the control group ($M_{difference} = 1$; Table 3). Results from a RM-ANOVA did not demonstrate significant differences for between- or within-subjects factors. Analyses revealed a large effect size ($\eta^2 = 0.14$), suggesting an improvement in the yoga but not in the control group (Table 3). For the IES, RM-ANOVA analyses revealed no significant differences on between- or within-subjects factors, but did show small to medium effect sizes in favor of the yoga group (Table 3). Because of small sample sizes, results for PCL-M and IES should be interpreted with caution.

WL Yoga Group Analyses

We tested for differences between Time 1 and Time 2 (pre = Time 1 and post = Time 2) for WL yoga group self-selectors versus non-self-selectors (Figure 1). RM-ANOVA analyses revealed no statistically significant differences between self-selectors and non-self-selectors for all CAPS outcomes (past-month lowest $p = 0.60$ [reexperiencing]). For self-selectors, we evaluated PTSD-outcome data across time for Stage 1 (pre = Time 1 and post = Time 2) and Stage 2 of the WL yoga group participation (Time 1, Time 2 and post-yoga = Time 3). See Figure 1. For the CAPS past-week, within-subjects RM-ANOVA analyses did not demonstrate any significant differences between participants' control group and WL yoga group phases but medium to large effect sizes were observed (Table 4).

For CAPS past-month, within-subjects RM-ANOVAs revealed significant differences for total, $F(2,5) = 6.47$, $p = 0.02$, and reexperiencing, $F(2,5) = 8.25$, $p = 0.01$, symptoms. No significant differences were observed for avoidance, $F(2,5) = 3.40$, $p = 0.09$, or hyperarousal symptoms, $F(2,5) = 2.09$, $p = 0.19$. For CAPS total symptoms, post hoc Tukey's pairwise comparisons showed no significant differences between Time 1 and Time 2 assessments ($M_{difference} = -2.50$) $t(29) = -0.35$, $p = 0.94$, but there were significant differences between Time 1 and Time 3 ($M_{difference} = -23.5$) $t(29) = -3.27$, $p = 0.02$, and between Time 2 and Time 3 ($M_{difference} = -21.00$) $t(29) = -2.93$, $p = -2.93$. For reexperiencing symptoms, post hoc Tukey's contrasts showed no significant differences between Time 1 and Time 2 ($M_{difference} = -3.83$) $t(29) = -1.57$, $p = 0.30$, or Time 2 and Time 3 ($M_{difference} = -6.00$) $t(29) = -2.46$, $p = 0.08$ (Table 4), but there was a significant difference between Time 1 and Time 3 ($M_{difference} = -9.83$) $t(29) = -4.03$, $p = 0.01$. Results from the PCL-M did not demonstrate significant differences across time but they did demonstrate a large effect size ($\eta^2 = 0.51$). Similarly, no significant differences across time were observed for IES total or IES subscales and large effect sizes were observed.

Table 3
PCL-M and IES–Descriptive Statistics and RM-ANOVA Comparing Yoga and Control Groups

	Group						RM-ANOVA								
	Yoga ($n = 8$)[a] ($n = 5$)[b]			Control ($n = 7$)[a] ($n = 5$)[b]			Group			Time			Group*Time		
	Pre	Mid	Post	Pre	Mid	Post									
	Mean (SD)						*F*	*p*	η^2	*F*	*p*	η^2	*F*	*p*	η^2
PCL-M	51.50 (9.68)	48.88 (17.15)	43.00 (14.28)	57.00 (16.99)	64.14 (14.3)	58.00 (17.7)	$F_{1,13} = 3.00$	0.11	0.14***	$F_{2,26} = 1.70$	0.20	0.02	$F_{2,26} = 1.43$	0.26	0.02*
IES-Total	1.93 (1.00)	1.81 (0.62)	1.59 (1.01)	2.28 (1.19)	3.24 (2.65)	2.50 (1.44)	$F_{1,8} = 1.25$	0.30	0.08**	$F_{2,16} = 0.84$	0.41	0.00	$F_{2,16} = 0.90$	0.40	0.01*
IES-Intrusion	1.90 (0.95)	1.65 (0.46)	1.53 (0.53)	2.23 (1.16)	2.20 (1.25)	2.38 (1.35)	$F_{1,8} = 0.89$	0.37	0.08**	$F_{2,16} = 0.22$	0.78	0.00	$F_{2,16} = 0.64$	0.42	0.01*
IES- Avoidance	1.88 (1.03)	1.90 (0.70)	1.72 (0.79)	2.12 (1.36)	2.36 (1.23)	2.50 (1.56)	$F_{1,8} = 0.56$	0.48	0.05**	$F_{2,16} = 0.14$	0.84	0.00	$F_{2,16} = 0.50$	0.59	0.01*
IES-Hyperarousal	2.03 (1.13)	1.90 (0.85)	1.50 (1.33)	2.50 (1.14)	2.48 (1.14)	2.677 (1.53)	$F_{1,8} = 1.18$	0.31	0.10 ***	$F_{2,16} = 0.19$	0.82	0.00	$F_{2,16} = 0.79$	0.47	0.02*

Note. PCL-M = PTSD Checklist Military Version; IES = Impact of Events Scale; RM-ANOVA = repeated measures analysis of variance; SD = standard deviation; η^2 = effect size

[a]Sample size for PCL-M.

[b]Sample size for IES.

*Small effect size. **Medium effect size. ***Large effect size.

Table 4
CAPS Past Week and Past Month, Descriptive Statistics, and RM-ANOVA—Wait-list Yoga Group

		Wait-list yoga group ($n = 7$)					
		Time 1	Time 2	Time 3	RM-ANOVA – Time		
		Mean (SD)			*F*	*p*	η^2
CAPS Past week	Total	67.17 (9.58)	62.83 (18.70)	43.83 (21.40)	$F_{2,5} = 3.96$	0.07	0.16^{**}
	Reexperiencing	18.00 (8.65)	13.00 (9.47)	7.83 (8.13)	$F_{2,5} = 5.03$	0.06	0.15^{**}
	Avoidance	27.00 (1.79)	25.33 (11.22)	7.83 (8.13)	$F_{2,5} = 2.35$	0.16	0.10^{*}
	Hyperarousal	22.17 (6.94)	24.50 (7.82)	18.33 (7.78)	$F_{2,5} = 1.31$	0.30	0.08^{*}
CAPS Past month	Total	71.00 (6.90)	68.50 (14.72)	47.50 (19.87)	$F_{2,5} = 6.47$	0.02^{***}	0.17^{**}
	Reexperiencing	21.83 (6.05)	18.00 (7.71)	12.00 (8.27)	$F_{2,5} = 8.25$	0.01^{***}	0.16^{**}
	Avoidance	27.00 (1.79)	26.00 (9.17)	17.17 (9.70)	$F_{2,5} = 3.40$	0.09	0.10^{*}
	Hyperarousal	22.17 (6.94)	24.50 (7.06)	18.33 (6.62)	$F_{2,5} = 2.09$	0.19	0.08^{*}

Note. RM-ANOVA = repeated measures analysis of variance; CAPS = Clinician Administered PTSD Scale; SD = Standard deviation; η^2 = effect size.
*Small effect size. **Medium effect size. ***Significant at $p < 0.05$.

Treatment Dropout

Overall, 51% of participants (26 of 51 randomized to start treatment) either withdrew or were lost to follow up across the entire study, including Stages 1 and 2. During Stage 1, the dropout rate was 39% (20 of 51 participants randomized to start treatment). Over half of the yoga group (62%) and nearly half of the WL yoga group (46%) dropped out of the study. In contrast, dropout was less than one-quarter for the control group (16%). Comparing individual groups (yoga, control, and WL yoga), a chi square test of independence between the yoga and WL yoga group was not significant, X^2 $(2, n = 39) = 0.83$, $p < 0.05$, suggesting similar dropout during yoga treatments. A chi square test of independence between the yoga group and control group was significant, X^2 $(2, n = 51) = 11.09$, $p < 0.05$, and a chi square test between the WL yoga and control group was also significant, X^2 $(2, n = 38) = 4.01$, $p < 0.05$. Thus, dropout was significantly lower in the control group compared to the yoga groups.

Discussion

Overall, results did not support our primary hypothesis that compared to controls, veterans participating in yoga would experience greater PTSD symptom reductions. CAPS analyses did not show significant between-group differences but showed small effect sizes, indicating within-group decreases for yoga but not controls. Because we wish to be conservative in our interpretations and considering that there are different thresholds for clinical significance in the field (e.g., Schnurr et al., 2003; Weathers et al., 2001), yoga group participants may or may not have experienced clinically significant symptom reductions, as indicated by a 10- or 15-point drop in CAPS.

Similar to Mitchell et al. (2014), results showed significant decreases in past-week CAPS reexperiencing and within-group medium effect sizes for both groups, which may be due to

self-monitoring effects. Baseline mean PCL-M scores for the yoga group ($M = 51$) and control group ($M = 57$) exceeded the cutoff score of 50 (Forbes et al., 2001), screening positive for PTSD. After yoga, mean scores fell below this threshold for the yoga group ($M = 43$) but not the control group ($M = 58$). Despite no significant between-group differences in PCL-M or IES, they had medium to large effects in the yoga group, which could suggest PTSD symptom reduction. However, high dropout rates and lack of immunity against Type II error due to small sample size requires cautious interpretation.

Results supported the second hypothesis that veterans in the WL yoga group would see improvement in PTSD symptoms after yoga participation. In contrast to the WL yoga group's symptoms during the control group phase, after yoga participation they had significant decreases in past-month CAPS total and reexperiencing. Self-report results also indicated significant decreases in PTSD symptoms after yoga participation in the WL yoga group, although a conclusion of efficacy here must be tempered by small sample sizes.

There are several possible explanations why WL yoga self-selector's PTSD symptoms improved more than the randomized yoga group's PTSD symptoms. First, WL analyses even for the significant results were likely underpowered leading to statistical anomaly. Second, participants could have been influenced by demand characteristics, which suggest that when a participant knows a study's purpose, their results are influenced in the direction of study predictions. During their control group participation (Stage 1; Figure 1), WL self-selectors may have gleaned this study's purpose, which may have influenced their results during the intervention in Stage 2, such that their PTSD symptoms decreased.

Third, participating in Stage 1 itself affected the WL group self-selectors. Stage 1 was somewhat analogous to a run-in period to screen for compliance. Yet run-in periods may inflate or weaken results in clinical trials, decreasing generalizability (Pablos-Méndez, Barr, & Shea, 1998). Similar to a run-in period, self-selectors within the WL may have had higher motivation than non-self-selectors. It is likely that results from the primary analysis are more representative and thus more generalizable to the veteran population diagnosed with PTSD. Therefore, an interpretation of these results is that yoga might be especially beneficial for veterans who are highly motivated to practice it.

The power of motivation may be important to further explore. We found that self-selectors did not have more severe PTSD symptoms than non-self-selectors, so symptom severity was apparently not a motivator. While not measured in this study, one difference between the self-selection and randomized groups may have been intention or interest in yoga as part of a larger psychosocial context of the intervention (Gard et al., 2014). Intention could be an important variable for interventions such as yoga requiring sizeable time commitment and requesting behavior changes. Future controlled trials may need to not only measure but also account for intention in randomization procedures.

Limitations and Strengths

Although we successfully recruited veterans with PTSD (Figure 1), dropout was higher in the yoga groups relative to the control group. This study's dropout is on the high end of ranges in published studies: 7% and 32% for yoga treatment studies; 0 to 54% for traditional psychotherapies; and 68% for cognitive behavioral therapy (van der Kolk et al., 2014; Mitchell et al., 2014; Garcia, Kelley, Rentz, & Lee, 2011; Gutner, Gallagher, Baker, Sloan, & Resick, 2015; Hembree et al., 2003; Schottenbauer et al., 2008). Reasons for this may be because of the substantial time commitment for the yoga intervention, perceived heightened anxiety or triggers through enhanced mind–body awareness or interoception, and the use of a group yoga intervention format. Recruitment in this study was slow, and participant and yoga room scheduling conflicts were frequent. Future research might use individual sessions instead of group classes to possibly increase retention and allow individual modifications to the manualized intervention, or future research could use rolling admission (Mitchell et al., 2014). Yoga participant retention may also be enhanced by increasing engagement (Hoge et al., 2014) through the use of motivational interviewing strategies (Hettema, Steele, & Miller, 2005) to increase veterans' readiness for change and treatment adherence (Jackupack et al., 2013).

Logistical challenges of conducting a yoga intervention study included limited yoga class venues, which may have been mitigated with a rolling entry design with a consistent yoga class location and time. Another alternative to our design or a rolling entry design would be integrating yoga into one-on-one office visits with trained providers (e.g., primary care providers and/or mental health professionals), which may increase retention and allow individual modifications to the manualized intervention. For example, coordination with PTSD or mental health clinics in the Veterans Health Administration (VHA) may allow mental health providers to support engagement in the yoga program and thus enhance participation. In addition, this study had other design-related limitations: self-selection bias (all participants were knowledgeable of study purpose and intervention upon recruitment, and control participants had the choice to opt into the WL condition), lack of active control group, and use of completer versus intention-to-treat analysis.

Study strengths include recruitment and intervention locations and inclusion of female and male participants, which may have increased external validity. Because this study included recruitment and yoga classes at both VHA and non-VHA sites and some veterans are not treated at VHA facilities, the sample may be more representative than other yoga studies exclusively conducted at the VHA. On the other hand, some veterans like to go to VHA sites and feel comfortable going there often. Even though our design may have increased external validity, we may have had difficulty retaining clients because some of the classes were at non-VHA sites.

Conclusion

Additional treatment options for veterans with PTSD are needed, and yoga has been proposed as an adjunctive intervention with limited support from preliminary studies. Results from this first RCT of yoga for female and male veterans with PTSD are consistent with an existing RCT limited to women (Mitchell et al., 2014). Data from clinician interviews and self-report surveys indicated that participants in both yoga and control groups experienced reductions in PTSD symptoms. Furthermore, data from WL yoga self-selectors offered some support for yoga decreasing PTSD symptoms, although the sample size was too small for conclusive interpretations. Consistent with current literature regarding high rates of dropout for veterans in PTSD treatment, this study faced challenges retaining veterans in treatment.

Acknowledgements

The authors thank Barbara Niles, PhD for her valuable help with this manuscript.

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC: Author.

Blake, D., Weathers, F., Nagy, L., Kaloupek, D., Klauminzer, G., Charney, D., ... Vuxkley, T C. (2000). Instruction manual: Clinician-administered PTSD scale (CAPS). West Haven: National Center for Posttraumatic Stress Disorder.

Cabral, P., Meyer, H. B., & Ames, D. (2011). Effectiveness of yoga therapy as a complementary treatment for major psychiatric disorders: A meta-analysis. The Primary Care Companion to CNS Disorders, 13(4). http://doi.org/10.4088/PCC.10r01068

Campbell K., Rohlman D., Storzbach D., Binder, L. M., Anger, W. K., Kovera, C. A., ... Grossmann, S. J. (1999). Test-retest reliability of psychological and neurobehavioral tests self-administered by computer. Assessment, 6(1), 21–32.

Carter, J. J., Gerbarg, P. L., Brown, R. P., Ware, R., D'Ambrosio, C. D., Anand, L., ... Katzman, M. A. (2013). Multi-component yoga breath program for Vietnam veteran post traumatic stress disorder: Randomized controlled trial. Journal of Traumatic Stress Disorders & Treatment, 02(03). https://doi.org/10.4172/2324-8947.1000108

Cicchetti, D., Fontana, A., & Showalter, D. (2009). Evaluating the reliability of multiple assessments of PTSD symptomatology: Multiple examiners, one patient. Psychiatry Research, 166(2–3), 269–280. https://doi.org/10.1016/j.psychres.2008.01.014

Clancy, C. P., Graybeal, A., Tompson, W. P., Badgett, K. S., Feldman, M. E., Calhoun, P. S., … Beckham, J. C. (2006). Lifetime trauma exposure in veterans with military-related posttraumatic stress disorder: Association with current symptomatology. The Journal of Clinical Psychiatry, 67(9), 1346–1353.

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

Creamer, M., Bell, R., & Failla, S. (2003). Psychometric properties of the Impact of Event Scale-Revised. Behaviour Research and Therapy, 41(12), 1489–1496. http://doi.org/10.1016/j.brat.2003.07.010

Dick, A. M., Niles, B. L., Street, A. E., DiMartino, D. M., & Mitchell, K. S. (2014). Examining mechanisms of change in a yoga intervention for women: The influence of mindfulness, psychological flexibility, and emotion regulation on PTSD symptoms. Journal of Clinical Psychology, 70(12), 1170–1182. http://doi.org/10.1002/jclp.22104

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175–191.

First, M. B., Williams, J. B.W., Spitzer, R. L., & Gibbon, M. (2007). Structured clinical interview for DSM-IV-TR axis I disorders, clinical trials version (SCID-CT). New York: Biometrics Research, New York State Psychiatric Institute.

Forbes, D., Fletcher, S., Lockwood, E., O'Donnell, M., Creamer, M., Bryant, R. A., … Silove, D. (2011). Requiring both avoidance and emotional numbing in DSM-V PTSD: Will it help? Journal of Affective Disorders, 130(3), 483–486. http://doi.org/10.1016/j.jad.2010.10.032

Fulton, J. J., Calhoun, P. S., Wagner, H. R., Schry, A. R., Hair, L. P., Feeling, N., … Beckham, J. C. (2015). The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) veterans: A meta-analysis. Journal of Anxiety Disorders, 31, 98–107. http://doi.org/10.1016/j.janxdis.2015.02.003

Garcia, H. A., Kelley, L. P., Rentz, T. O., & Lee, S. (2011). Pretreatment predictors of dropout from cognitive behavioral therapy for PTSD in Iraq and Afghanistan war veterans. Psychological Services, 8(1), 1–11. http://doi.org/10.1037/a0022705

Gard, T., Noggle, J. J., Park, C. L., Vago, D. R., & Wilson, A. (2014). Potential self-regulatory mechanisms of yoga for psychological health. Frontiers in Human Neuroscience, 8. http://doi.org/10.3389/fnhum.2014.00770

Gutner, C. A., Gallagher, M. W., Baker, A. S., Sloan, D. M., & Resick, P. A. (2015). Time course of treatment dropout in cognitive-behavioral therapies for posttraumatic stress disorder. Psychological Trauma: Theory, Research, Practice, and Policy. http://doi.org/10.1037/tra0000062

Hembree, E. A., Foa, E. B., Dorfan, N. M., Street, G. P., Kowalski, J., & Tu, X. (2003). Do patients drop out prematurely from exposure therapy for PTSD? Journal of Traumatic Stress, 16(6), 555–562. http://doi.org/10.1023/B:JOTS.0000004078.93012.7d

Hettema, J., Steele, J., & Miller, W. R. (2005). Motivational interviewing. Annual Review of Clinical Psychology, 1(1), 91–111. http://doi.org/10.1146/annurev.clinpsy.1.102803.143833

Hoge, C. W., Grossman, S. H., Auchterlonie, J. L., Riviere, L. A., Milliken, C. S., & Wilk, J. E. (2014). PTSD treatment for soldiers after combat deployment: Low utilization of mental health care and reasons for dropout. Psychiatric Services, 65(8), 997–1004. https://doi.org/10.1176/appi.ps.201300307

Hoskins, M., Pearce, J., Bethell, A., Dankova, L., Barbui, C., Tol, W. A., … Bisson, J. I. (2015). Pharmacotherapy for post-traumatic stress disorder: Systematic review and meta-analysis. The British Journal of Psychiatry, 206(2), 93–100. http://doi.org/10.1192/bjp.bp.114.148551

Jakupcak, M., Hoerster, K. D., Blais, R. K., Malte, C. A., Hunt, S., & Seal, K. (2013). Readiness for change predicts VA mental healthcare utilization among Iraq and Afghanistan war veterans. Journal of Traumatic Stress, 26(1), 165–168. http://doi.org/10.1002/jts.21768

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. http://doi.org/10.1155/2015/351746

Johnston, J. M., Minami, T., Greenwald, D., Li, C., Reinhardt, K., & Khalsa, S. B. (2015). Yoga for military service personnel with PTSD: A single arm study. Psychological Trauma: Theory, Research, Practice, and Policy. http://doi.org/10.1037/tra0000051

Keen, S. M., Kutter, C. J., Niles, B. L., & Krinsley, K. E. (2008). Psychometric properties of PTSD checklist in sample of male veterans. Journal of Rehabilitation Research and Development, 45(3), 465–74.

Kessler, R. C., Berglund, P., Demler O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. Archives of General Psychiatry, 62(6), 593–602. http://doi.org/10.1001/archpsyc.62.6.593

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: The Official Publication of the American Federation for Clinical Research, 61(5), 827–834. http://doi.org/10.231/JIM.0b013e3182906862

Macy, R. J., Jones, E., Graham, L. M., & Roach, L. (2015). Yoga for trauma and related mental health problems a meta-review with clinical and service recommendations. Trauma, Violence, & Abuse. http://doi.org/10.1177/1524838015620834

Magruder, K., Serpi, T., Kimerling, R., Kilbourne, A. M., Collins, J. F., Cypel, Y., ... Reinhard, M. J. (2015). Prevalence of posttraumatic stress disorder in Vietnam-era women veterans: The health of Vietnam-era women's study (HealthVIEWS). JAMA, 72(11), 1127–1134.

Martin, E. C., Dick, A. M., Scioli-Salter, E. R., & Mitchell, K. S. (2015). Impact of a yoga intervention on physical activity, self-efficacy, and motivation in women with PTSD symptoms. Journal of Alternative & Complementary Medicine, 21(6), 327–332. http://doi.org/10.1089/acm.2014.0389

Metcalf, O., Varker, T., Forbes, D., Phelps, A., Dell, L., DiBattista, A., ... O'Donnell, M. (2016). Efficacy of fifteen emerging interventions for the treatment of posttraumatic stress disorder: A systematic review. Journal of Traumatic Stress, 29(1), 88–92. https://doi.org/10.1002/jts.22070

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. http://doi.org/10.1002/jts.21903

Office of the Deputy Assistant Secretary of Defense. (2017). 2014 demographics profile of the military community. Retrieved from http://download.militaryonesource.mil/12038/MOS/Reports/2014-Demographics-Report.pdf

Pablos-Méndez, A., Barr, R. G., & Shea, S. (1998). Run-in periods in randomized trials: Implications for the application of results in clinical practice. JAMA, 279(3), 222–225.

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: Journal of the American Medical Association, 314(5), 456–465. https://doi.org/10.1001/jama.2015.8361

Quiñones, N., Maquet, Y. G., Vélez, D. M. A., & López, M. A. (2015). Efficacy of a Satyananda yoga intervention for reintegrating adults diagnosed with posttraumatic stress disorder. International Journal of Yoga Therapy, 25(1), 89–99. http://doi.org/10.17761/1531-2054-25.1.89

Reddy, S., Dick, A. M., Gerber, M. R., & Mitchell, K. (2014). The effect of a yoga intervention on alcohol and drug abuse risk in veteran and civilian women with posttraumatic stress disorder. The Journal of Alternative and Complementary Medicine, 20(10), 750–756. http://doi.org/10.1089/acm.2014.0014

Rhodes, A., Spinazzola, J., & van der Kolk, B. (2016). Yoga for adult women with chronic PTSD: A long-term follow-up study. Journal of Alternative and Complementary Medicine, 22(3), 189–196. http://doi.org/10.1089/acm.2014.0407

Richardson, L. K., Frueh, B. C., & Acierno, R. (2010). Prevalence estimates of combat-related post-traumatic stress disorder: Critical review. Australian and New Zealand Journal of Psychiatry, 44(1), 4–19. http://doi.org/10.3109/00048670903393597

Riley, K. E., & Park, C. L. (2015). How does yoga reduce stress? A systematic review of mechanisms of change and guide to future inquiry. Health Psychology Review, 9(3), 379–396. http://doi.org/10.1080/17437199.2014.981778

Rosenbaum, S., Vancampfort, D., Steel, Z., Newby, J., Ward, P. B., & Stubbs, B. (2015). Physical activity in the treatment of post-traumatic stress disorder: A systematic review and meta-analysis. Psychiatry Research, 230(2), 130–136. https://doi.org/10.1016/j.psychres.2015.10.017

Schmalzl, L., Crane-Godreau, M. A., & Payne, P. (2014). Movement-based embodied contemplative practices: Definitions and paradigms. Frontiers in Human Neuroscience, 8. https://doi.org/10.3389/fnhum.2014.00205

Schnurr, P. P., Friedman, M. J., Foy, D. W., Shea, M. T., Hsieh, F. Y., Lavori, P. W., ... & Bernardy, N. C. (2003). Randomized trial of trauma-focused group therapy for posttraumatic stress disorder: Results from a Department of veterans Affairs cooperative study. Archives of General Psychiatry, 60(5), 481–489.

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. http://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. H., … Davidson, R. J. (2014). Breathing-based meditation decreases posttraumatic stress disorder symptoms in U.S. military veterans: A randomized controlled longitudinal study. Journal of Traumatic Stress, 27(4), 397–405. http://doi.org/10.1002/jts.21936

Stankovic, L. (2011). Transforming trauma: A qualitative feasibility study of integrative restoration (iRest) yoga nidra on combat-related post-traumatic stress disorder. International Journal of Yoga Therapy, 21(1), 23–37. http://doi.org/10.17761/ijyt.21.1.v823454h5v57n160

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. http://doi.org/10.7205/MILMED-D-12-00536

Strauss, J. L., Coeytaux, R., McDuffie, J., Nagi, A., & Williams, J. W. (2011). Efficacy of complementary and alternative medicine therapies for posttraumatic stress disorder. Washington DC: Department of Veterans Affairs. Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK82774/

Street, A. E., Gradus, J. L., Giasson, H. L., Vogt, D., & Resick, P. A. (2013). Gender differences among veterans deployed in support of the wars in Afghanistan and Iraq. Journal of General Internal Medicine, 28(2), 556–562. http://doi.org/10.1007/s11606-013-2333-4

Streeter, C. C., Gerbarg, P. L., Saper, R. B., Ciraulo, D. A., & Brown, R. P. (2012). Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder. Medical Hypotheses, 78(5), 571–579. http://doi.org/10.1016/j.mehy.2012.01.021

Sundin, E. C., & Horowitz, M. J. (2002). Impact of Event Scale: Psychometric properties. The British Journal of Psychiatry, 180(3), 205–209. http://doi.org/10.1192/bjp.180.3.205

Surís, A., & Lind, L. (2008). Military sexual trauma: A review of prevalence and associated health consequences in veterans. Trauma, Violence, & Abuse, 9(4), 250–269. http://doi.org/10.1177/1524838008324419

Telles, S., Singh, N., & Balkrishna, A. (2012). Managing mental health disorders resulting from trauma through yoga: A review. Depression Research and Treatment, 2012, 1–9. http://doi.org/10.1155/2012/401513

Urbaniak, G. C., & Plous, S. (2015). Research randomizer (version 4.0) [computer software]. Retrieved from http://www.randomizer.org/

Van der Kolk, B. A. (2006). Clinical implications of neuroscience research in PTSD. Annals of the New York Academy of Sciences, 1071(1), 277–293. http://doi.org/10.1196/annals.1364.022

Van der Kolk, B. A., 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), e559–e565. http://doi.org/10.4088/JCP.13m08561

Vasterling, J. J., Proctor, S. P., Friedman, M. J., Hoge, C. W., Heeren, T., King, L. A., & King, D. W. (2010). PTSD symptom increases in Iraq-deployed soldiers: Comparison with nondeployed soldiers and associations with baseline symptoms, deployment experiences, and postdeployment stress. Journal of traumatic stress, 23(1), 41–51.

Weathers, F. W., Keane, T. M., & Davidson, J. R. T. (2001). Clinician-administered PTSD scale: A review of the first ten years of research. Depression and Anxiety, 13(3), 132–156. http://doi.org/10.1002/da.1029

Weathers, F. W., Litz, B. T., Herman, D., Huska, J., & Keane, T. (1994). The PTSD checklist-civilian version (PCL-C). Boston, MA: National Center for PTSD.

Weiss, D. S., & Marmar, C. R. (1997). The Impact of Event Scale – Revised. In J. P. Wilson & T. M. Keane (Eds.), Assessing psychological trauma and PTSD (pp. 399–411). New York: Guilford Press.

Wilkins, K. C., Lang, A. J., & Norman, S. B. (2011). Synthesis of the psychometric properties of the PTSD checklist (PCL) military, civilian, and specific versions. Depression and Anxiety, 28(7), 596–606. http://doi.org/10.1002/da.20837

Wynn, G. H. (2015). Complementary and alternative medicine approaches in the treatment of PTSD. Current Psychiatry Reports, 17(8), 600. http://doi.org/10.1007/s11920-015-0600-2