

Military-Tailored Yoga for Veterans with Post-traumatic Stress Disorder[†]

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ABSTRACT Introduction: Among veterans of post-9/11 conflicts, estimates of post-traumatic stress disorder (PTSD) range from 9% shortly after returning from deployment to 31% a year after deployment. Clinical and pharmaceutically based treatments are underutilized. This could be due to concerns related to lost duty days, as well as PTSD patients' fears of stigma of having a mental health condition. Yoga has been shown to reduce PTSD symptoms in the civilian population, but few studies have tested the impact of yoga on veterans of post-9/11 conflicts. The purpose of this study is to test the impact of yoga on post-9/11 veterans diagnosed with PTSD. Materials and Methods: Participants were 18 yr of age or older and veterans of post-9/11 conflicts. They had subthreshold or diagnostic-level PTSD related to their combat military service, as determined by a score of 30 or higher on the PTSD Checklist-Military version (PCL-M). Veterans participated in 60-min weekly yoga sessions for 6 wk taught by a Warriors at Ease-trained yoga instructor who is a, post-9/11 veteran. The yoga sessions incorporated Vinyasa-style yoga and a trauma-sensitive, military-culture informed approach advocated by two separate organizations: Warriors at Ease and Meghan's Foundation. Data were collected at baseline and again after 7 wk. The primary outcome was PCL-M score. Participants also completed the Patient Health Questionnaire, the Beck Anxiety Inventory, the Pittsburgh Sleep Quality Index, and the Mindful Attention Awareness Scale at both time points. Results: Eighteen Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn veterans completed the pre- and post-intervention self-report questionnaires. Age ranged from 26 to 62 yr (median = 43 yr), length of service ranged from 2 to 34 yr (median = 18.8 yr), and 13 (72.2%) had completed college. Decreased PTSD symptomatology was demonstrated in the three-symptom clusters represented in the PCL-M (i.e., hyperarousal, re-experiencing, and avoidance). In addition, the total score on the PCL-M decreased significantly, by both statistical and clinical measures. The participants also demonstrated improved mindfulness scores and reported decreased insomnia, depression, and anxiety symptoms. Conclusion: This study demonstrates that a trauma-sensitive yoga intervention may be effective for veterans with PTSD symptoms, whether as stand-alone or adjunctive therapy. The impressive decrease in PTSD symptomatology may be due to the tailored military-specific nature of this intervention and the fact that it was led by a veteran of post-9/11 conflicts. More research is needed with a larger sample and a more diverse veteran population.

INTRODUCTION

Service members deployed to the Middle East in support of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn (OEF/OIF/OND) were at high risk of experiencing traumatic situations, such as being shot at, or witnessing a friend die. Estimates of post-traumatic stress disorder (PTSD) among veterans of these operations range from 9% shortly after returning from deployment to 31% a year after deployment.¹ Other studies suggest that 17–20%

of Vietnam combat veterans have been, or are currently, diagnosed with PTSD.^{2,3}

As described in the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM 5), PTSD is diagnosed by assessing for symptoms associated with a traumatic event that begin after the traumatic event occurs, persist for more than a month, and cause distress and/or impair function. Mental health providers look for the presence of one or more intrusion symptoms (e.g., flash backs or recurring dreams), persistent avoidance of stimuli associated with the event, negative alterations in cognition and mood, and marked alterations in arousal and reactivity.⁴ However, most validated measures assess for PTSD symptoms in three major clusters: persistent re-experiencing of the events, persistent avoidance of stimuli that remind one of the event, and hyperarousal symptoms.

People with PTSD suffer from heightened sympathetic activation, which increases their heart rate and blood pressure, slows digestive functioning, decreases blood flow to extremities, and increases stress hormones such as cortisol. The high levels of sympathetic activation and disturbances in the hypothalamic–pituitary–adrenal axis have also been linked to physiological disturbances, such as arterial damage and coronary heart disease.⁵ PTSD can cause emotional,

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mental, and behavioral disturbances and has been linked to suicide.⁶

Current treatments for PTSD include psychotherapy and pharmacological treatment. Effective evidence-based psychotherapies include exposure-based therapies, cognitive-based therapies, and eye-movement desensitization and reprocessing therapy. Pharmacological treatment includes selective serotonin-reuptake inhibitors, selective serotonin-norepinephrine reuptake inhibitors, and prazosin, an alpha-blocker.⁷ A review of Veterans Administration data for 20,284 veterans with PTSD found that about 64% initiated psychotropic medication and/or counseling, but 36% did not receive or participate in any conventional treatment.⁸ Barriers to seeking or completing conventional therapies include concerns about the invasiveness of treatment, lack of emotional readiness for treatment, stigma associated with having a mental health condition, and logistical issues.^{9,10}

If traditional medical care is not acceptable to military veterans, is there another option that might be more palatable? Complementary and alternative medicine (CAM) includes practices or treatments that are not considered to be part of conventional medicine. A survey conducted in 2011 found that 50% of veterans under the care of the Veterans Administration use at least one form of CAM.¹¹ The most utilized CAM therapies were mindfulness, stress management, progressive muscle relaxation, art therapy, yoga, and meditation. Although CAM treatments may be more acceptable than conventional treatments to veterans with PTSD, many CAM treatments are not standardized or manualized, which is a barrier to reproducibility. However, CAM treatments can be adapted for various populations. For example, they can be tailored to trauma-sensitive patients, which might be beneficial for a veteran population with PTSD. Complementary practices are not only growing in popularity within veteran populations, they are also widely used in the civilian population. The National Center for Health Statistics found that the use of yoga, tai chi, and qi gong increased from 6% in 2002 to 10% in 2012. Of these three mind-body therapies, yoga was the most commonly used.¹²

Slow rhythmic breathing that is synchronized to the body movements of yoga can help activate the parasympathetic nervous system and stimulate vagal activity.¹³ The parasympathetic nervous system is the rest-and-digest portion of the autonomic nervous system; it has important functions in decreasing the heart rate and blood pressure, speeding up digestive functioning, and normalizing stress hormones. Yoga may be beneficial to veterans and service members with PTSD by activating the parasympathetic nervous system to tamp down the hyperarousal cluster of symptoms. Studies have shown that yoga can also reduce levels of the stress hormone cortisol and help restore balance in the hypothalamic-pituitary-adrenal axis.¹⁴

Research on the effects of yoga has shown improvement in mental well-being, whether as a stand-alone or as an adjunctive therapy, for many different health conditions,

such as pregnancy, prenatal and postpartum depression, stress, PTSD, anxiety, cardiovascular conditions, arthritis, headaches, low back pain, asthma, type II diabetes, multiple sclerosis, human immunodeficiency virus, breast cancer, osteoporosis, and Parkinson's disease.¹⁵ Specific to PTSD, trauma-sensitive yoga has been used with good effect in many populations, such as women suffering the after-effects of interpersonal violence,^{16,17} children exposed to interpersonal trauma in urban settings,^{18,19} and communities devastated by natural disasters.^{20,21}

A popular mind-body therapy that has been manualized and used with military veterans is mind-body stress reduction (MBSR). The aim of MBSR is to teach participants to attend to the present moment in a nonjudgmental way. Components of MBSR include mindful meditation, gentle yoga, and slow breathing. The course is conducted over 8 wk, with an additional all-day retreat. Research suggests that MBSR reduces PTSD symptoms in veterans.²²⁻²⁶ Unfortunately, 85% or more of the participants in published MBSR studies were Vietnam veterans. Thus, it is unknown how well this works with OEF/OIF/OND veterans who tend to be younger than Vietnam veterans and are less likely to be retired or unemployed.²⁷

Warriors at Ease (WAE) is a non-profit organization that provides advanced training to certified yoga instructors based on a specialized approach that is trauma-informed, incorporates evidenced-based techniques, and is sensitive to the unique aspects of military culture.²⁸ The WAE approach was initially developed in 2009 by four co-founders who were involved pilot yoga and meditation programs at Walter Reed Army Medical Center and VA Hospitals in Washington D.C. and Miami. There are more than 725 WAE teachers offering trauma-sensitive yoga to veterans, service members, and military families. WAE instructors offer yoga and meditation on military installations, in VA health care facilities, and other veteran service organizations such as Team Red, White, and Blue, Meghan's Foundation, Wounded Warrior Project, and Veterans of Foreign Wars. These offerings, however, have not been tested for their effectiveness in reducing PTSD.

This study piloted the trauma-sensitive yoga protocol developed by WAE and promoted by Meghan's Foundation. Participants were OEF/OIF/OND veterans with PTSD living in Honolulu, Hawai'i. The aim of the study is to assess the impact of yoga to decrease PTSD symptoms in post-9/11 veterans when used as an adjunctive therapy to the usual care of psychotherapy and pharmacological treatments. It was hypothesized that the veterans with PTSD that completed this trauma-sensitive yoga intervention would show decreases in PTSD symptoms, depressive symptoms, insomnia, and anxiety symptoms and increases in mindfulness.

METHODS

This study was approved by the Institutional Review Board of the University of Hawai'i. Written informed consent was

obtained from each participant before enrollment in the study. There was no cost to participants for the yoga course. Meghan’s Foundation provided yoga mats for participants who did not have their own. Yoga mats and yoga blocks were brought to each class by the instructor. A \$5 gift card was provided to potential enrollees upon completion of the consent form in appreciation for agreeing to participate in the research.

Yoga Intervention

The intervention for this study was taught by an OEF/OIF/OND veteran who was also a certified yoga instructor trained in the WAE protocol. The intervention was designed to provide a Vinyasa-style yoga class that is appropriate for a military audience, specifically combat veterans. Three key components of Vinyasa yoga are breath work, physical postures, and meditation. The Vinyasa style focuses on moving from pose to pose while coordinating with the breath. The trauma-sensitive protocol advocated by WAE and Meghan’s Foundation is an approach designed to create a welcoming space where participants can access the present moment and reclaim a sense of well-being. Elements of trauma-sensitive yoga include no hands-on adjustment of participants’ postures during the classes, the avoidance of potentially vulnerable yoga

positions such as “happy baby,” body sensing, using the English-language name vs. the Sanskrit name for each yoga pose, and giving participants the option of keeping their eyes open throughout the class. The WAE protocol also includes modifications for participants with combat-related wounds, traumatic injuries, and other health conditions that may warrant adaptive yoga practices.

In this intervention for able-bodied veterans, each session was similar in sequence, starting with a 10-min warm-up inclusive of 3–5 min of meditation (Table I). This seated meditation component refers to bringing a mindful awareness to internal cues (such as bodily sensations, breath, thoughts, and emotions) and external cues (such as sights and sounds in the room). The seated meditation is followed by 25 min of standing yoga, 10 min of balancing yoga, and 10 min of mat yoga. The last pose of yoga is known in Sanskrit as Savasana, which is translated as corpse pose. As the word “corpse” is associated with death, the word “resting” was used instead, and the pose was referred to as the “resting position.”

Participants

Recommended sample size was estimated using an online power calculator.^{29,30} Because we were anticipating a medium to large effect size based on extant literature reporting on the effect of trauma-sensitive yoga in other populations, we set the effect size as 0.50. Setting the alpha at 0.05 and the beta at 0.20 yielded a recommended sample size of 34.

Participants were recruited using flyers and Internet advertisements. For example, a flyer advertising the study was uploaded to websites of veteran service organizations, such as the Wounded Warrior Project and Team Red, White, and Blue, and also posted at these venues. Eligible participants were veterans who deployed to Iraq or Afghanistan in support of OEF/OIF/OND. All participants were 18 yr of age or older. They must have had subthreshold or diagnostic-level PTSD related to their combat military service, as determined by a score of 30 or higher on the PTSD Checklist-Military version (PCL-M).³¹ Although there is no absolute method for determining the correct cut point on the PCL, a score of 50 is typically used as an indicator of PTSD in mental health settings. However, Lang et al recommend using a cutoff of 30 in populations where trauma exposure is high, as it has a sensitivity of 0.98.³² Research also suggests that the prevalence of PTSD can be as high as 15% among individuals scoring 30–34, 16–39% among individuals scoring 34–44, and 40% among individuals scoring 45–50.³³ Excluded were individuals with noncombat-related PTSD, those unable to mentally or physically perform yoga, and those who were pregnant.

Under the direction of the yoga instructor, subjects agreed to practice yoga once a week for 6 wk. The intervention was conducted over a 10-wk period in fall 2016 at the Oahu Veterans Center and at a private yoga studio in Hawai’i, and participants were asked to attend once a week for at least five sessions in

TABLE I. Yoga Sequence

Warm-up 10 min
Relaxed yoga breathing in seated posture
Neck stretch, wrists rotation, and extension
Table top → cat/cow stretch
Thread the needle
Opposite arm and leg balance in table top
Sun salutation A
Standing yoga 25 min
Warrior 1
Warrior 2
Reverse warrior
Extended side angle
Plank or modified plank
Triceps push-up *optional and can be on knees
Cobra or upward dog
Downward dog *optional to use chair
Triangle pose
Pyramid pose
Balancing yoga 10 min
Tree pose
Eagle and modified eagle
Warrior 3
Extended leg
Chair pose ***using wall or chair to help with balance
Mat yoga 10 min
Hamstring stretch with strap
IT band stretch with strap
Boat and half boat pose
Modified bridge pose
Resting position 5 min
Soft, relaxation breathing
Body scanning meditation

seven consecutive weeks. Participants were encouraged to continue ongoing psychotherapy and/or pharmacological treatment. Participants were asked about their involvement in other therapies before and after the study. All the veterans were provided with a resource list that included information on Military OneSource, Veterans Crisis Line, and services provided by the Vet Center.

Measures

Baseline data were collected from the participants, including sex, age, race/ethnicity, deployment history (OEF, OIF, and/or OND), branch of military service (Marine, Army, Navy, and Air Force), marital status (single, married, divorced/separated, or widowed), educational attainment (high school or equivalent, some college, bachelor's degree, graduate degree, or professional license), and current treatment for PTSD (medications, cognitive therapy, or no treatment).

The PCL-M was administered at pre-screening immediately after consent.³¹ If eligible for the study, participants were then asked to complete four psychosocial questionnaires – the Patient Health Questionnaire (PHQ-8),³⁴ the Beck Anxiety Inventory (BAI),³⁵ the Pittsburgh Sleep Quality Index (PSQI),^{36,37} and the Mindful Attention Awareness Scale (MAAS).^{38,39} These data were collected within a week of consent, and the individual then entered the yoga intervention. Follow-up data were collected within a week of the participant finishing his/her fifth weekly session in seven consecutive weeks.

The primary outcome measure was the PCL-M. The PCL-M is a 17-item questionnaire with a 5-point scale, from 1=*not at all* to 5=*extremely*. Sample items ask how often in the past month the respondent was bothered by physical reactions (e.g., heart pounding and sweating) when something reminded them of a stressful military experience; or how often in the past month they were bothered by a loss of interest in things previously enjoyable to them. The 17 PTSD symptoms are grouped into three clusters: five re-experiencing symptoms, seven avoidance symptoms, and five hyperarousal symptoms. All items are summed to obtain a total severity score (the range of total possible scores is 17–85). As noted, researchers have used different cutoffs for study participation. A cutoff of 30 was used for this study to capture participants with subthreshold and diagnostic-level PTSD symptoms.³³ The PCL-M has been shown to have high internal consistency (0.96–0.98) and good convergent validity (0.62–0.90 depending on the comparator instrument).⁴⁰

The PHQ-8 is a validated instrument for identifying depression in the general population.³⁴ It includes eight items scored using a 4-point scale from 0=*not at all* to 3=*nearly every day*. Sample items include “how often in the last two weeks have you been bothered by trouble concentrating on things, such as reading the newspaper or watching television” and “feeling bad about yourself, or that you are a failure, or have let yourself or your family down.” Item scores are

totalled, and the range of possible scores is from 0 to 24. A total score of 0–9 indicates no depression, 10–14 mild depression, 15–19 moderate depression, and 20+ severe depression. A psychometric study by Kroenke and colleagues with 6,000 primary care patients found that 88% of those diagnosed with “major depression” had a score of 10 or greater, indicating good concurrent validity, and a Cronbach's alpha of 0.86, indicating good internal consistency.⁴¹

The BAI is a 21-item questionnaire to assess anxiety symptoms.³⁵ The respondent is asked on a 0=*not at all* to 3=*severely* scale how much he or she was bothered by each symptom (e.g., feeling nervous, unable to relax, and feeling shaky or unsteady during the past month). Total scores can range from 0 to 63. A score of 0–21 is considered a normal level of anxiety, 22–26 as mild anxiety, 27–31 as moderate anxiety, and 32–63 as severe anxiety. The BAI has demonstrated high internal consistency (0.94) and validity as a screening instrument in detecting the presence of current anxiety in adults.³⁵

Insomnia and sleep habits were evaluated by the PSQI, which has 19 self-rated questions measuring sleep quality in the past month. Sample items include “how many minutes does it take for you to fall asleep each night” and “in the past month how often do you have to get up in the middle of the night or early morning.” The 19 responses are coded into seven component scores (e.g., subjective sleep quality, sleep duration, sleep disturbances, and use of sleeping medication), and the sum of scores for these seven components yields a global score with a range of 0–21. Buysse and colleagues found that a global PSQI score greater than 5 distinguished poor from good sleepers.³⁶ In a study of 3,095 men, Spira et al found that the PSQI had a Cronbach's alpha of 0.69 and better predictability of sleep disorders than the Epworth Sleepiness Scale.³⁷

The MAAS is widely used to measure mindfulness as present-centered attention awareness in everyday experiences.³⁸ Mindfulness, a receptive attention to and awareness of the present moment, has gained the attention of clinicians in the last 25 yr due to its association with improved mental and physical health.³⁹ The MAAS has 15 items, and individuals respond to each item on a 6-point scale, from 1=*almost always* to 6=*almost never*. Sample questions include “I find myself doing things without paying attention,” and “I do jobs or tasks automatically, without being aware of what I'm doing.” Psychometric study of the MAAS has yielded Cronbach alphas from 0.78 to 0.92, and test–retest reliability of 0.81.⁴²

Data Analysis

Before conducting analyses, baseline and post-intervention data were assessed for normal distribution using the Shapiro–Wilk test, and the assumption was considered satisfied. Scores on the primary (PCL-M) and secondary (self-reported anxiety, depression, insomnia, and mindfulness)

measures were compared before and after the intervention using the paired *t*-test to evaluate change following the yoga intervention. Effect sizes (Cohen’s *d*) of the intervention on outcomes were estimated by dividing the mean change between baseline and post-test by the standard deviation (SD) of the mean change.⁴³ Additionally, changes between baseline and post-test scores were compared for participants receiving adjuvant treatments for PTSD (vs. those that were not) and for participants with PCL-M pre-test scores of 50 and greater (vs. those with lower pre-test scores). Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows. All statistical tests were two-tailed, and *p* < 0.05 was considered statistically significant.

RESULTS

Fifty-two OEF/OIF/OND veterans with combat-related symptoms inquired about and were verbally informed about the study. Of these, 33 veterans consented and completed the PCL-M to screen for eligibility to participate. Ten were excluded because their PCL-M scores were less than 30. Twenty-three

veterans met eligibility criteria and enrolled in the study. Of these 23, 18 veterans completed five out of seven consecutive weeks of the yoga intervention, for a completion rate of 78.3%. Reasons for dropout included conflict with work or school schedules.

Participant characteristics are shown in Table II. Age in years of participants ranged from 26 to 62 (median = 43). Half were females and half were males. The majority of the study sample had served in the Army, and 13 of the 18 participants had been enlisted personnel. Length of service in years ranged from 2 to 34 (median = 18.8). Half of the participants identified themselves as White, and the remaining identified as Asian, Pacific Islander, and Hispanic Latino. Equal proportions were married, single, and divorced or separated. All participants had attended some college, and ten had a graduate degree. Six (33%) of the 18 reported concurrent treatment (one with counseling and five with counseling and medication), and all six had been in treatment for more than a year. Seven (39%) had baseline PCL-M scores of 50 or greater. Five of the six participants in concurrent treatment had a baseline PCL-M of 50 or greater, and the sixth participant scored 41 (not shown in table).

Baseline and post-intervention scores on the primary (PCL-M) and secondary measures are shown in Table III. For the entire sample, the total PCL-M score decreased 17.6 points from the mean baseline score of 47.7 (*p* < 0.001). A change of 9 points or higher is considered clinically meaningful.⁴⁴ The scores on each of the three PCL-M clusters also decreased, and these improvements were statistically significant (*p* < 0.001). Based on the mean change from baseline and post-intervention total PCL-M score and the SD of the mean change, the effect size was 1.93, which is very large.⁴¹

Although the post-yoga PSQI score was reduced from baseline (*p* < 0.001), this improvement may not be clinically meaningful, as the post-intervention PSQI score was still greater than 5.00, which is consistent with sleep disturbances. The change in PHQ-8 score was clinically as well as statistically meaningful, as it dropped from a baseline score of 11.9, in the mild depression range, to 6.8, in the no-depression range (*p* < 0.001). The change in BAI score was also clinically significant, as it decreased from 20.3, moderate anxiety, to 11.2, mild anxiety (*p* < 0.001). The increase in mean MAAS score was statistically significant, signaling an improvement in mindfulness (*p*=0.001). The Cohen’s *d* estimates for all outcome measures were 1.0 or greater, indicating a high effect size of the intervention on all five measures.

Findings from stratified analyses are shown in Table IV. The six participants in concurrent treatment had significantly worse baseline scores and showed significantly greater improvement in PTSD symptoms, depression, and anxiety. However, differences between participants with and without concurrent treatment were not significant for baseline PSQI score or on change in PSQI score, indicating similarly poor sleep quality for both groups at baseline and follow-up. The seven participants who

TABLE II. Participant Characteristics (*N* = 18)

	Value
Age in years, mean (SD), (median = 43, range 26–62)	43 (9.7)
Sex (<i>n</i>)	
Male	9
Female	9
Military Branch (<i>n</i>)	
Army	12
Navy	1
Air Force	2
Marine Corps	3
How many years of service, mean (SD), (range 2–34, median=18.8)	17.4 (9.2)
Current rank	
Officers	5
Enlisted	13
Ethnicity (<i>n</i>)	
White	10
Asian	5
Pacific Islander	2
Hispanic Latino	1
Marital status	
Single	6
Married	6
Divorced/separated	6
Highest level of education (<i>n</i>)	
Graduate degree	10
Bachelor	3
Some college	5
High school education	0
Concurrent treatment	
Psychotherapy only	1
Medications and psychotherapy	5
None	12
PCL-M score	
>50	7
<50	11

TABLE III. Mean Baseline and Post-test Scores on PTSD and Other Measures (*N* = 18)

Measure	Baseline Mean (SD)	Post Mean (SD)	Change Mean (SD)	<i>t</i> -Test (<i>p</i> -value)	Effect Size ^a
PCL-M total score	47.7 (15.0)	30.1 (8.4)	17.6 (9.1)	8.2 (<0.001)	1.93
Hyperarousal	15.2 (3.9)	9.1 (1.9)	6.1 (2.8)	9.2 (<0.001)	2.17
Re-experiencing	12.8 (6.1)	7.8 (2.9)	5.0 (4.1)	5.2 (<0.001)	1.23
Avoidance	19.2 (6.3)	13.1 (4.4)	6.2 (3.3)	7.9 (<0.001)	1.86
PSQI	13.0 (4.8)	9.7 (3.9)	3.3 (3.0)	4.6 (<0.001)	1.08
PHQ-8	11.9 (6.5)	6.8 (4.3)	5.1 (3.9)	5.6 (<0.001)	1.32
BAI	20.3 (12.8)	11.2 (9.7)	9.1 (6.8)	5.7 (<0.001)	1.32
MAAS	47.9 (19.2)	60.0 (13.7)	-12.1 (12.1)	-4.2 (0.001)	-1.00

^aEffect size was estimated by dividing the mean of the change between baseline and post-test score by the SD of the mean change. Numbers in italics are the *p*-values.

TABLE IV. Mean Scores on Baseline Measures and of Change Between Baseline and Post-test Comparing Participants by Adjuvant Therapy and Baseline PCL-M Score (*N* = 18)

Measure	Adjuvant Therapy		<i>p</i> -Value	Baseline PCL-M Score		<i>p</i> -Value
	No (<i>n</i> = 12)	Yes (<i>n</i> = 6)		Score <50 (<i>n</i> = 11)	Score 50+ (<i>n</i> = 7)	
PCL-M						
Baseline	41.0 (12.1)	61.0 (10.9)	<i>0.004</i>	36.9 (5.7)	64.6 (5.9)	< <i>0.001</i>
Change	14.6 (7.8)	23.7 (9.1)	<i>0.042</i>	12.2 (5.1)	26.1 (7.2)	< <i>0.001</i>
PSQI						
Baseline	11.8 (5.1)	15.5 (3.0)	<i>0.120</i>	10.5 (4.4)	17.0 (1.5)	<i>0.002</i>
Change	3.1 (3.1)	3.8 (3.2)	<i>0.637</i>	3.2 (3.3)	3.6 (2.8)	<i>0.800</i>
PHQ-8						
Baseline	9.3 (6.1)	17.0 (3.8)	<i>0.013</i>	8.1 (4.8)	17.9 (3.5)	< <i>0.001</i>
Change	14.4 (9.1)	27.2 (6.9)	<i>0.008</i>	12.2 (6.6)	28.9 (5.4)	< <i>0.001</i>
BAI						
Baseline	14.0 (10.4)	33.0 (5.6)	<i>0.001</i>	12.2 (8.5)	33.1 (5.6)	< <i>0.001</i>
Change	5.8 (4.8)	15.7 (5.4)	<i>0.001</i>	6.5 (5.8)	13.1 (6.7)	<i>0.041</i>
MAAS						
Baseline	56.6 (17.1)	30.7 (8.2)	<i>0.003</i>	58.3 (17.0)	31.7 (7.6)	<i>0.001</i>
Change	-9.2 (13.5)	-17.8 (6.4)	<i>0.159</i>	-7.8 (13.4)	-18.7 (5.8)	<i>0.061</i>

Numbers in italics are the *p*-values.

scored 50 or greater on the PCL-M at baseline had significantly worse pre-intervention scores on the same four measures, and their improvement was significantly greater on three of the measures (PCL-M, PHQ-8, and BAI).

DISCUSSION

This pre-post study of a military-focused, trauma-sensitive yoga intervention demonstrated decreased PTSD symptomatology in all three-symptom clusters represented by the PCL-M (i.e., hyperarousal, re-experiencing, and numbness/avoidance). In addition, the amount of improvement in the PCL-M scores after the yoga intervention was both clinically meaningful and statistically significant. The intervention also improved mindfulness scores and decreased insomnia, depression, and anxiety symptoms. Thus, the results of this small pilot study are encouraging and show that trauma-sensitive yoga can help alleviate negative mental health symptoms in OEF/OIF/OND veterans with combat-related PTSD. To our knowledge, this is the first trial of trauma-sensitive, military-tailored Vinyasa yoga among OEF/OIF/OND veterans.

Research on mind-body therapies other than yoga, including MBSR and meditation, confirm that CAM approaches can reduce PTSD symptoms in OEF/OIF/OND veterans.^{22–26,45–55} However, the results of previous studies were not as dramatic as the results of this study. There are several possible reasons for this large magnitude of change. First, it could be that the non-yoga mind-body therapies tested previously required less physical activity than our Vinyasa yoga intervention, which is a movement-based yoga practice that synchronizes breath to movement. Vinyasa yoga is strenuous enough to improve cardiorespiratory fitness in unfit or sedentary individuals.⁵⁶ A meta-analysis examining the impact of physical activity as a PTSD treatment modality found that physical activity is effective in reducing both PTSD and depressive symptoms.⁵⁷

A second possible reason this study fared better than other mind-body therapies evaluated in the literature is because the intervention was specifically tailored for veterans whose PTSD was related to combat. As noted, trauma-sensitive yoga has also been shown to be effective in other populations, including victims of interpersonal violence and natural disasters.^{16–21} The WAE protocol used in the intervention was developed for

veterans suffering from the effects of combat-related trauma, the target of this study.²⁸

A third reason could be that the intervention was led by a combat veteran who had deployed to Iraq and Afghanistan. In contrast, investigational trials of other mind–body interventions targeting veterans were conducted by academic professionals with no military services experience.⁵⁵ Sharing the experience of military service and multiple combat deployments with each other and with the intervention leader may have helped build trust and rapport between the participants and the instructor. As one yoga participant stated after class, “the success or failure of getting veteran recruits hinges on the yoga instructor’s credibility, ability to successfully teach the yoga class, and willingness to modify the activities for the participants.” A strong group rapport was also noted by a participant who told the instructor, “Knowing that other people in the class have a similar background helps a lot, especially that first time trying yoga. I do not see myself going to a yoga studio or yoga class if the students are not veterans.” Thus, it is possible that due to the good rapport established with the instructor and within the group, participants may have developed feelings of friendship and wanted to demonstrate this by reporting improved symptoms.

The peer-support aspect of the intervention should be examined in more depth. In a qualitative study of 23 veterans with PTSD, Hundt and colleagues found that veterans felt positively about peer-support interventions and anticipated benefits such as social support, normalization of symptoms, and increased initiation and adherence to adjuvant treatment.⁵⁸ Study participants expressed preference for peer-support groups segregated by specific trauma type and era of service, supporting the intent of our research to focus on post-9/11 veterans.

In comparing subgroups of participants, the findings suggest that the intervention is even more impactful in those with higher PCL-M scores (50 or greater) and those receiving adjuvant therapies. These groups overlapped, as five of the six individuals receiving adjuvant therapy scored 50 or higher on the PCL-M. It could be that these individuals were especially sensitive to the rapport established within this group of peers, as well as to the yoga protocol itself.

The secondary measure that improved the least was the PQSI score, and this was true for the full sample and in the analysis stratified by concurrent treatment and PCL-M score. We ran a bivariate correlation between baseline PQSI score and age to see if lack of meaningful improvement in sleep quality was related to the older median age of the sample (43 years). Research suggests that sleep architecture is modified by age, with reducing proportions of time spent in deep sleep over the life course.⁵⁹ However, the age–PSQI correlation was not significant in our sample. In a study of 152 Australian Vietnam war veterans, 100% of veterans with PTSD and 90% of veterans without PTSD reported clinically significant sleep disturbances. This suggests that serious sleep problems in veterans may be due to military-

related factors other than combat-associated PTSD.⁶⁰ More research is needed to understand how to improve sleep quality in veterans.

Limitations

There were several limitations to this study. The sample size was small, and the characteristics of the final 18 participants differed from what we expected. For example, females comprise 15.5% of the Department of Defense active duty force,⁶¹ but in this study, 50% of the participants were females. Many of the male participants commented on their first day that they were reluctant to participate because they felt yoga was only for females, and four of the five dropouts were males. Also, the participants in this study were older than expected. Over one-half of active duty enlisted personnel are 25 yr of age or younger and 20% are aged 26–30 yr.⁶¹ This study recruited OEF/OIF/OND veterans only, but the median age was 43 yr. The other unexpected finding was that the participants in this study were well educated, with all having some college experience and five being officers. It appeared that the enlisted individuals gained their college experience post-deployment, likely through the GI Bill, and that the officers may have been older than the average recruit when they were deployed to the Middle East. Perhaps the recruitment process or the choice of intervention (yoga) attracted more females and older and more educated veterans. A nationwide prevalence survey reported that the mean age of yoga participants was 43 yr and that two-thirds of yoga users were female and college-educated.⁶² Other limitations include lack of a control group and a lack of long-term post-intervention follow-up.

Future studies should recruit a larger sample and younger subjects (e.g., veterans under age 30 yr), compare findings against a control group, and follow-up with participants at least 6 mo post-intervention. Research is also needed on how to integrate yoga into military settings and make it more broadly applicable. For example, the WAE protocol tested in this study was appropriate for physically able veterans. However, there is a need to consider physical limitations with veterans with comorbidities (e.g., neck/back pain, traumatic brain injury, and amputation). More research is needed to learn how to increase the acceptability of yoga among males and how to garner support for yoga training among the military leadership and medical personnel.

CONCLUSION

This study such as the WAE protocol, demonstrates that a trauma-sensitive yoga intervention may be effective for veterans with PTSD symptoms. Although effective for all veterans scoring 30 or higher on the PCL-M, this intervention appears to have a greater impact on veterans scoring 50 or higher and veterans on concurrent pharmacological and cognitive therapies. The impressive decrease in PTSD symptoms may be due to the tailored military-specific nature of

the intervention and the fact that it was led by a veteran of post-9/11 conflicts. More research is needed with a larger sample and a more diverse veteran population.

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