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Yoga for Military Service Personnel With PTSD: A Single Arm Study

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This study evaluated the effects of yoga on posttraumatic stress disorder (PTSD) symptoms, resilience, and mindfulness in military personnel. Participants completing the yoga intervention were 12 current or former military personnel who met the *Diagnostic and Statistical Manual for Mental Disorders-Fourth Edition-Text Revision* (*DSM–IV–TR*) diagnostic criteria for PTSD. Results were also benchmarked against other military intervention studies of PTSD using the Clinician Administered PTSD Scale (CAPS; Blake et al., 2000) as an outcome measure. Results of within-subject analyses supported the study's primary hypothesis that yoga would reduce PTSD symptoms ($d = 0.768$; $t = 2.822$; $p = .009$) but did not support the hypothesis that yoga would significantly increase mindfulness ($d = 0.392$; $t = -0.9500$; $p = .181$) and resilience ($d = 0.270$; $t = -1.220$; $p = .124$) in this population. Benchmarking results indicated that, as compared with the aggregated treatment benchmark ($d = 1.074$) obtained from published clinical trials, the current study's treatment effect ($d = 0.768$) was visibly lower, and compared with the waitlist control benchmark ($d = 0.156$), the treatment effect in the current study was visibly higher.

Keywords: yoga, posttraumatic stress disorder, PTSD, military service personnel, complementary and integrative medicine

Posttraumatic stress disorder (PTSD) is a mental health condition that may result from experiencing traumatic events. PTSD, particularly in the military, is a focus of much research investigation (e.g., Foa, Keane, Friedman, & Cohen, 2009) and military service men and women are particularly at risk for PTSD. For example, interpersonal violence, such as front-line combat, which many troops experience, is more highly correlated with PTSD than other, noninterpersonal types of trauma, such as natural disasters and motor vehicle accidents (*Diagnostic and Statistical Manual for Mental Disorders-Fourth Edition-Text Revision* [*DSM–IV–TR*]; American Psychological Association, 2000), and military personnel not involved in combat are also exposed to a variety of psychosocial and physical stressors and other military-specific situations to which the general population would not normally be exposed.

Recent studies have evaluated the impact of yoga on PTSD symptoms in a civilian population, including a protocol of yogic breathing with exposure treatment, which reduced anxiety and depressive symptoms in survivors of the South-East Asia tsunami (Descilo et al., 2010). Two yoga studies (van der Kolk, 2006; van der Kolk et al., 2014) included women with PTSD. These studies found that the yoga interventions significantly improved PTSD re-experiencing and avoidance symptoms.

Thus far, two studies (Mitchell et al., 2014; Staples, Hamilton, & Uddo, 2013) assessing yoga for PTSD symptoms have included military service personnel. Mitchell et al. (2014) conducted an RCT of 38 women, some of whom were military veterans, with full or subthreshold PTSD and found that both the yoga group and control group had significant reductions in re-experiencing and hyperarousal symptoms after a 12 session program. Staples et al. (2013) conducted a single-arm trial with military veterans with military-related PTSD and found that the 12 veterans who participated in the 12 session yoga intervention had a significant im-

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provement in PTSD hyperarousal symptoms and overall sleep quality as well as a reduction in sleep-related daytime dysfunction.

This empirical evaluation of contemplative practices such as yoga to manage PTSD symptoms for people with PTSD is understandable given the evidence base for yoga in other populations, and also because PTSD is a psychophysiological condition (Telles, Singh, & Balkrishna, 2012) warranting interventions that address both the physical and psychological symptoms of PTSD. Yoga is an integrative system of practices geared toward self-understanding, self-regulation, and psychological and physical well-being (Garfinkel & Schumacher, 2000; Khalsa, 2004). Yoga has also been shown to increase an inhibitory neurotransmitter gamma amino butyric acid (GABA; Streeter et al., 2007, 2010), which is relevant to people with PTSD as this group of people has been shown to be low in GABA system activity and to experience reduction in anxiety and depressive symptoms when prescribed pharmacological agents which increase activity of the GABA system (Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012). Yogic practices include components that may reduce, interrupt, or reframe re-experiencing, stress, arousal, and avoidance symptoms of PTSD by eliciting the relaxation response (Benson, 1975), which counterbalances the "fight or flight response" by down regulating the stress system and increasing present-moment nonjudgmental awareness and acceptance, which is often challenging for people with PTSD. The mindfulness and psychophysiological stress reduction skills in a yoga practice provide the practitioner with tools to manage triggers and symptoms with acceptance rather than avoidance. This may reduce reactivity and ensuing learned avoidance behaviors, and may help counteract trauma-relevant avoidance in these individuals.

Yoga contains within its system not only mental practices but also physical poses (*asanas*) that have been shown to reduce musculoskeletal and mental tension, increase cognitive attentiveness or mind-body awareness and mindfulness, and improve physical flexibility and strength (Netz & Lidor, 2003; Serber, 2000). Yogic breathing exercises (*pranayama*) modify respiratory frequency and tidal volume, which elicits psychological and physiological changes (Brown & Gerbarg, 2009; Pal, Velkumary, & Madanmohan, 2004). Kulkarni and Bera (2009) propose that modulation of breath, via its impact on the central nervous system (CNS), plays a critical role in maintaining balance or allostasis and reducing cognitive and emotional reactivity. Thus, Kulkarni and Bera (2009) propose that modulation of breath results in psychological and physiological change, including increasing mindfulness and reducing stress.

Mindfulness, or present-moment nonjudgmental awareness, is an integral dimension in yoga practice, and yoga has been shown to increase mindfulness (Shelov, Suchday, & Friedberg, 2009). It has been negatively correlated with physical and psychiatric symptoms and positively correlated with well-being; Carmody and Baer (2008) indicate that various psychological and physical complaints have been reduced through a mindfulness practice, as have previous studies (Baer, 2003; Kabat-Zinn, 2003).

Resilience is an individual's ability to adjust or cope with change or misfortune (Rutter, 1987). Yoga has been seen to improve resilience in other populations by reducing oxidative stress (Martarelli & Pompei, 2009) and reducing and preventing inflammation (Olivo, 2009), as well as by reducing anxiety (Subramanya & Telles, 2009), perceived stress, and depressive symptoms (Simard & Henry, 2006), and by increasing meaning and promoting dynamic coping (Chan, Chan, & Ng, 2009). Resilience may be critical in creating an *optimal healing environment* (OHE; Osuch & Engel, 2004), which includes a multicomponent (i.e., social, psychological, spiritual, physical, and behavioral) approach (Jonas & Chez, 2004) toward optimizing healing. Based on their research, Osuch and Engel explicitly recommend mind/body practices as a means to heal trauma. Frueh et al. (2007) noted the necessity for the U.S. Department of Veterans Affairs to update policies to include empirically supported concepts of resilience.

The theoretical focus of the yoga intervention in the current protocol was to help participants increase awareness, release chronic tension and decrease maladaptive automatic reactions, develop a nonjudgmental attitude, and induce a state of relaxation to optimally manage current symptoms and metabolize previous experiences. The current study extends prior research and is unique in that it uses a manualized Kripalu yoga intervention to explore whether the physical, cognitive, and psychological practices used in the intervention are an effective means of decreasing PTSD symptoms as assessed by the CAPS, and evaluates whether yoga may increase mindfulness as demonstrated by the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), and resilience, as measured by the Resilience Scale (RS; Wagnild, 2009; Wagnild & Young, 1990), in military service men and women. Also unique is that the data for the participants in the study were benchmarked against other interventions used to treat the military men and women with PTSD. This enabled the authors to contextualize the results of the current yoga intervention with other PTSD treatments used for the military population given the study's lack of control group.

Method

After all protocol materials were approved by the Institutional Review Boards (IRB) from the Department of Defense Telemedicine and Advanced Technology Research Center, the Brigham and Women's Hospital, and Northeastern University, recruitment of participants took place via posting flyers in the local area as well as advertisements in the newspaper and on trains through the Massachusetts Bay Transportation Authority. Potential participants underwent a telephone screening to preliminarily assess eligibility, and, when deemed potentially eligible, came in for an in-person interview. During this meeting, informed consent was obtained and an interview was then performed to ensure inclusion criteria were met. After screening into the study, participants underwent a baseline CAPS assessment and then completed baseline questionnaires before undertaking the 10-week yoga intervention. At the final yoga class, they completed self-report questionnaires, and, after completing the yoga program, underwent a postintervention CAPS evaluation.

Participants

Eligible participants were military personnel (active duty or veteran) aged 18 and older with a *DSM–IV–TR* diagnosis of PTSD, as ascertained by the PTSD module from the Structured Clinical Interview for *DSM–IV–TR* (SCID; First, Spitzer, Gibbon, & Williams, 1997). Potential participants were excluded if they engaged in mind-body practices directly related to yoga for more than 1 hr

weekly, or if they were unable to follow the requirements for study participation because of physical, mental health, or cognitive limitations (i.e., chronic psychosis, cognitive impairments, third trimester in pregnancy, etc.). Participants who were receiving additional treatment (e.g., medication or psychotherapy) were eligible if they met diagnostic criteria for PTSD at the time of screening, despite receiving treatment.

Measures

Structured Clinical Interview for *DSM–IV* (SCID), PTSD module. The SCID is a widely used structured clinical interview for psychiatric disorders that contains a PTSD-specific module with 19 items. The SCID PTSD module has questions related to each of the *DSM–IV–TR* diagnostic criteria; patients' responses are listed as present, absent, or sub threshold (First, Spitzer, Gibbon, & Williams, 1997).

Demographic information form. The participants filled out a demographic information form, which delineated their age, race, and gender.

Medical and personal history form. This form ascertained information about personal history, current and previous medical psychological concerns, and military service.

The Clinician Administered PTSD Scale (CAPS) for the *DSM–IV*. The CAPS for the *DSM–IV*, revised version (Blake et al., 2000) was used to assess PTSD symptoms. It was administered at baseline and posttreatment for the current protocol. The CAPS evaluations were administered by independent masters'—and doctoral-level clinicians. The clinician scored the CAPS according to the "rule of 4" (Weathers, Keane, & Davidson, 2001), which required that total symptom severity scores (*frequency* plus *intensity*) for each item be equal to or greater than four, with *intensity* scores being at least two. Cicchetti, Fontana, and Showalter (2009) found excellent interrater reliability for frequency and severity for the re-experiencing, arousal, and avoidance subscales ($r > .92$ for each subscale) and good internal consistency ($\alpha > .87$ for each subscale). Cronbach's αs for the current study were $\alpha = .82$, 0.67, 0.90, and 0.81 for the re-experiencing, arousal, and avoidance subscales and the total scale, respectively.

Resilience Scale. The 25-item Resilience Scale (RS; Wagnild, 2009; Wagnild & Young, 1990) was administered at baseline and posttreatment. It measures the degree of individual resilience, as defined by five interrelated components: *perseverance*, *equanimity*, *meaningfulness*, *self-reliance,* and *existential aloneness* (Wagnild & Young, 1990). All items are scored on a 7-point scale from 1 = *disagree*) to 7 = *agree*. Possible scores range from 25 to 175, with scores greater than 145 indicating moderately high to high resilience, 125–145 indicating moderate levels of resilience, and scores of 120 and below indicating low resilience (Wagnild, 2009). Internal consistency of the RS was consistently high in 11 of 12 reviewed studies (Cronbach's α coefficient ranged from 0.85 to 0.94), with the lowest reported coefficient at 0.72. Cronbach's α for the current study was $\alpha = .97$ at pretest. The data regarding sensitivity to change was not available.

Five-Facet Mindfulness Questionnaire. The Five-Facet Mindfulness Questionnaire (FFMQ; Baer, 2006) was administered at baseline and posttreatment. The FFMQ is a 39-item self-report questionnaire using a five-point Likert-type scale from 1 = *never or very rarely true* to 5 = *very often or always true* and assessing five component skills: *observing*, *describing*, *acting with awareness*, *nonjudging of inner experience*, and *nonreactivity to inner experience* (Baer et al., 2008). The factor structure for this scale was created using data derived from 613 undergraduate psychology students (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The FFMQ was then validated with a sample of 119 meditators, 174 demographically matched nonmeditators, 293 community nonmeditating people, and 261 nonmeditating students. Alpha coefficients of four of the five facets of mindfulness ranged from 0.72 to 0.92. For the facet of *nonreactivity to inner experience*, the α coefficient was 0.67 in the student sample, but ranged from 0.81 to 0.86 for the other three groups. For the current study, the total score was used. Cronbach's α for the current study was $\alpha = .86$ at pretest. The data regarding sensitivity to change was not available.

Participant compliance logs and homework supportive materials. Participants completed daily logs to track homework compliance and were given an audio yoga practice CD and written guidelines to support daily home practice.

Intervention

Yoga classes were taught by an instructor (author, J.M.J.) with advanced training including a 500-hr certification from the Kripalu Yoga Teachers' Association. The yoga intervention, developed from the Kripalu Yoga methodology, entailed twice weekly 90-min group classes for 10 weeks (20 sessions) and included poses, breathing strategies, meditative practices, and an integrative relaxation at the end of each group practice. Participants were also asked to perform a 15-min daily home yoga practice during the intervention. During the group yoga classes, the instructor supported the participants when needed to ensure they could safely practice the components of the intervention. Session structure included check-ins at the beginning of each class, a group centering and breathing practice, a 10–15 min warm-up period, and 50–55 min of practice involving poses. The last 5–10 min was a deep relaxation to integrate the breathing and poses. General themes for practice included: increasing strength and flexibility and reducing stress; balancing the sleep-wake system; developing a responsive (rather than avoidant or hyperaware) relationship with the environment, self, and others; and cultivating mindful awareness in poses.

Study Design

This study was a single arm intervention study. Data was analyzed for the 12 participants who completed pre- and postintervention self-report questionnaires (FFMQ, RS) and the 10 participants who completed the pre- and postintervention CAPS measure (two participants did not return to undergo postintervention CAPS administration) using matched-pair *t* tests.

Benchmarking. To overcome the limitations of a single arm intervention, the prepost effect size of the CAPS measure in this study was benchmarked against meta-analytically aggregated treatment and control condition effect sizes from published studies that used the CAPS with military personnel with PTSD. This was done to enable a more meaningful interpretation of the treatment effect size obtained from the current study. The benchmarks were created by conducting a literature review using MEDLINE, PILOTS, and PsycINFO databases, with search terms "clinician administered PTSD scale" and "military" with no initial date limitations to be as inclusive as possible

of potentially relevant studies. The literature review was limited to studies using the CAPS as an outcome measure.

Results from the benchmark literature review netted 196, 101, and 26 citations from the PILOTS, PsycINFO, and MEDLINE databases, respectively; of these 323 citations, 19 contained the appropriate parameters for inclusion. However, only nine protocols (Beidel, Frueh, Uhde, Wong, & Mentrikoski, 2011; Chard, Schumm, Owens, & Cottingham, 2010; Frueh, Turner, Beidel, Mirabella, & Jones, 1996; Jakupcak et al., 2006; Jakupcak, Wagner, Paulson, Varra, & McFall, 2010; McLay, Wood, Webb-Murphy, Spira, Wiederhold, Pyne, & Wiederhold, 2011; Monson, Schnurr, Resick, Friedman, Young-Xu, & Stevens, 2006; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001; Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011) fit the inclusion criteria and also provided data (e.g., the prepost mean CAPS scores and *SD*s or data on least square means) permitting the calculation of effect size for each study. To ensure consistency, the effect sizes of each study were calculated independently. Calculation of effect sizes were ascertained using the group means at baseline and immediately postintervention, as well as the baseline *SD* (Becker, 1988; Minami, Serlin, Wampold, Kircher, & Brown, 2008; Morris, 2000). After the effect sizes for all relevant conditions were computed, the unbiased estimator *d* and the variance of the unbiased estimator *d* were computed for each (Morris, 2000).

From the nine studies included, 12 treatments and one waitlist control condition were acquired for comparison with the current protocol. Two benchmarks were created, one which included the 12 treatment conditions and one for the waitlist condition. The unbiased estimator effect size (d_{yCAPS}) was compared with the clinical trials benchmarks calculated from the values in Table 2. Effect sizes from each study were aggregated across studies to obtain one prepost effect size d_{tCAPS} using standard meta-analytic procedures for prepost effect sizes (Becker, 1988; Morris, 2000); this effect size d_{tCAPS} is the PTSD treatment efficacy benchmark obtained from 12 clinical trials. As only one study (Monson et al., 2006) included a control group, the prepost effect size of this control group was used as the control benchmark. The effect size of the current intervention was then compared to these benchmarks similar to Wade, Treat, and Stuart (1998). Statistical benchmarking following Minami et al. (2008) was not possible because of the small number of participants in this study.

Results

Demographic Variables

Thirty-eight participants were screened via in person interview and consented to participate in the study. Of these, 12 undertook the intervention and provided prepost data for the study, 13 were lost to follow up while awaiting a yoga treatment cohort to form, 4 participants were excluded because of ineligibility (3 practiced more than an hour weekly of mind-body practices directly related to yoga and one did not fit the diagnostic criteria for PTSD), and 8 withdrew from the study, with the predominant reason being that they were no longer available by the time the cohort formed for the intervention to begin. Age ranged from 36–63, with a mean age of 51 (*SD* = 8.26). Fifty percent of the participants (6) identified themselves as White and 50% (6) as Black; 1 participant (8%) was female, and 11 (92%) were male. Of the types of trauma endorsed as most related to PTSD symptoms, 50% (6) endorsed combat, 33.3% (4) endorsed automobile accidents, and 16.67% (2) endorsed military sexual trauma (MST) as most impactful. Nine (75%) of the participants attended at least 10 classes during the intervention; mean attendance by the 12 participants was 13.67 with a range of 3 to 18 of 20 classes attended by each participant.

PTSD Symptoms

Outcome data for individuals who participated in the intervention for at least three sessions and who completed the pre- and postintervention CAPS measure and/or self-report questionnaires were used. Table 1 provides CAPS, RS, and FFMQ scores.

Table 1
Mean Scores on PTSD, Resilience, and Mindfulness Measures

Measure	Baseline mean (*SD*)	Post mean (*SD*)	Effect size[a]/test statistic	*p* value (one-tailed)
CAPS total score	70.40 (21.56)	52.21 (24.10)	$d = .840$ $t = 2.822$	.009
Re-experiencing	19.50 (7.82)	13.80 (7.35)	$d = .729$ $t = 2.204$	.030
Avoidance	30.80 (16.92)	21.20 (14.36)	$d = .567$ $t = 1.999$	.038
Hyperarousal	22.00 (6.85)	15.30 (8.17)	$d = .978$ $t = 3.086$	.006
RS total score	131.25 (29.91)	139.92 (20.54)	$d = .290$ $t = -1.220$	.124
FFMQ total Score	115.67 (14.75)	122 (15.54)	$d = .429$ $t = -0.9500$	.181

Note. PTSD = Posttraumatic stress disorder; CAPS = Clinician Administered PTSD Scale; RS = Resilience Scale; FFMQ = Five Facet Mindfulness Questionnaire.
[a] Effect size calculations in Table 1 are based on group means at baseline and immediately postintervention, as well as the baseline *SD* (Becker, 1988; Minami, Serlin, Wampold, Kircher, & Brown, 2008; Morris, 2000). Effect sizes ascertained for Table 2 and for the abstract have undergone calculations to reduce bias; therefore, CAPS total score effect size is reduced from $d = .840$ to $d = .768$ in Table 2 as well as the CAPS, RS, and FFMQ effect sizes in the abstract reflect the "unbiased" effect size.

CAPS (Blake et al., 2000) mean change was 18.2, indicating a statistically ($t = 2.822$; $p = .009$) and clinically significant reduction in PTSD symptoms, with a 25% drop on CAPS scores. Mean CAPS score at baseline was 70.40 ($SD = 21.60$), which fell in the "severe PTSD symptomatology" (Weathers et al., 2001) range; postintervention mean CAPS score was 52.20 ($SD = 24.10$), which fell in the "moderate/PTSD threshold" (Weathers et al., 2001) range.

Individual CAPS scores. Using the criteria from Weathers et al. (2001), 4 of the 10 participants (40%) demonstrated a clinically significant drop of 15 points or more on the CAPS. Using the criteria from Schnurr et al. (2003) of a change in CAPS score of 10 points or greater, 6 (60%) individuals had a clinically significant reduction in PTSD symptoms.

CAPS subscale scores. CAPS subscale scores were significantly reduced. Criterion B (re-experiencing) and Criterion C (avoidance) mean scores decreased from $M = 19.50$ ($SD = 7.82$) to $M = 13.80$ ($SD = 7.35$) and $M = 30.80$ ($SD = 16.92$) to $M = 21.20$ ($SD = 14.36$) respectively, reaching statistical significance below the $p < .05$ level (re-experiencing, $p = .030$; avoidance, $p = .038$). Criterion D (hyperarousal, $p = .006$) mean scores also dropped significantly from $M = 22.00$ ($SD = 6.85$) to $M = 15.30$ ($SD = 8.17$).

Benchmarking results. Table 2 provides data on the studies included in the benchmarking results. The difference between the current study ($d = 0.768$) and the treatment benchmark ($d = 1.074$) was $d = -0.306$; the difference between the current protocol ($d = 0.768$) and the control benchmark ($d = 0.156$) was $d = 0.612$. Following guidelines for the lowest meaningful significant change of $d = 0.200$ described by Cohen (1988), the treatment effect was significantly lower ($d = -0.306$) than the treatment benchmark and was significantly ($d = 0.612$) higher than the waitlist control benchmark.

Table 2
Benchmarking Studies and Data for Calculating Unbiased Effect Size and Variance

Study name	*n*	*M* Pre	*M* Post	*SD* Pre	*D*	Var *d*
Aggregated treatment benchmark $d = 1.074$						
Beidel et al. (2011)						
TMT with exposure	14	84.90	69	14.30	1.047	0.101
Exposure alone	16	90.60	65.50	14.40	1.650	0.151
Chard et al. (2010)						
OEF/OIF	51	71.88	31.50	16.41	2.424	0.075
Vietnam veterans	50	66.48	42.50	16.58	1.424	0.035
Frueh et al. (1996)						
TMT	11	82.46	65.55	19.23	0.812	0.107
Jakupcak et al. (2006)						
Behavioral activation	9	74.66	60.44	22.11	0.581	0.110
Jakupcak et al. (2010)						
Behavioral activation	5	71	49.40	16.87	1.024	0.464
McLay et al. (2011)						
Virtual reality exposure	10	83.5	48.10	18.10	1.788	0.310
Treatment as usual	10	89.13	80.80	24.32	0.313	0.077
Rothbaum et al. (2001)						
Virtual reality exposure	9	68	57.78	15.26	0.605	0.112
Tan et al. (2011)						
Heart rate variability biofeedback	10	86.41	71.24	19.32	0.718	0.110
Treatment as usual	10	89.13	80.80	24.32	0.313	0.077
Waitlist benchmark $d = .156$						
Monson et al. (2006)						
Waitlist	30	79.1	76.03	19.18	0.156	0.023
Current study $d = .768$						
Yoga Intervention	10	70.40	52.20	21.56	0.768	0.220

Note. OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom; TMT = Trauma Management Therapy.

Resilience

The Resilience Scale (RS; Wagnild & Young, 1990) was administered pre- and posttreatment. The mean RS score at baseline was $M = 131.25$ ($SD = 29.91$) and at postintervention was $M = 139.92$ ($SD = 20.54$), demonstrating an increase in resilience; this was a small increase based on Cohen's criteria (Cohen, 1988) and this increase did not reach statistical significance ($d = 0.270$; $t = -1.220$; $p = .124$). Participant mean scores were in the moderate (125–145) range of resilience. There was considerable variability in the change of scores among participants, with a range from −25 (reduction in resilience) to 55 (increase in resilience).

Mindfulness

The Five Facet Mindfulness Questionnaire (FFMQ; Baer, 2006) was completed pre- and posttreatment. The mean group score for the FFMQ was $M = 115.67$ ($SD = 14.75$) at baseline and $M = 122.00$ ($SD = 15.54$) after the intervention. Like the RS, the FFMQ mean score change demonstrated an increase in mindfulness, and this was moderate based on Cohen's criteria (Cohen, 1988), albeit not statistically significant ($d = 0.392$; $t = -0.9500$; $p = .181$). Mindfulness scores change ranged from −14 (reduction in mindfulness) to 80 (increase in mindfulness).

Discussion

Current results support yoga as a potentially feasible, safe, and effective intervention for PTSD military personnel and suggest that further study of this type of intervention is warranted. Participants who undertook the intervention experienced a mean reduction in PTSD scores on the CAPS. These score changes were both clinically and statistically significant, demonstrating that yoga is potentially an effective treatment for PTSD symptoms in military personnel and veterans. All of the CAPS subscales decreased significantly, which supports data from other protocols using yogic practices in a veteran population with PTSD (i.e., Mitchell et al., 2014; Staples et al., 2013) and aligns with the extant research on yoga and its impact on stress and relaxation physiology (i.e., Field, 2011; Li & Goldsmith, 2012; Streeter et al., 2010), despite the small sample size. These findings, as well as the fact that there were no adverse events nor reported side effects or difficulties in the current intervention, demonstrate the potential viability of yoga as an efficacious intervention for PTSD symptoms.

Reduction of PTSD symptoms was significant, and, while not as high as the aggregated treatment benchmark, heterogeneity within the studies in the benchmark and the small sample size in this study requires careful interpretation of these results. Of note, yoga is an ongoing life-skills practice rather than a short term intervention to reduce psychopathology, and it is theoretically feasible that

the ongoing practice of yoga with service personnel could continue to enhance their ability to manage future life stressors and reduce symptoms and also increase wellbeing over time. It is also important to consider the utilization of yoga in conjunction with other interventions for PTSD; many components of yoga practice (i.e., self-acceptance, psychophysiological self-regulation, breathing practices, etc.) could help manage psychophysiological reactions increased by other interventions—indeed, these practices are already incorporated into other mental health interventions.

Likely contributors to nonsignificant findings on the resilience and mindfulness measures are small sample size in the study and individual variation among subjects, both in terms of scores on outcome measures as well as compliance in class attendance and home practice. Furthermore, the mindfulness and resilience measures' sensitivity to change is not known, so it is possible that these measures do not reflect change in these constructs.

Although it is possible that results indicate that mindfulness is not impacted by this intervention, extant research on yoga and mindfulness (i.e., Shelov, Suchday, & Friedberg, 2009) warrants alternate explanations. Future studies evaluating the temporal course between PTSD symptoms and these constructs in the military population as well as research to empirically validate the constructs of mindfulness and resilience as related to this population are needed.

As to limitations of the study, small sample size, and the fact that the study was a preliminary single arm trial makes it difficult to state definitively that the reduction in symptoms was specifically because of the intervention. Another limitation is that participants with psychiatric comorbidity and a variety of medical concerns as well as those taking psychotropic medication or in mental health treatment were allowed in the study, so it is possible that results of measures were impacted by other concurrent pharmacological or psychological interventions. Furthermore, only one yoga instructor conducted the intervention. Having more than one instructor with equivalent skill and ability conducting the intervention would reduce potential bias. Another limitation is that the mindfulness and resilience measures' sensitivity to change is not known.

Despite the limitations enumerated, there were several strengths in this study. Methodological strengths include the use of a primary outcome measure (CAPS), high in sensitivity and specificity, thereby increasing the likelihood that the assessment of PTSD symptoms and are valid and reliable. Further strengthening this protocol is the comparison of the treatment effect size with published clinical trials, which was helpful in contextualizing this study as related to other research on interventions with military service men and women with PTSD. Additionally, there was a significant reduction in PTSD symptoms despite the chronic and entrenched mental and physical health concerns endorsed by participants—and this reduction was achieved with no side effects nor adverse events. Also important is that yoga is straightforward to learn and practice, strength-based and positively focused, and goes beyond treatment of symptoms to enhancing the lives of the participants in a more general, comprehensive manner.

This study provides important information about the effect of yoga on service personnel and compares current study data with other treatments for PTSD. Ideally, it will be followed by well-controlled randomized trials of yoga with military personnel using highly sensitive and specific quantitative physiological (i.e., heart rate variability, magnetic resonance spectroscopy) and psychological outcome measures (clinician-administered and self-report) as well as qualitative measures. These studies will further elucidate both the specific and indirect role that yoga may play in helping service men and women recover from PTSD and the psychophysiological mechanisms through which this takes place.

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*References marked with an asterisk indicate studies included in the meta-analysis that are discussed in the text.

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