

A Pilot Study of a Randomized Controlled Trial of Yoga as an Intervention for PTSD Symptoms in Women

Karen S. Mitchell,^{1,2} Alexandra M. Dick,¹ Dawn M. DiMartino,³ Brian N. Smith,^{1,2} Barbara Niles,^{1,2} Karestan C. Koenen,⁴ and Amy Street^{1,2}

¹National Center for PTSD, VA Boston Healthcare System, Boston, Massachusetts, USA

²Department of Psychiatry, Boston University School of Medicine, Boston, Massachusetts, USA

³Simmons College School of Social Work, Boston, Massachusetts, USA

⁴Department of Epidemiology, Columbia University, New York, New York, USA

Posttraumatic stress disorder (PTSD) is a debilitating condition that affects approximately 10% of women in the United States. Although effective psychotherapeutic treatments for PTSD exist, clients with PTSD report additional benefits of complementary and alternative approaches such as yoga. In particular, yoga may downregulate the stress response and positively impact PTSD and comorbid depression and anxiety symptoms. We conducted a pilot study of a randomized controlled trial comparing a 12-session Kripalu-based yoga intervention with an assessment control group. Participants included 38 women with current full or subthreshold PTSD symptoms. During the intervention, yoga participants showed decreases in reexperiencing and hyperarousal symptoms. The assessment control group, however, showed decreases in reexperiencing and anxiety symptoms as well, which may be a result of the positive effect of self-monitoring on PTSD and associated symptoms. Between-groups effect sizes were small to moderate (0.08–0.31). Although more research is needed, yoga may be an effective adjunctive treatment for PTSD. Participants responded positively to the intervention, suggesting that it was tolerable for this sample. Findings underscore the need for future research investigating mechanisms by which yoga may impact mental health symptoms, gender comparisons, and the long-term effects of yoga practice.

Posttraumatic stress disorder (PTSD) is a debilitating condition that results from exposure to traumatic events. Generally, PTSD appears to be twice as common among women as men in the United States (Kessler et al., 2005; Mitchell, Mazzeo, Schlesinger, Brewerton, & Smith, 2012). Empirically based treatments for PTSD, including cognitive processing therapy and prolonged exposure, have excellent remission rates (e.g., Resick, Williams, Suvak, Monson, & Gradus, 2012). There has been increased interest, however, in complementary treatments, including mindfulness-based practices, as adjunctive treatments to traditional psychotherapies. Indeed, the Institute of Medicine (IOM) recently released a report calling for more research on complementary and alternative approaches to the treatment of PTSD (IOM, 2012). Mindfulness introduces one possible strategy for reducing the avoidance symptoms characteristic of

PTSD by encouraging focusing one's attention on the present moment and emphasizing attention to thoughts, feelings, and emotions without judgment. These techniques may enhance ability to tolerate unpleasant feelings and decrease avoidance of traumatic memories (Follette, Palm, & Pearson, 2006).

Yoga, consisting of breathing exercises and physical poses, is a mindfulness technique that emphasizes attention to emotional and physical stimuli and may be effective as an alternative treatment for a variety of physical and mental health conditions. There are few published scientific investigations of yoga for PTSD. In a small study ($N = 8$) of women randomly assigned to eight sessions of hatha yoga exercises or dialectical behavior therapy, only the yoga group demonstrated significant reductions in symptoms of intrusions and hyperarousal (van der Kolk, 2006). A yoga breath intervention for tsunami survivors nonrandomly assigned 183 participants to the yoga breath intervention alone, yoga breath intervention + exposure treatment, or a waitlist control group. Both the breath intervention and combined treatment participants had improvements in PTSD, depression, and quality of life (Descilo et al., 2010).

A recent randomized controlled trial (RCT) compared Patanjali yoga, practiced 1 hour per day for 7 days, to a waitlist control group among 22 male flood survivors in India (Telles, Singh, Joshi, & Balkrishna, 2010). There were no group differences in heart-rate variability, breath rate, fear, anxiety, sadness, or

We wish to thank Michelle Schlesinger for her contributions to an earlier version of the yoga curriculum used in the current study. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States government.

Correspondence concerning this article should be addressed to Karen S. Mitchell, 150 S. Huntington Ave, 116B-3, Boston, MA 02130. VA Boston Healthcare System. E-mail: ksmitch@bu.edu

Published 2014. This article is a US Government work and is in the public domain in the USA. View this article online at wileyonlinelibrary.com
DOI: 10.1002/jts.21903

disturbed sleep; however, when examined separately, only the yoga group's mean sadness scores decreased significantly from pre- to postintervention. Taken together, these preliminary findings suggest that yoga may have a positive impact on PTSD and associated symptoms; however, most studies have used small samples and/or nonrandomized designs.

There are several potential pathways by which yoga impacts PTSD symptoms. Short- and long-term yoga practice have been associated with reduced basal cortisol and catecholamine secretion, decreased sympathetic and increased parasympathetic activity, and salutary effects on cognitive activity and cerebral neurophysiology (Rocha et al., 2012; West, Otte, Geher, Johnson, & Mohr, 2004). Yoga also may reduce the stress response by downregulating the hypothalamic–pituitary–adrenal axis (Ross & Thomas, 2010) and upregulating gamma-aminobutyric acid (Streeter et al., 2007), which may decrease hyperarousal symptoms.

Practicing yoga also can increase resilience and enhance mind–body awareness, which may help individuals adjust their cognitions and behaviors (Khalsa, 2004). Further, yoga may be intrinsically rewarding to participants and may serve as a means of behavioral activation, influencing engagement in other pleasant activities (Uebelacker et al., 2010). Enhanced mindfulness also may increase participants' awareness and acceptance of their emotions, improving their emotion-regulation skills (Holzel et al., 2011), thereby reducing avoidance and reexperiencing symptoms.

Yoga also may be effective for conditions comorbid with PTSD, including depression and anxiety (e.g., Iverson et al., 2011). In a single-group design with 17 participants with major depression who practiced Iyengar yoga for up to three times per week for 8 weeks, postintervention reductions were observed for depression, anxiety, anger, neurotic symptoms, and low-frequency heart rate variability, suggesting that yoga practice may reduce stress responsiveness (Shapiro et al., 2007). Kjellgren and colleagues (Kjellgren, Bood, Axelsson, Norlander, & Saatcioglu, 2007) found that nonrandomly assigned Sudarshan Kriya yoga participants ($n = 55$) had significant reductions in depression and anxiety symptoms, compared to control participants ($n = 48$), over the course of the intervention. A recent RCT by Streeter et al. (2010) compared 12 sessions of Iyengar yoga to a walking group and found that yoga participants ($n = 19$) evidenced significant improvements in mood and anxiety, relative to the walking group participants ($n = 15$).

Thus, yoga potentially could have a positive impact on PTSD, depression, and anxiety symptoms and may have high utility as an adjunctive/complementary treatment. Intervention studies of yoga for mental health conditions, however, are in their infancy. More rigorous and randomized controlled trials are needed to determine the effectiveness of yoga for PTSD.

The present study piloted an RCT of a 12-session yoga intervention, as compared to an assessment control, for women with PTSD symptoms. We hypothesized that participants assigned to the yoga intervention would report significantly greater reductions in PTSD, anxiety, and depression symptoms as compared

to the control. A secondary aim was to examine participants' tolerance for and the feasibility of the yoga intervention.

Method

Participants

Participants included veteran and civilian adult women recruited through fliers at a large northeastern Veterans Affairs (VA) medical center, use of a research participant recruitment database, and Craigslist (see Figure 1). Thirty-eight participants were randomized to the yoga ($n = 20$) or control ($n = 18$) groups.

Procedure

Study procedures were approved by the VA Boston Healthcare System Institutional Review Board. Recruitment was conducted in April–June 2011. Groups were conducted in June–September 2011; the 1-month follow-up assessment was completed in October 2011. A research assistant conducted a preliminary telephone screen for eligibility. Inclusion criteria at this stage were age 18–65 years and a positive on the Primary Care PTSD screen (PC-PTSD). Exclusion criteria were participation in a yoga class within the past 6 months, substance-dependence problem in the past 3 months, recent change of psychiatric medication, and indication of current suicide or homicide risk.

Candidates who met these initial criteria attended an in-person informed consent session and subsequent diagnostic assessment, including interviews and self-report questionnaires (see below), conducted by trained master's level research assistants. Individuals who reported at least subthreshold PTSD during their in-person interview, as indicated by the presence of at least one symptom in each criterion cluster, or meeting criteria for at least two symptom clusters (Mitchell et al., 2012; Schnurr, Friedman, & Rosenberg, 1993), were randomly assigned to either the yoga or the assessment control condition. The principal investigator (PI) used the Microsoft Excel random numbers function to assign participants to groups. Neither the group instructors nor participants were blinded to the randomization, as this would not have been feasible.

In the yoga intervention group, participants obtained a letter, signed by their primary care physician, stating that they were able to practice gentle to moderate yoga. They were asked to refrain from attending sessions while under the influence of alcohol or illicit substances. To maximize the likelihood that participants could attend most sessions, they were given the option to attend 12 weekly sessions or 12 twice-weekly sessions over 6 weeks, but were not allowed to switch from one group to the other once the intervention had begun. All sessions were 75-minutes long. A research assistant made weekly reminder calls to each participant.

The intervention was designed by the PI and the National Yoga Alliance-certified yoga instructor (curriculum available upon request). Only one instructor taught the yoga groups;

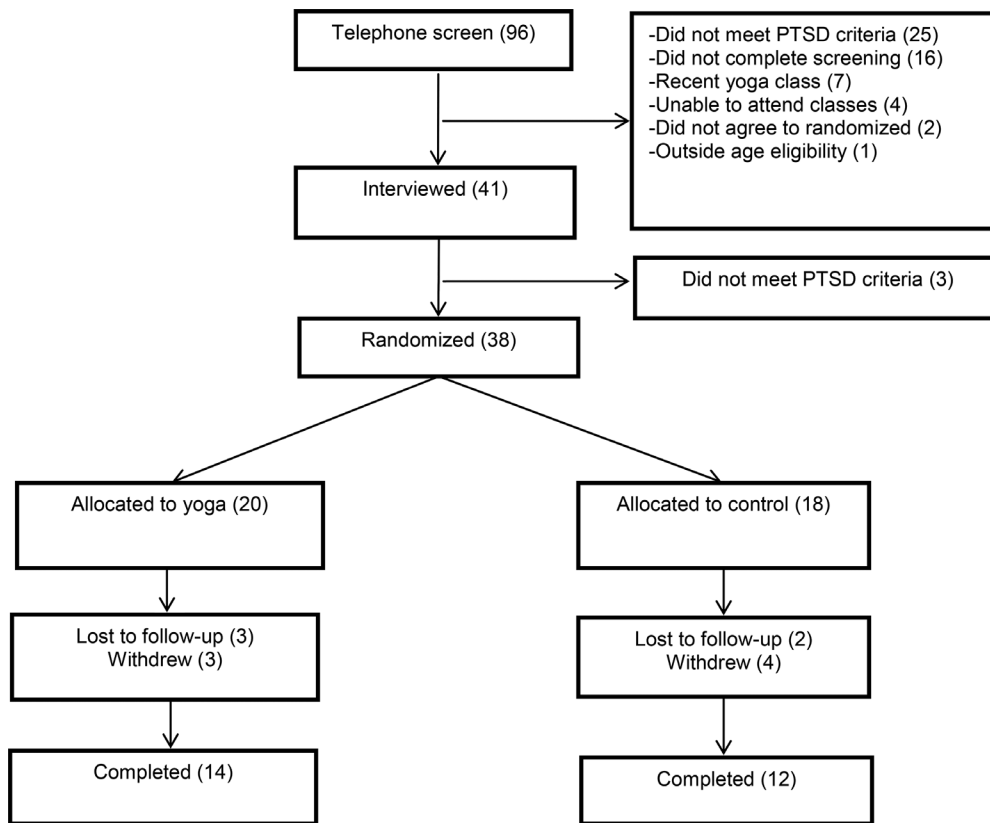


Figure 1. Flow of participants in study. PTSD = posttraumatic stress disorder.

a trained research assistant attended the classes to provide participant payments and administer questionnaires. The style of yoga was consistent with Kripalu, a form of hatha yoga that emphasizes the connections between mind and body and includes breathing and physical postures. Initial yoga classes began with simple poses that increased in difficulty over time. Participants were given ample instruction on modifications to the poses and informed that at any point they could break from the poses and simply sit and practice the accompanying breathing exercises. The yoga class also used guidelines for trauma-sensitive yoga (Emerson, Sharma, Chaudhry, & Turner, 2009), which emphasizes inviting participants to try poses, but never making them feel that they have to do or stay in a pose that feels uncomfortable. The tone is one of safety and nonjudgmental self-study. In addition, aspects of mindfulness, such as attending to thoughts and feelings without labeling them as good or bad, were emphasized. Specific PTSD symptoms, however, were not discussed during the class.

Participants completed several measures before every yoga session (weekly yoga participants) or alternating yoga sessions (biweekly yoga participants). All participants were compensated \$30 for the initial assessment. They received a yoga mat and water bottle and were compensated \$20 in cash at the end of each yoga class. They completed the postintervention assessment during the final class, and the 1-month follow-up assessment, for which they were compensated \$30.

In the assessment control condition, participants met once per week for 12 weeks in groups of 4–5 to complete the same weekly questionnaires as yoga participants. All sessions were conducted by a trained, master's-level research assistant, who also made weekly reminder calls. Assessment control group participants completed the full packet of questionnaires in the 12th week and at the 1-month follow-up assessment. They were then offered 12 yoga sessions and also were provided with a yoga mat and water bottle. They received \$30 for the initial assessment, \$20 for each weekly assessment and for the postintervention assessments, and \$30 for completing the 1-month follow-up assessment.

At the end of the study, all participants were provided with an information sheet about yoga for PTSD, beginning a home practice, and local resources for psychotherapy and domestic violence. A list of VA services was provided to veterans.

Measures

The PC-PTSD is a 4-item measure that was used to assess past-month PTSD symptoms during the telephone screening (Prins et al., 2003). The measure's developers reported that the PC-PTSD demonstrated acceptable temporal stability ($r = .83$) and convergent validity and has a sensitivity of .78 and a specificity of .87 (Prins et al., 2003). Endorsement of at least two symptoms was considered a positive screen.

The PTSD Symptom Scale-Interview (PSS-I) was used to diagnose PTSD prior to randomization (Foa, Riggs, Dancu, & Rothbaum, 1993). The PSS-I correlates strongly with other PTSD interviews and has excellent internal consistency and convergent validity (Foa & Tolin, 2000). The Structured Clinical Interview for *DSM-IV* (SCID-I/P; First, Spitzer, Gibbon, & Williams, 2002) was used to assess other Axis I disorders. Participants were administered the screening module as well as the mood episodes and substance use disorders sections; additional modules were administered based on positive results on the screen.

The demographic questionnaire and The Trauma Life Events Questionnaire (TLEQ) were completed at baseline. The PCL, CES-D, and STAI questionnaires were completed at baseline, postintervention, and at the 1-month follow-up assessment. The PCL also was administered weekly. Measures were counterbalanced to control for order effects.

The TLEQ is a self-report measure of exposure to a range of potentially traumatic events, including natural disasters, serious accidents, combat, and sexual and physical assault. This instrument has adequate test-retest reliability and content validity (Kubany et al., 2000).

The PTSD Checklist-Civilian (PCL-C) is a 17-item measure of *DSM-IV* (APA, 2000). Criteria for PTSD, including reexperiencing (Cluster B), avoidance (Cluster C), and hyperarousal (Cluster D) symptoms (Dobie et al., 2002). Participants were asked to answer questions based on symptoms in the previous month. The weekly version of the PCL was used during the intervention phase of the study. Changes of 10–20 points are considered clinically significant (Monson et al., 2008). In the current study, Cronbach's α at baseline was .87.

The Center for Epidemiological Studies-Depression Scale (CES-D) was used to measure depression symptomatology and consists of four subscales: Negative Affect, Positive Affect, Interpersonal Symptoms, and Somatic and Vegetative Activity. All subscales yield internally consistent scores (Cronbach's $\alpha \geq .80$) and demonstrate convergent and concurrent validity (Radloff, 1977). Total scores were used in the current investigation; Cronbach's α was .91 at baseline.

The State-Trait Anxiety Inventory (STAI) has two subscales, state (STAI-S) and trait anxiety (STAI-T), each consisting of 20 items. This measure has been found to yield internally consistent scores (Cronbach's $\alpha = .93$). Additionally, concurrent, convergent, divergent, and construct validity of the STAI were demonstrated by its developers (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI-S and STAI-T scores were analyzed in separate models in the current study. At baseline, Cronbach's α were .94 and .95, respectively, for these scales.

A demographic questionnaire was used to assess participants' age, ethnicity, height, weight, level of education, and prior yoga experience. Participants also indicated whether they previously had participated in psychotherapy or pharmacotherapy for PTSD or other psychiatric conditions.

A comments page was provided with each weekly assessment so that participants could provide feedback about the sessions, with an option to provide this feedback anonymously.

Data Analysis

Descriptive statistics were calculated using PASW Statistics version 18. Growth curve models (GCMs), using a multi-level framework, were estimated using Mplus 6.0 (Muthén & Muthén, 1998-2010). GCMs reflect dynamic change processes and model the influence of time-varying and time-invariant covariates. The intercept and slope are random; time is a Level 1 predictor. Level 2 represents interindividual differences and included group (coded 1 for yoga and 0 for control). For the current study, observations were nested within person, as data were longitudinal. Because yoga groups met either weekly or twice weekly, assessment time points were not equidistant. The "even" assessment time points were dropped for the weekly analyses. Specifically, the pre-yoga, Session 1, Session 3, Session 5, Session 7, Session 9, Session 11, postintervention, and 1-month follow up assessments were included for the PCL. In the STAI or CES-D models, only three time points (baseline, postintervention, and 1-month follow-up) were available for analysis. A variable representing the number of days since baseline (coded as zero) at each assessment point was included in the analyses. Between-groups effect sizes, analogous to Cohen's d , were calculated using the following formula (Feingold, 2009):

$$B * (\text{time}) / SD_{\text{raw}}$$

where B = the unstandardized coefficient of the regression of slope onto dummy-coded treatment group, time = the mean number of days since baseline at the 1-month follow-up, and SD_{raw} = the baseline standard deviation for the total sample.

The full intent-to-treat (ITT) sample ($n = 38$) was included in the analyses. All available data were used in the growth curve models (Muthén & Muthén, 1998-2010). Because of the relatively large number of statistical comparisons, p values $< .01$ were considered significant.

Results

Demographic information is presented for the 38 participants who were randomized (see Table 1 for demographics within each group). The participants' mean age was 44.37 years ($SD = 12.37$), and their body mass index was in the overweight range ($M = 29.33$, $SD = 7.38$). The sample included 9 veterans and 29 civilians; veterans had a marginally significantly higher mean age (49.67 years) than did civilians (42.72 years), $t(33.03) = 2.24$, $p = .032$. There were no significant differences in ethnicity, education, whether they previously had practiced yoga, or PCL, STAI, or CES-D baseline scores (all $p > .05$).

There were no significant differences between study completers and noncompleters in terms of age, $t(36) = -1.85$,

Table 1
Demographic Characteristics

Characteristics	Yoga group (<i>n</i> = 20)		Assessment control group (<i>n</i> = 18)	
	<i>n</i>	%	<i>n</i>	%
Race/ethnicity				
White/Caucasian	12	60.0	8	44.4
Black/African American	6	30.0	8	44.4
Asian American	0	0.0	2	11.1
Mixed/others	2	10.0	0	0.0
Years of education				
High school diploma/GED	2	10.0	0	0.0
Some college/associate's degree	4	20.0	11	61.1
Completed 4-year degree	6	30.0	4	22.2
Postbaccalaureate degree	8	40.0	3	16.7
≥ 1 prior yoga class	9	45.0	9	50.0
Regular yoga practice				
Less than 1 month	10	76.9	7	63.6
1.5 months	1	7.7	0	0.0
3 months	1	7.7	2	18.2
6 months	0	0.0	1	9.1
24 months	0	0.0	1	9.1
29 months	1	7.7	0	0.0
Prior mental health contact	17	85.0	14	82.4
PTSD psychotherapy	7	46.7	5	35.7

Note. GED = general education degree; PTSD = posttraumatic stress disorder.

$p = .073$), BMI, $t(36) = 0.34$, $p = .738$, education $\chi^2(3, N = 38) = 5.82$, $p = .152$, ethnicity $\chi^2(3, N = 38) = 1.14$, $p = .768$, or the proportion who had taken a yoga class before $\chi^2(1, N = 38) = 0.05$, $p = .852$. There was a marginally significant difference in baseline PCL scores, with noncompleters having higher scores ($M = 59.20$) than did completers ($M = 49.83$); $t(31) = 2.08$, $p = .046$.

Many participants reported multiple traumatic events on the TLEQ, including childhood physical abuse (47.4%), physical assault by romantic partner (59.5%), sexual abuse before the age of 13 (52.6%), sexual abuse between the ages of 13 and 18 (35.1%), adulthood sexual assault (57.9%), and the unexpected death of a loved one (86.8%). Twenty-nine (70.7%) met full criteria for current PTSD according to the PSS-I; the remaining nine (22.0%) had subthreshold PTSD. In addition, 34.2% of the women met criteria for current major depression.

Both the yoga and control groups experienced clinically significant decreases in PCL scores from baseline to postintervention and baseline to the 1-month follow-up (see Table 2 for study outcome means by group). In GCMs, slope means demonstrate whether the outcome changed significantly over time. Results revealed a significant decrease in PCL scores over time (see

Table 3 for slope means and statistics for all study outcomes); however, the impact of group was nonsignificant (unstandardized $B = -0.03$, $t = -0.54$, $p = .591$). When estimated separately for each group, PCL scores decreased significantly over the course of the intervention among yoga participants; the assessment control group had marginally significant decreases, as p values $< .01$ were considered significant.

When change in PCL reexperiencing was estimated in a separate model, scores decreased significantly, and there was no effect of group ($B = -0.01$, $t = -0.83$, $p = .409$). When examined separately, yoga and assessment-control participants' scores decreased significantly. PCL avoidance scores demonstrated marginally significant decreases; the impact of the group was nonsignificant ($B = 0.01$, $t = 0.25$, $p = .806$). Decreases were nonsignificant for the yoga group and marginally significant in the assessment control group. PCL hyperarousal symptoms decreased significantly, although the impact of group again was nonsignificant ($B = 0.003$, $t = 0.19$, $p = .850$). Hyperarousal scores decreased significantly for the yoga group alone. Decreases were marginally significant in the control group. Between-groups effect sizes, as described above, were small to medium: 0.20 (total), 0.31 (reexperiencing), 0.09 (avoidance), and 0.08 (hyperarousal).

Results revealed marginally significant decreases in CES-D scores, and there was no impact of group upon their trajectory ($B = 0.02$, $t = 0.42$, $p = .676$). Decreases were nonsignificant for both the yoga and assessment control groups. STAI-S scores decreased significantly, although again the impact of group was nonsignificant ($B = 0.01$, $t = 0.35$, $p = .727$). In addition, scores decreased significantly for the assessment control group, but not the yoga group. Similarly, STAI-T scores decreased significantly for the total sample. Although there was no effect of group ($B = 0.01$, $t = 0.38$, $p = .704$), when estimated separately, the assessment control group evidenced significant decreases, but the yoga group did not. Between-groups effect sizes for these models were small: .15 (CES-D), .12 (STAI-S), and .10 (STAI-T).

As noted above, noncompleters had marginally significantly higher PCL scores than did study completers. An equal number of participants, however, dropped out of the yoga and control groups. No adverse reactions were noted in either group. Yoga group participants made many positive comments regarding the study, for example, "the PTSD symptoms . . . are more easily controlled when I BREATHE deeply and consciously relax my body;" and "it . . . has been a life-changing experience for me. I am learning to notice 'me' more than ever before." No negative comments were made regarding the yoga intervention. Participants were informed that yoga may trigger negative emotions and that they could speak to the PI if they had any concerns. Only one participant requested to meet with the PI and was later referred to a therapist. Thus, preliminary evidence suggests that women with full or subthreshold PTSD can tolerate trauma-sensitive yoga, and subjective reports indicate positive reactions.

Table 2
Means and Standard Deviations for Study Outcomes by Treatment Group

Measure	Yoga group (n = 20)						Control group (n = 18)					
	Baseline		Postyoga		1-month follow-up		Baseline		End of assessments		1-month follow-up	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
PCL total	51.94	14.36	39.07	16.01	40.91	18.89	53.44	10.56	39.09	12.65	42.18	14.20
PCL-reexperiencing	15.25	5.24	11.64	4.73	11.92	4.89	15.67	3.76	12.73	4.31	13.42	4.06
PCL-avoidance	21.56	7.81	15.57	7.64	17.75	10.37	20.39	5.01	14.64	4.84	16.45	6.25
PCL-hyperarousal	16.42	4.65	11.86	4.88	13.77	5.23	17.50	4.05	11.73	4.84	13.17	5.59
STAI-state	47.75	14.73	42.00	16.84	36.85	17.62	47.94	11.68	40.70	13.61	41.83	15.09
STAI-trait	52.33	16.34	47.71	15.68	44.33	16.91	54.44	10.30	46.64	10.43	48.00	7.95
CES-D	29.58	16.01	22.50	15.82	24.38	16.75	30.83	8.96	21.64	11.21	25.50	11.39

Note. PCL = PTSD Checklist; STAI = State Trait Anxiety Inventory; CES-D = Center for Epidemiologic Studies-Depression Scale.

Discussion

In recent years, the benefits of yoga for mental health have been touted in the media, and the IOM has mandated the scientific study of complementary and alternative medicine (IOM, 2012). There are, however, no previously published RCTs of yoga for PTSD and few for depression or anxiety. In the current study, our yoga group had significant decreases in PTSD symptoms, including reexperiencing and hyperarousal symptoms, specifically. Contrary to expectations, the assessment control group, which consisted of attending weekly group sessions to complete questionnaires, also showed decreases in reexperiencing and anxiety symptoms. Indeed, both the yoga and control groups evidenced clinically significant change on the PCL over the course of the study. No significant differences in symptoms were observed between the intervention and control groups at the conclusion of the study.

These findings prompt us to consider factors common to both conditions that may have contributed to reduction of symptoms in both groups. Completing the baseline assessment may have served to “normalize” participants’ reactions and symptoms.

The weekly assessment may have increased self-monitoring in the control group. These participants had relatively minimal interactions with one another, and the weekly assessment was brief. Nonetheless, several participants in the assessment control condition noted on the comments page that “I liked the routine [of attending assessment sessions]. It made me feel more aware of my problems and how to deal with them” and “to see the different faces and races knowing things can happen to anyone” was beneficial. Self-monitoring has been shown to improve PTSD symptoms in adults with PTSD; however, participants who responded to self-monitoring alone tended to have lower symptoms at baseline and higher overall initial functioning levels (Tarrier, Sommerfield, Reynolds, & Pilgrim, 1999). In the current study, regular group assessment meetings also may have provided an element of behavioral activation for participants. In addition, the warm and empathic attention from the study team may have had a positive impact on participant symptoms.

Notably, another investigation with a small sample also failed to detect significant group differences but did observe different

Table 3
Results of Growth Curve Model Results for PTSD, Depression, and Anxiety Symptoms

Variable	Total sample			Yoga group			Control group		
	M	t	p	M	t	p	M	t	p
PCL total	-0.09	-3.55	<.001	-0.10	-2.96	.003	-0.09	-2.42	.02
PCL-reexperiencing	-0.03	-3.95	<.001	-0.04	-3.36	.001	-0.03	-2.47	.006
PCL-avoidance	-0.03	-2.58	.01	-0.03	-0.69	.49	-0.04	-2.24	.03
PCL-hyperarousal	-0.03	-3.78	<.001	-0.03	-2.97	.003	-0.03	-2.45	.01
CES-D	-0.04	-2.07	.04	-0.03	-1.03	.30	-0.05	-1.92	.06
STAI-state	-0.05	-3.33	.001	-0.04	-1.34	.18	-0.06	-2.98	.003
STAI-trait	-0.04	-3.44	.001	-0.04	-1.41	.16	-0.05	-4.04	<.001

Note. PCL = PTSD Checklist; STAI = State Trait Anxiety Inventory; CES-D = Center for Epidemiologic Studies-Depression Scale; M = slope mean. All p values < .01 were considered statistically significant.

patterns when the yoga and control groups were analyzed separately (Telles et al., 2010). As with many studies, our sample may have been too small to detect more nuanced differences between the groups, given the relatively small effect sizes, which were similar to those reported in other yoga trials (e.g., Telles et al., 2010). Power analyses revealed that we had < 10% power to detect such effect sizes. Nonetheless, previous findings regarding yoga for PTSD are based upon nonrandomized and/or uncontrolled trials. The current study provides important effect-size data for future investigations and underscores the need for additional, larger RCTs.

As described above, yoga participants shared many positive thoughts on the comments page. One benefit to offering yoga in clinical settings is that it may be appealing to patients who do not fully respond to traditional psychotherapy (IOM, 2012). Given its popularity, yoga also may help attract and retain patients in clinical settings. Although we wish to be cautious in drawing conclusions based on our pilot data and cannot definitively conclude that yoga is beneficial for PTSD above and beyond the nonspecific factors, such as self-monitoring and behavioral activation that our control group also experienced, this first RCT of yoga for PTSD suggests some useful clinical implications. Our participants did not report worsened symptoms or other adverse reactions as a result of the intervention, and it is important to have demonstrated this empirically.

Many questions remain regarding the benefits of yoga in addition to its impact above and beyond general behavioral activation. Although many different styles of yoga exist, to date no studies have addressed which type(s) are most beneficial to physical and mental health, which elements of yoga influence symptom reduction, what types of mindfulness practices are most appealing to participants, or to whom they are most beneficial. Yoga is conceptualized as a potential adjunctive treatment to evidence-based therapies for conditions such as PTSD; however, little research has examined it as such, or investigated whether participating in yoga could help treatment-naïve patients prepare for trauma-focused therapy. In addition, the impact of yoga and mindfulness practices on quality of life and functioning remains unknown. Theoretically, one of the mechanisms by which yoga impacts mental health is through enhanced mindfulness. Yet, much remains to be discovered regarding the various pathways in which yoga and other mindfulness techniques exert their influence on psychiatric symptoms.

In addition to the small sample size, several limitations should be considered. First, study noncompleters had marginally significantly higher PCL scores than did study completers, suggesting that participants with more pathology were less likely to tolerate attending either the yoga or control group. As an equal number withdrew from each condition, it does not seem that yoga had an adverse effect on individuals with greater levels of symptomatology. This may have resulted, however, in decreased variability in outcome measures.

Although this intervention included a 1-month follow-up assessment, future research is needed to determine the long-term

impact of yoga for PTSD and related symptoms. We did not have enough power to detect statistical differences between groups in the GCMs. In addition, the small sample size precluded comparisons by age, racial/ethnic group, veteran status, or full versus subthreshold PTSD. The size and education level of the sample make it unclear as to how these results would generalize to samples of women with lower levels of education, or to men. The race composition and education level of the sample, however, generally were comparable to that of the Boston area (United States Census Bureau, 2013). This study has several important strengths, most notably, the use of a randomized controlled design. Participants were diverse in terms of age, race, and physical fitness level. Our findings lay the groundwork for additional important research in this area and highlight the need for future research investigating mechanisms by which yoga may impact mental health symptoms, gender comparisons, and the long-term effects of yoga practice.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.
- Descilo, T., Vedamurtachar, A., Gerbarg, P. L., Nagaraja, D., Gangadhar, B. N., Damodaran, B., . . . Brown, R. P. (2010). Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia tsunami. *Acta Psychiatrica Scandinavica*, *121*, 289–300. doi:10.1111/j.1600-0447.2009.01466.x
- Dobie, D. J., Kivlahan, D. R., Maynard, C., Bush, K. R., McFall, M., Epler, A. J., & Bradley, K. A. (2002). Screening for post-traumatic stress disorder in female Veteran's Affairs patients: Validation of the PTSD checklist. *General Hospital Psychiatry*, *24*, 367–374. doi:10.1016/S0163-8343(02)00207-4
- Emerson, D., Sharma, R., Chaudhry, S., & Turner, J. (2009). Yoga therapy in practice. Trauma-sensitive yoga: Principles, practice, and research. *International Journal of Yoga Therapy*, *19*, 123–128.
- Feingold, A. (2009). Effect sizes for growth-modeling analysis for controlled clinical trials in the same metric as for classical analysis. *Psychological Methods*, *14*, 43–53. doi:10.1037/a0014699
- First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (2002). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition With Psychotic Screen (SCID-I/P W/PSY SCREEN)*. Washington, DC: New York State Psychiatric Institute, Biometrics Research.
- Foa, E. B., Riggs, D. S., Dancu, C. V., & Rothbaum, B. O. (1993). Reliability and validity of a brief instrument for assessing post-traumatic stress disorder. *Journal of Traumatic Stress*, *6*, 459–473. doi:10.1002/jts.2490060405
- Foa, E. B., & Tolin, D. F. (2000). Comparison of the PTSD Symptom Scale–Interview Version and the Clinician-Administered PTSD Scale. *Journal of Traumatic Stress*, *13*, 181–191. doi:10.1023/A:1007781909213
- Follette, V., Palm, K. M., & Pearson, A. N. (2006). Mindfulness and trauma: Implications for treatment. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, *24*, 45–61. doi:10.1007/s10942-006-0025-2
- Holzel, B. K., Carmody, J., Vangel, M., Congleton, C., Yerramsetti, S. M., Gard, T., & Lazar, S. W. (2011). Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Research*, *191*, 36–43. doi:10.1016/j.psychres.2010.08.006

- Institute of Medicine. (2012). *Treatment for posttraumatic stress disorder in military and veteran populations: Initial assessment*. Washington, DC: National Academies Press.
- Iverson, K. M., Hendricks, A. M., Kimerling, R., Kregel, M., Meterko, M., Stolzmann, K. L., . . . Lew, H. L. (2011). Psychiatric diagnoses and neurobehavioral symptom severity among OEF/OIF VA patients with deployment-related traumatic brain injury: A gender comparison. *Womens Health Issues, 21*, S210–S217. doi:10.1016/j.whi.2011.04.019
- 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*, 593–602. doi:10.1001/archpsyc.62.6.593
- Khalsa, S. B. S. (2004). Yoga as a therapeutic intervention: A bibliometric analysis of published research studies. *Indian Journal of Physiology and Pharmacology, 48*, 269–285.
- Kjellgren, A., Bood, S. A., Axelsson, K., Norlander, T., & Saaticioglu, F. (2007). Wellness through a comprehensive yogic breathing program—a controlled pilot trial. *BMC Complementary and Alternative Medicine, 7*. doi:10.1186/1472-6882-7-43
- Kubany, E. S., Haynes, S. N., Leisen, M. B., Owens, J. A., Kaplan, A. S., Watson, S. B., & Burns, K. (2000). Development and preliminary validation of a brief broad-spectrum measure of trauma exposure: The Traumatic Life Events Questionnaire. *Psychological Assessment, 12*, 210–224. doi:10.1037//1040-3590.12.2.210
- Mitchell, K. S., Mazzeo, S. E., Schlesinger, M., Brewerton, T., & Smith, B. N. (2012). Comorbidity of partial and subthreshold PTSD among men and women with eating disorders in the National Comorbidity Survey-Replication study. *International Journal of Eating Disorders, 45*, 307–315. doi:10.1002/eat.20965
- Monson, C. M., Gradus, J. L., Young-Xu, Y., Schnurr, P. P., Price, J. L., & Schumm, J. A. (2008). Change in posttraumatic stress disorder symptoms: Do clinicians and patients agree? *Psychological Assessment, 20*, 131–138. doi:10.1037/1040-3590.20.2.131
- Muthén, L. K., & Muthén, B. O. (1998-2010). *Mplus users guide* (6th ed.). Los Angeles, CA: Author.
- Prins, A., Ouimette, P., Kimerling, R., Cameron, R. P., Hugelshofer, D. S., Shaw-Hegwar, J., & Sheikh, J. I. (2003). The primary care PTSD screen (PC-PTSD): Development and operating characteristics. *Primary Care Psychiatry, 9*, 9–14. doi:10.1185/135525703125002360
- Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385–401. doi:10.1177/014662167700100306
- Resick, P. A., Williams, L. F., Suvak, M. K., Monson, C. M., & Gradus, J. L. (2012). Long-term outcomes of cognitive-behavioral treatments for posttraumatic stress disorder among female rape survivors. *Journal of Consulting and Clinical Psychology, 80*, 201–210. doi:10.1037/a0026602
- Rocha, K. K., Ribeiro, A. M., Rocha, K. C., Sousa, M. B., Albuquerque, F. S., Ribeiro, S., & Silva, R. H. (2012). Improvement in physiological and psychological parameters after 6 months of yoga practice. *Consciousness and Cognition, 21*, 843–850. doi:10.1016/j.concog.2012.01.014
- Ross, A., & Thomas, S. (2010). The health benefits of yoga and exercise: A review of comparison studies. *Journal of Alternative and Complementary Medicine, 16*, 3–12. doi:10.1089/acm.2009.0044
- Schnurr, P. P., Friedman, M. J., & Rosenberg, S. D. (1993). Premilitary MMPI scores as predictors of combat-related PTSD symptoms. *American Journal of Psychiatry, 150*, 479–483.
- Shapiro, D., Cook, I. A., Davydov, D. M., Ottaviani, C., Leuchter, A. F., & Abrams, M. (2007). Yoga as a complementary treatment of depression: Effects of traits and moods on treatment outcome. *eCAM, 4*, 493–502. doi:10.1093/ecam/nel114
- Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., Vagg, P. R., & Jacobs, G. A. (1983). *State-trait Anxiety Inventory* (Form Y). Redwood City, CA: Mind Garden.
- Streeter, C. C., Jensen, J. E., Perlmutter, R. M., Cabral, H. J., Tian, H., Terhune, D. B., . . . Renshaw, P. F. (2007). Yoga asana sessions increase brain GABA levels: A pilot study. *Journal of Alternative & Complementary Medicine, 13*, 419–426. doi:10.1089/acm.2007.6338
- Streeter, C. C., Whitfield, T. H., Owen, L., Rein, T., Karri, S. K., Yakhkind, A., . . . Jensen, J. E. (2010). Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. *Journal of Alternative and Complementary Medicine, 16*, 1145–1152. doi:10.1089/acm.2010.0007
- Tarrier, N., Sommerfield, C., Reynolds, M., & Pilgrim, H. (1999). Symptom self-monitoring in the treatment of posttraumatic stress disorder. *Behavior Therapy, 30*, 597–605. doi:10.1016/S0005-7894(99)80027-6
- Telles, S., Singh, N., Joshi, M., & Balkrishna, A. (2010). Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: A randomized controlled study. *BMC Psychiatry, 10*, 18. doi:10.1186/1471-244X-10-18
- Uebelacker, L. A., Tremont, G., Epstein-Lubow, G., Gaudiano, B. A., Gillette, T., Kalibatseva, Z., & Miller, I. W. (2010). Open trial of Vinyasa yoga for persistently depressed individuals: Evidence of feasibility and acceptability. *Behavior Modification, 34*, 247–264. doi:10.1177/0145445510368845
- United States Census Bureau. (2013, January 10). *State & County Quick-Facts: Boston, Massachusetts*. Retrieved from <http://quickfacts.census.gov/qfd/states/25/2507000.html>
- van der Kolk, B. A. (2006). Clinical implications of neuroscience research in PTSD. *Annals of the New York Academy of Sciences, 1071*, 277–293. doi:10.1196/annals.1364.022
- West, J., Otte, C., Geher, K., Johnson, J., & Mohr, D. C. (2004). Effects of hatha yoga and African dance on perceived stress, affect, and salivary cortisol. *Annals of Behavioral Medicine, 28*, 114–118. doi:10.1207/s15324796abm2802_6