

# A Yoga Program for the Symptoms of Post-Traumatic Stress Disorder in Veterans

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**ABSTRACT** The purpose of this pilot study was to evaluate the feasibility and effectiveness of a yoga program as an adjunctive therapy for improving post-traumatic stress disorder (PTSD) symptoms in Veterans with military-related PTSD. Veterans ( $n = 12$ ) participated in a 6 week yoga intervention held twice a week. There was significant improvement in PTSD hyperarousal symptoms and overall sleep quality as well as daytime dysfunction related to sleep. There were no significant improvements in the total PTSD, anger, or quality of life outcome scores. These results suggest that this yoga program may be an effective adjunctive therapy for improving hyperarousal symptoms of PTSD including sleep quality. This study demonstrates that the yoga program is acceptable, feasible, and that there is good adherence in a Veteran population.

## INTRODUCTION

War-related post-traumatic stress disorder (PTSD) exacts an incalculable toll on survivors, their interpersonal and occupational networks as well as the Veterans Affairs (VA) Health Care and Benefits systems and society as a whole. The prevalence of PTSD among Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans from all branches of service from 2007 to 2008 was 13.8%,<sup>1</sup> and PTSD has been identified by the House Committee on Veterans Affairs as one of the signature wounds of Veterans returning from these wars. In 2005, 14 years after the Gulf War, Veterans reported PTSD rates of 15.2%.<sup>2</sup> Results of the National Vietnam Veterans' Readjustment Study (NVVRS) showed a lifetime PTSD prevalence of 30.9 % among male and 26.9% among female Vietnam theater Veterans.<sup>3</sup> According to the Department of Veterans Affairs Strategic Plan, rates of PTSD are steadily rising within the Veteran population.<sup>4</sup>

Two evidence-based psychotherapy treatments that are supported as first-line treatments for PTSD by the Veterans Health Administration are prolonged exposure therapy (PE) and cognitive processing therapy (CPT).<sup>5</sup> Although both of these therapies have been shown to reduce overall PTSD symptoms in Veterans,<sup>6-8</sup> improvements in the hyperarousal symptom cluster of PTSD have not been consistently observed.<sup>7,9</sup> In addition, although CPT and PE are effective in many cases, some Veterans do not improve with these treatments or remain somewhat symptomatic.<sup>6,10</sup> In one study of CPT, 31.7% of Veterans were classified as unchanged and 10.6% deteriorated based on PTSD checklist (PLC)<sup>11</sup> scores.<sup>6</sup>

For PE, 26% of OEF/OIF Veterans completing the treatment still had PLC scores above the suggested cut-off value for PTSD.<sup>12</sup> Therefore, there is a need to investigate additional treatments that may be used as adjunctive therapy as well as interventions that address the treatment of hyperarousal symptoms of PTSD.

Problems with sleep and anger are components of the hyperarousal symptom cluster of PTSD and hyperarousal symptoms may actually determine subsequent PTSD symptom severity.<sup>13,14</sup> Sleep problems are more frequently experienced in Veterans with PTSD than those without PTSD.<sup>15</sup> In Veterans with lifetime PTSD, lower quality of sleep was directly correlated to hypervigilance scores which are part of the hyperarousal symptom cluster.<sup>16</sup> Furthermore, it is possible that sleep problems may predict PTSD symptoms.<sup>17</sup> Anger, a primary component of combat-related PTSD,<sup>18</sup> appears to be a function of PTSD itself since studies have shown that aggression<sup>19</sup> and anger<sup>20</sup> were not correlated with combat exposure or the presence of concurrent psychiatric disorders.<sup>19,20</sup>

Sleep and anger problems are often experienced as severe and acutely distressing. In Veterans, the hyperarousal symptom cluster had the strongest impact on overall functioning compared to the reexperiencing and numbing/avoidance clusters.<sup>21</sup> Poor overall functioning, in turn, can result in decreased quality of life and as many as 59% of subjects with PTSD from 11 treatment trials had severe quality of life impairment.<sup>22</sup> Vietnam Veterans with PTSD have been shown to have a significant risk of diminished well-being<sup>23</sup> and Gulf War Veterans with PTSD have also reported lower levels of functioning and quality of life compared to those without PTSD.<sup>24</sup> Clinically significant PTSD improvement in Vietnam Veterans as a result of PTSD treatment has been associated with improvement in quality of life domains<sup>25</sup> and both improvements occurred at the same time in the course of treatment.<sup>26</sup> Therefore, treating PTSD is expected to improve quality of life.

Yoga is a system of mind-body techniques for improving physical and mental health and includes physical postures,

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The contents of this report do not represent the views of the Department of Veterans Affairs or the United States Government.

doi: 10.7205/MILMED-D-12-00536

breathing, focused concentration, and meditation. Yoga has been shown to improve quality of life in military personnel deployed to Iraq<sup>27</sup> and in Veterans with back pain.<sup>28</sup> Many studies have been done showing that yoga can improve sleep<sup>29,30</sup> and reduce anger<sup>31,32</sup> in a variety of populations. However, none of these studies have been done in Veterans with PTSD. The effect of yoga on Veterans with PTSD has only been reported in one qualitative study to date. Eleven combat Veterans reported reduced rage, anxiety, and emotional reactivity and increased self-awareness and self-efficacy after participation in a yoga nidra intervention (iREST).<sup>33</sup> This intervention is based on principles from yoga and other forms of therapy but it does not involve performing a series of yoga postures and PTSD symptoms were not directly measured.

A few studies have been performed on the effects of yogic interventions for PTSD in non-Veterans. Two pilot studies are briefly described in a review article on PTSD.<sup>34</sup> In the first study with 8 participants, 8 sessions of yoga significantly improved PTSD-related reexperiencing, avoidance, and total scores on the Clinician-Administered PTSD Scale, but not hyperarousal. In the second study, 4 women with PTSD had decreased in the frequency of intrusions and hyperarousal symptoms after 1 session of hatha yoga exercises compared to 4 women receiving dialectical behavioral therapy. Improvements in PTSD symptoms in survivors of the 2004 South-East Asia tsunami were also measured using an intervention involving yogic breathing alone, but not yoga postures.<sup>35</sup>

Although currently there is a lack of empirical data on yoga for Veterans with PTSD, various forms of meditation have been shown to be helpful. Transcendental meditation,<sup>36</sup> mindfulness meditation,<sup>37,38</sup> and mantra meditation<sup>39</sup> have all been shown to reduce PTSD symptoms in Veterans. Both yoga and meditation are mind-body modalities that decrease parasympathetic activity and are likely to work via similar mechanisms to reduce PTSD symptoms. A recent theory suggests that stress can be reduced by yoga-based practices that shift regulatory systems such as the hypothalamic–pituitary–adrenal axis, and neuroendocrine, cardiac, metabolic and immune systems toward optimal homeostasis.<sup>40</sup> Meditation is often practiced as a component of yoga and the focused attention aspect of meditation, including the use of mantra, is incorporated into some yoga traditions. Given these common characteristics, yoga is also likely to have a beneficial effect for PTSD.

To our knowledge, this is the first study using a yoga intervention that includes performing yoga postures for reducing PTSD symptoms in Veterans. The purpose of this preliminary pilot study was to evaluate the feasibility of providing a yoga intervention in an outpatient VA PTSD population and the acceptability of this therapy to this population of Veterans as well as to examine the effects on PTSD symptoms, sleep problems, anger, and quality of life. This investigation is consistent with a major initiative identified in the Department of Veterans Affairs strategic plan to explore innovative treatment approaches, including testing

complementary medicine techniques, for treating mental health conditions.<sup>4</sup>

**METHODS**

**Participants**

All procedures followed were in accordance with the ethical standards of the G.V. (Sonny) Montgomery VA Medical Center Institutional Review Board and the Southeast Louisiana Veterans Health Care System Institutional Review Board. Participant characteristics are listed in Table I. Participants were previously diagnosed with PTSD by a thorough clinical interview conducted by a mental health professional specializing in assessment and treatment of military-related PTSD as part of the routine evaluation procedure in a PTSD Clinical Team at a Veterans Affairs Health Care System in the Southeast region of the United States. Exclusion criteria included current or lifetime bipolar or psychotic disorder; current substance dependence; pregnancy; or a significant medical condition that would interfere with participation in the yoga

**TABLE I.** Participant Characteristics

	Value
Age in Years, Mean (SD), (Range 58–64)	62.2 (2.2)
Sex (n)	
Male	10
Female	2
Military Status (n)	
Veteran	11
Reserve Member	1
Military Branch (n)	
Army	7
Navy	4
Marine Corps	1
Period of Military Service (n)	
During Vietnam Only	9
During and After Vietnam	1
Post-Vietnam	2
Race (n)	
Black/African American	6
White	5
American Indian/Alaskan Native	1
Highest Level of Education (n)	
College Graduate	3
Some College	6
High School Education	3
Living Situation (n)	
Married and Living With Partners	5
In a Relationship But Not Living With Partners (2 Divorced/Separated; 1 Widowed)	3
Not in a Relationship and Living Alone (1 Divorced/Separated; 1 Widowed)	2
Divorced/Separated, Not in a Relationship and not Living Alone	2
Employment Status (N)	
Unemployed	10
Steady Employment	1
Temporary Employment	1
Receiving Disability for PTSD (N)	9

intervention. Participants were recruited for the study by referral from PTSD Clinical Team clinicians. There were 25 referrals and 15 participants were enrolled in the study. The others were not enrolled because 3 could not accommodate the schedule of the yoga sessions and 7 did not respond in time. Three subjects withdrew during the 6 week yoga intervention and were not included in the data analysis. Reasons for withdrawal included experiencing pain unrelated to the intervention, side effects of new medication, and a daycare scheduling conflict. No adverse effects were reported.

### Yoga Intervention

The yoga intervention for this study was developed and taught by 3 certified yoga teachers and was based on the yoga tradition of the Krishnamacharya Healing and Yoga Foundation (KHYF). This yoga style emphasizes a therapeutic approach that links the breath to movement and uses a specific meditative focus. The yoga intervention was designed to provide practitioners the experience of focus, peace, and calmness and to help them develop self-awareness and the ability to be more present in the moment. According to this yoga tradition, by learning these skills participants may gain a sense of control of their thoughts and emotions; feel safer in their daily environments; and experience an overall decrease in stress.

The yoga intervention was held for 1 hour twice a week for 6 weeks (12 sessions total). Each session was structured to include about 3 minutes for self-awareness by “checking in” with the body, mind and breath; 40 minutes of postures with breath awareness; and 5 to 10 minutes of full body relaxation with a focus on extending the exhale and a guided visualization. The simple and gentle yoga postures emphasized flexibility with flowing movements while coordinating the breath with the movement to facilitate the movement and to help maintain focus. Throughout the series, the yoga postures remained fairly consistent. Commonly used postures included a dynamic side angle stretch (a gentle version of *parsvottanasana*) followed by *chakravakasana* (sunbird); *virabhadrasana* (warrior pose) followed by *uttanasana* (standing forward bend); and alternate leg *urdhva prasarita padasana* (upward stretched legs) followed by *apanasana* (knees to chest pose).

The coordinated breath with the postures gradually progressed over the sessions; moving from normal breathing, to extending the exhale, to inserting a pause between the inhale and exhale. Participants were taught Ujjayi breath to learn how to comfortably control the breath, to feel the spaces between the breath, and to achieve an inner focus. Ujjayi breath is slow deep breath involving a slight constriction of the back of the throat so the breath becomes audible. Sound, in the form of humming, was also included to assist in breath extension and to allow participants to feel a gentle vibration to increase the relaxation response. The guided relaxations at the end of each session included themes such as increased

sense of well-being, self-nourishment, creating space around the heart, focusing on a peaceful place, and mentally connecting with sources of joy.

All 3 teachers completed a 4-year KHYF Yoga Therapy Training Program. They were present at the beginning and ending sessions. The rest of the sessions were attended by 2 teachers: one observing and the other teaching. Attendance was recorded and written records were kept of feedback given by the instructors and participants at the end of each session.

### Measures

PTSD symptoms were measured using the PTSD checklist—military version (PCL-M).<sup>11</sup> The PCL contains 17 items corresponding to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*) criteria for PTSD. Past month symptom severity is indicated using a 5-point scale. Higher scores indicate greater PTSD symptoms. The PCL has been shown to have excellent internal consistency (Cronbach's  $\alpha = 0.94$ ).<sup>41</sup> It has good test-retest reliability,<sup>11</sup> sensitivity, and specificity<sup>41</sup> and has significant convergent validity with established PTSD instruments.<sup>42</sup>

The Pittsburgh Sleep Quality Index (PSQI) was used to measure quality of sleep.<sup>43</sup> The PSQI is a 19 item questionnaire that measures 7 components of sleep: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component score has a range of 0 to 3. The global score is a sum of the component scores and can range from 0 to 21. A score greater than 5 indicates poor sleep quality.<sup>43</sup> The PSQI has good internal consistency (Cronbach's  $\alpha = 0.83$ )<sup>43</sup> and moderate to high convergent validity with other sleep quality scales.<sup>44</sup>

The State-Trait Anger Expression Inventory-2 (STAXI-2) was used to measure anger.<sup>45</sup> This is a 57 item consisting of a 4-point scale that consists of 6 scales and an Anger Expression Index. The 6 scales are as follows: State Anger measures the intensity of anger at a particular time; Trait Anger assesses how often angry feelings are experienced over time; Anger Expression—Out measures expressing anger in aggressive behavior; Anger Expression—In measures how often angry feelings are experienced but suppressed; Anger Control—Out assesses how often the outward expression of anger is controlled; Anger Control—In measures the suppression of angry feelings by calming down. The Anger Expression Index is based on the responses of the Anger Expression and Anger Control scales and provides an overall index of anger expression. The STAXI-2 has been shown to have good concurrent validity.<sup>45</sup>

Quality of life was measured using the Outcome Questionnaire 45.2 (OQ-45.2).<sup>46</sup> The OQ-45.2 is a 45-item scale that measures functioning in 3 domains: Symptom Distress (particularly depression and anxiety), Interpersonal Functioning, and Social Role. Each item is rated using a 5-point Likert

scale ranging from 0 to 4. The possible range of scores is from 0 to 180 with higher scores indicating greater psychosocial impairment. The OQ-45.2 has been shown to have good internal consistency (Cronbach's  $\alpha = 0.93$ ) and test-retest reliability ( $r = 0.84$ ) as well as high to moderately high concurrent validity with a variety of standardized scales intended to measure similar variables.<sup>46</sup>

A program evaluation was also given at the end of the last session to provide an opportunity for participants to give written comments about the yoga program. The evaluation also asked participants how much they enjoyed the sessions, how helpful they found the sessions for improving their quality of life, and how likely they were to recommend the program to other Veterans.

**Data Analysis**

Baseline and post data were assessed for normal distribution using the Shapiro-Wilk test. Differences in the pre- to post-measurements of normally distributed data were analyzed using a 2-tailed paired *t*-test. Differences in pre- to post-measurements of data that were not normally distributed were analyzed using the Wilcoxon signed rank test. *P*-values less than 0.05 were considered statistically significant. Responses for one missing question on the PCL-M and one missing question on the PSQI were imputed with the

Expectation/Maximization (EM) algorithm. All data were analyzed using SYSTAT (v.12.02).

**RESULTS**

The yoga sessions were well attended with a mean session attendance 10.5 (SD = 1.6) out of 12 sessions. Results for all of the outcome measures are shown in Table II. There was a significant decrease in PTSD hyperarousal symptoms  $t(11) = 2.92, p < 0.05$ , PSQI total score symptoms  $t(10) = 2.78, p < 0.05$ , and the PSQI subscale of daytime dysfunction (due to sleepiness)  $t(11) = 2.57, p < 0.05$ . Effect sizes were measured using Cohen's *d* where 0.2 = small, 0.5 = medium, and 0.8 = large effect sizes.<sup>47</sup> The baseline to post effect sizes with 95% confidence intervals were as follows: PTSD hyperarousal symptoms ( $d = 0.36, CI = -1.62$  to  $2.62$ ); PSQI total score ( $d = 0.42, CI = -1.12$  to  $2.66$ ); and daytime dysfunction subscale of the PSQI ( $d = 0.66, CI = 0.21$  to  $1.11$ ). The effect size was medium for the daytime dysfunction subscale and small for the hyperarousal symptoms and the total PSQI score. Although the total PTSD score and reexperiencing scores decreased slightly and the avoidance score increased slightly, these changes were not statistically significant. There were also no significant improvements in any of the other PSQI subscales or in any of the scales or subscales of the STAXI-2 or the OQ-45.2.

**TABLE II.** Mean Scores on PTSD, Sleep Quality, Anger, and Quality of Life Outcome Measures

Measure	Baseline Mean (SD)	Post Mean (SD)	Test Statistic	<i>p</i> Value
PCL-M Total Score	58.2 (15.4)	57.1 (12.6)	$t = 0.43$	0.678
Hyperarousal	18.7 (3.5)	17.4 (4.0)	$t = 2.92$	0.014
Reperiencing	16.7 (5.4)	15.8 (3.8)	$t = 0.74$	0.475
Avoidance	22.8 (7.8)	23.9 (6.0)	$t = -0.70$	0.500
PSQI Total Score	14.6 (2.6)	13.3 (3.8)	$t = 2.78$	0.020
Sleep Duration	2.6 (0.7)	2.6 (0.7)	— <sup>a</sup>	— <sup>a</sup>
Sleep Disturbances	2.0 (0.6)	1.8 (0.7)	$Z = -0.82$	0.414
Sleep Latency	2.3 (0.8)	2.0 (1.2)	$Z = -1.63$	0.102
Daytime Dysfunction	1.9 (0.8)	1.4 (0.8)	$t = 2.57$	0.026
Habitual Sleep Efficiency	2.2 (1.1)	2.0 (1.3)	$Z = -0.41$	0.680
Sleep Quality	1.9 (0.7)	1.8 (0.8)	$Z = -1.00$	0.317
Use of Sleep Medication	1.8 (1.4)	1.9 (1.4)	$Z = 0.82$	0.414
STAXI-2				
State Anger	24.3 (10.0)	21.3 (9.9)	$Z = -1.17$	0.240
Trait Anger	22.9 (6.6)	22.3 (7.6)	$t = 0.62$	0.551
Anger Expression Index	46.2 (12.7)	45.3 (11.0)	$t = 0.51$	0.620
Anger Expression—Out	17.8 (4.7)	16.8 (3.6)	$t = 1.19$	0.261
Anger Expression—In	20.0 (4.7)	19.3 (4.4)	$t = 0.72$	0.489
Anger Control—Out	18.3 (4.4)	18.8 (3.5)	$Z = 1.03$	0.305
Anger Control—In	21.2 (4.0)	20.0 (5.2)	$Z = -1.07$	0.283
OQ-45.2 Total Score	86.7 (21.0)	82.6 (20.6)	$t = 1.39$	0.193
Symptom Distress	51.6 (13.2)	48.5 (14.1)	$t = 1.33$	0.210
Interpersonal Functioning	23.8 (6.6)	22.7 (4.3)	$t = 1.04$	0.320
Social Role	11.3 (4.9)	11.5 (3.7)	$t = -0.14$	0.892

*n* = 12 except for habitual sleep efficiency, total PSQI, and state anger where *n* = 11. The Wilcoxon signed ranks test was performed for the following subscales: sleep disturbances, sleep latency, sleep efficiency, sleep quality, use of sleep mediation, state anger, anger control-out, and anger control-in. Paired *t*-tests were performed for the other measures. <sup>a</sup>Because the paired data for sleep duration were identical at baseline and post, a *t* statistic and *p* value could not be calculated.

All Veterans filled out the anonymous program evaluation following the last session. Seventy-five percent answered the question about their enjoyment of the yoga classes with the highest rating “extremely.” The other 25% rated the enjoyment question with the next highest rating “very.” Eighty-three percent thought the yoga classes were helpful in improving quality of life and scored this question in the highest 2 out of 5 rating levels. All Veterans said they were likely to recommend the yoga program to other Veterans.

## DISCUSSION

The results of this preliminary study suggest that this yoga program may be an effective adjunctive therapy for improving hyperarousal symptoms of PTSD, including some elements of sleep quality. Total PTSD scores were not significantly improved, however. This yoga program was feasible and had good adherence in a Veteran population. Although most of the Veterans in this study were from the Vietnam era, the fact that the program was well attended and enthusiastically accepted suggests that a yoga intervention may also be appealing to other PTSD Veteran populations, including Operation Enduring Freedom/Operation Iraqi Freedom/Operation New Dawn (OEF/OIF/OND) Veterans. Offering supplemental or complementary treatment options as an alternative to traditional psychotherapy may improve treatment engagement with OEF/OIF/OND Veterans since there is a need in this population to improve retention in mental health treatment.<sup>48</sup>

It is noted that improvements were not detected on the OQ-45.2 quality of life measure. However, on the evaluations most Veteran’s subjectively rated the yoga classes as being “very” or “extremely” helpful in improving quality of life. Similar observations have been reported in studies with acute stress disorder where participants gave high ratings on evaluations for the “usefulness” of either a writing exercise<sup>49</sup> or a self-help booklet<sup>50</sup> but neither PTSD symptoms nor depression or anxiety were improved compared to control groups using standardized measures. This discrepancy suggests that, although there was a perception of improved quality of life in our study, this perceived improvement may have been too small for measurement or in domains not detected by the quality of life scale.

Although the mechanisms by which yoga may improve PTSD symptoms have not been fully studied or elucidated, a recent theory has been proposed involving the role of  $\gamma$ -aminobutyric acid (GABA).<sup>40,51</sup> Low serum levels of GABA in subjects involved in road traffic accidents predicted the development of acute PTSD 6 weeks later.<sup>52</sup> At 1 year follow-up, subjects with chronic or delayed onset PTSD had significantly lower post-trauma GABA levels than those who did not develop PTSD.<sup>53</sup> Other evidence for the role of GABA in PTSD is suggested by improvement in PTSD symptoms by treatment with a selective GABA reuptake inhibitor that enhances GABA neurotransmission.<sup>54</sup> Finally, a neuroimaging study demonstrated decreased binding to the GABA<sub>A</sub> receptor in Veterans with PTSD compared to

Veterans without PTSD.<sup>55</sup> Brain GABA levels have been shown to increase as a result of a single yoga session compared to a reading session<sup>56</sup> and brain GABA levels were correlated with improved mood and decreased anxiety in participants of a 12-week yoga intervention as compared to a walking control intervention.<sup>57</sup> Though these studies suggest that GABA may be one of the neurotransmitters that plays a role in the improvement in PTSD symptoms as a result of a yoga intervention, this remains a theory until the appropriate studies are performed.

Limitations of this study include the small sample size and lack of a control group. To address the VA mandate to “explore new approaches to diagnosing and treating mental health . . . including complementary and alternative medical treatments,”<sup>4</sup> our aim was to perform a small pilot study to determine if a yoga intervention was acceptable and feasible. The lack of measurable change in overall PTSD and sleep quality scores, and in the anger and quality of life outcomes may have been due to the study being underpowered regarding sample size. Our initial power calculation showed that a sample size of 13 people was needed for the PTSD primary outcome measure to have a 0.80 power to find an effect size of  $d = 0.7$  at an  $\alpha$  level of 0.05. Although we recruited 15 people, only 12 completed the intervention which likely left the study underpowered. In addition, it is possible that the duration of the yoga program was not long enough to result in measurable improvements in total PTSD scores, quality of life (which was perceived as having improved), and some of the sleep subscales. A study with a larger sample size, a longer yoga program, and a control arm matched for time, attention, and expectancy is required to give more definitive results. Finally, this study investigated the yoga program as a whole. Yoga consists of postures, breathing, relaxation, and meditation. Therefore, future studies would be useful to determine which of these components are the most important for the treatment effect and whether there is an additive or synergistic effect when they are combined.

The amount of home practice performed as part of a yoga or meditation intervention has been shown to positively correlate with outcomes. Yoga home practice as part of a mindfulness intervention was significantly correlated with increased psychological well-being, and decreased stress and anxiety.<sup>58</sup> This study had no home practice assigned although the Veterans requested and received a DVD at the end of the study with a sample session so that they could continue the practice. Assigning a home practice and including compliance measurements in future studies would be helpful to determine if home practice would be associated with greater improvement in PTSD symptoms.

A recent survey on the use of yoga in specialized VA PTSD treatment programs showed that yoga programs have been implemented in 28.8% of VA specialized PTSD treatment programs.<sup>59</sup> The most commonly reported barriers to providing yoga programs were lack of trained staff (84.9%) and lack of funding (53.5%). Lack of research supporting

efficacy was also reported by 26.7% of the respondents. If additional studies show yoga to be beneficial for improving PTSD symptoms in Veterans, then there would be evidence to support examining ways to increase access to yoga for PTSD Veterans.

This preliminary study provides evidence that a yoga intervention may improve the hyperarousal symptoms of PTSD. Given that some Veterans do not improve or remain somewhat symptomatic even with the current evidence-based psychotherapy treatments, a simple and inexpensive yoga intervention that is widely accepted among Veterans may be a valuable adjunctive therapy for PTSD treatment.

## ACKNOWLEDGMENTS

The authors thank the yoga teachers Becky Deano, Libby Levin, and Tiffany Conner for their skillful development and teaching of the yoga intervention. We thank Christel Antonellis for her excellent support as the research assistant and Lynn Waelde, PhD, for her helpful suggestions on the data analysis. We also thank the Veterans for their participation in the study. This material is the result of work supported with resources and the use of facilities at the Southeast Louisiana Veterans Health Care System, New Orleans, Louisiana.

## REFERENCES

- Schnell TL, Marshall GN: Survey of individuals previously deployed for OEF/OIF. In: *Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery*, pp 87–115. Edited by Jaycox HL, Tanielian T. Santa Monica, CA, RAND Center for Military Health Policy Research, 2008.
- Kang HK, Li B, Mahan CM, Eisen SA, Engel CC: Health of US veterans of 1991 Gulf War: a follow-up survey in 10 years. *J Occup Environ Med* 2009; 51: 401–10.
- Kulka RA, Schlenger WE, Fairbank JA, et al: Trauma and the Vietnam War Generation: Report of Findings from the National Vietnam Veterans Readjustment Study. New York, Brunner/Mazel, 1990.
- Office of the Secretary: Department of Veterans Affairs Strategic Plan Refresh Fiscal Year 2011–2015. 2011. Washington, DC. Available at [www.va.gov/VA\\_2011-2015\\_Strategic\\_Plan\\_Refresh\\_wv.pdf](http://www.va.gov/VA_2011-2015_Strategic_Plan_Refresh_wv.pdf); accessed December 1, 2012.
- Karlin BE, Ruzek JI, Chard KM, et al: Dissemination of evidence-based psychological treatments for posttraumatic stress disorder in the Veterans Health Administration. *J Trauma Stress* 2010; 23: 663–73.
- Alvarez J, McLean C, Harris AH, Rosen CS, Ruzek JI, Kimerling R: The comparative effectiveness of cognitive processing therapy for male veterans treated in a VHA posttraumatic stress disorder residential rehabilitation program. *J Consult Clin Psychol* 2011; 79: 590–9.
- Monson CM, Schnurr PP, Resick PA, Friedman MJ, Young-Xu Y, Stevens SP: Cognitive processing therapy for veterans with military-related posttraumatic stress disorder. *J Consult Clin Psychol* 2006; 74: 898–907.
- Schnurr PP, Friedman MJ, Foy DW, et al: Randomized trial of trauma-focused group therapy for posttraumatic stress disorder: results from a department of veterans affairs cooperative study. *Arch Gen Psychiatry* 2003; 60: 481–9.
- Macdonald A, Monson CM, Doron-Lamarca S, Resick PA, Palfai TP: Identifying patterns of symptom change during a randomized controlled trial of cognitive processing therapy for military-related posttraumatic stress disorder. *J Trauma Stress* 2011; 24: 268–76.
- Foa EB: Prolonged exposure therapy: past, present, and future. *Depress Anxiety* 2011; 28: 1043–7.
- Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM: The PTSD Checklist (PCL): reliability, validity and diagnostic utility. Paper presented at the 9th annual conference of the International Society for Traumatic Studies. San Antonio, TX, 1993.
- Tuerk PW, Yoder M, Grubaugh A, Myrick H, Hamner M, Acierio R: Prolonged exposure therapy for combat-related posttraumatic stress disorder: an examination of treatment effectiveness for veterans of the wars in Afghanistan and Iraq. *J Anxiety Disord* 2011; 25: 397–403.
- Marshall GN, Schell TL, Glynn SM, Shetty V: The role of hyperarousal in the manifestation of posttraumatic psychological distress following injury. *J Abnorm Psychol* 2006; 115: 624–8.
- Schell TL, Marshall GN, Jaycox LH: All symptoms are not created equal: the prominent role of hyperarousal in the natural course of posttraumatic psychological distress. *J Abnorm Psychol* 2004; 113: 189–97.
- Neylan TC, Marmar CR, Metzler TJ, et al: Sleep disturbances in the Vietnam generation: findings from a nationally representative sample of male Vietnam veterans. *Am J Psychiatry* 1998; 155: 929–33.
- Westermeyer J, Khawaja IS, Freerks M, et al: Quality of sleep in patients with posttraumatic stress disorder. *Psychiatry (Edgmont)* 2010; 7: 21–7.
- McLay RN, Klam WP, Volkert SL: Insomnia is the most commonly reported symptom and predicts other symptoms of post-traumatic stress disorder in U.S. service members returning from military deployments. *Mil Med* 2010; 175: 759–62.
- Elbogen EB, Wagner HR, Fuller SR, Calhoun PS, Kinneer PM, Beckham JC: Correlates of anger and hostility in Iraq and Afghanistan war veterans. *Am J Psychiatry* 2010; 167: 1051–8.
- Lasko NB, Gurvits TV, Kuhne AA, Orr SP, Pitman RK: Aggression and its correlates in Vietnam veterans with and without chronic posttraumatic stress disorder. *Compr Psychiatry* 1994; 35: 373–81.
- Chemtob CM, Hamada RS, Roitblat HL, Muraoka MY: Anger, impulsivity, and anger control in combat-related posttraumatic stress disorder. *J Consult Clin Psychol* 1994; 62: 827–32.
- Shea MT, Vujanovic AA, Mansfield AK, Sevin E, Liu F: Posttraumatic stress disorder symptoms and functional impairment among OEF and OIF National Guard and Reserve veterans. *J Trauma Stress* 2010; 23: 100–7.
- Rapaport MH, Clary C, Fayyad R, Endicott J: Quality-of-life impairment in depressive and anxiety disorders. *Am J Psychiatry* 2005; 162: 1171–8.
- Zatzick DF, Marmar CR, Weiss DS, et al: Posttraumatic stress disorder and functioning and quality of life outcomes in a nationally representative sample of male Vietnam veterans. *Am J Psychiatry* 1997; 154: 1690–5.
- Barrett DH, Doebbeling CC, Schwartz DA, et al: Posttraumatic stress disorder and self-reported physical health status among U.S. Military personnel serving during the Gulf War period: a population-based study. *Psychosomatics* 2002; 43: 195–205.
- Lunney CA, Schnurr PP: Domains of quality of life and symptoms in male veterans treated for posttraumatic stress disorder. *J Trauma Stress* 2007; 20: 955–64.
- Schnurr PP, Hayes AF, Lunney CA, McFall M, Uddo M: Longitudinal analysis of the relationship between symptoms and quality of life in veterans treated for posttraumatic stress disorder. *J Consult Clin Psychol* 2006; 74: 707–13.
- Stoller CC, Greuel JH, Cimini LS, Fowler MS, Koomar JA: Effects of sensory-enhanced yoga on symptoms of combat stress in deployed military personnel. *Am J Occup Ther* 2012; 66: 59–68.
- Groessler EJ, Weingart KR, Aschbacher K, Pada L, Baxi S: Yoga for veterans with chronic low-back pain. *J Altern Complement Med* 2008; 14: 1123–9.
- Khalsa SB: Treatment of chronic insomnia with yoga: a preliminary study with sleep-wake diaries. *Appl Psychophysiol Biofeedback* 2004; 29: 269–78.
- Chen KM, Chen MH, Chao HC, Hung HM, Lin HS, Li CH: Sleep quality, depression state, and health status of older adults after silver yoga exercises: cluster randomized trial. *Int J Nurs Stud* 2009; 46: 154–63.
- Khalsa SB, Hickey-Schultz L, Cohen D, Steiner N, Cope S: Evaluation of the mental health benefits of yoga in a secondary school: a preliminary randomized controlled trial. *J Behav Health Serv Res* 2012; 39: 80–90.

32. Shapiro D, Cook IA, Davydov DM, Ottaviani C, Leuchter AF, Abrams M: Yoga as a complementary treatment of depression: effects of traits and moods on treatment outcome. *Evid Based Complement Alternat Med* 2007; 4: 493–502.
33. Stankovic L: Transforming trauma: a qualitative feasibility study of integrative restoration (iRest) yoga Nidra on combat-related post-traumatic stress disorder. *Int J Yoga Therap* 2011; 23–37.
34. van der Kolk BA: Clinical implications of neuroscience research in PTSD. *Ann N Y Acad Sci* 2006; 1071:277–93.
35. Descilo T, Vedamurtachar A, Gerbarg PL, et al: 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 Psychiatr Scand* 2010; 121: 289–300.
36. Rosenthal JZ, Grosswald S, Ross R, Rosenthal N: Effects of transcendental meditation in veterans of Operation Enduring Freedom and Operation Iraqi Freedom with posttraumatic stress disorder: a pilot study. *Mil Med* 2011; 176: 626–30.
37. Kearney DJ, McDermott K, Malte C, Martinez M, Simpson TL: Association of participation in a mindfulness program with measures of PTSD, depression and quality of life in a veteran sample. *J Clin Psychol* 2012; 68: 101–16.
38. Niles BL, Klunk-Gillis J, Ryngala DJ, Silberbogen AK, Paysnick A, Wolf EJ: Comparing mindfulness and psychoeducation treatments for combat-related PTSD using a telehealth approach. *Psychol Trauma* 2012; 4: 538–47.
39. Borrmann JE, Smith TL, Becker S, et al: Efficacy of frequent mantram repetition on stress, quality of life, and spiritual well-being in veterans: a pilot study. *J Holist Nurs* 2005; 23: 395–414.
40. Streeter CC, Gerbarg PL, Saper RB, Ciraulo DA, Brown RP: Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder. *Med Hypotheses* 2012; 78: 571–9.
41. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA: Psychometric properties of the PTSD Checklist (PCL). *Behav Res Ther* 1996; 34: 669–73.
42. Ruggiero KJ, Del BK, Scotti JR, Rabalais AE: Psychometric properties of the PTSD Checklist-Civilian Version. *J Trauma Stress* 2003; 16: 495–502.
43. Buysse DJ, Reynolds CF, III, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989; 28: 193–213.
44. Carpenter JS, Andrykowski MA: Psychometric evaluation of the Pittsburgh Sleep Quality Index. *J Psychosom Res* 1998; 45:5–13.
45. Spielberger C: STAXI-2 State Trait Anger Expression Inventory-2 Professional Manual. Lutz, FL, Psychological Assessment Resources, 1999.
46. Lambert MJ, Morton JJ, Hatfield D, et al. Administration and Scoring Manual for the OQ®-45.2 Outcome Questionnaire. Salt Lake City, UT, American Professional Credentialing Services, 2004.
47. Cohen J: The t test for means. In: *Statistical Power Analysis for the Behavioral Sciences*, Ed 2, pp 19–74. Hillsdale, NJ, Lawrence Erlbaum Associates, 1988.
48. Seal KH, Maguen S, Cohen B, et al: VA mental health services utilization in Iraq and Afghanistan veterans in the first year of receiving new mental health diagnoses. *J Trauma Stress* 2010; 23: 5–16.
49. Bugg A, Turpin G, Mason S, Scholes C: A randomised controlled trial of the effectiveness of writing as a self-help intervention for traumatic injury patients at risk of developing post-traumatic stress disorder. *Behav Res Ther* 2009; 47: 6–12.
50. Scholes C, Turpin G, Mason S: A randomised controlled trial to assess the effectiveness of providing self-help information to people with symptoms of acute stress disorder following a traumatic injury. *Behav Res Ther* 2007; 45: 2527–36.
51. Telles S, Singh N, Balkrishna A: Managing mental health disorders resulting from trauma through yoga: a review. *Depress Res Treat* 2012; 2012: 9 p, Article ID 401513. Available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3388328/>; accessed December 1, 2012.
52. Vaiva G, Thomas P, Ducrocq F, et al: Low posttrauma GABA plasma levels as a predictive factor in the development of acute posttraumatic stress disorder. *Biol Psychiatry* 2004; 55: 250–4.
53. Vaiva G, Boss V, Ducrocq F, et al: Relationship between posttrauma GABA plasma levels and PTSD at 1-year follow-up. *Am J Psychiatry* 2006; 163: 1446–8.
54. Connor KM, Davidson JR, Weisler RH, Zhang W, Abraham K: Tiagabine for posttraumatic stress disorder: effects of open-label and double-blind discontinuation treatment. *Psychopharmacology (Berl)* 2006; 184: 21–5.
55. Geuze E, van Berckel BN, Lammertsma AA, et al: Reduced GABA<sub>A</sub> benzodiazepine receptor binding in veterans with post-traumatic stress disorder. *Mol Psychiatry* 2008; 13: 74–83.
56. Streeter CC, Jensen JE, Perlmutter RM, et al: Yoga Asana sessions increase brain GABA levels: a pilot study. *J Altern Complement Med* 2007; 13: 419–26.
57. Streeter CC, Whitfield TH, Owen L, et al: Effects of yoga versus walking on mood, anxiety, and brain GABA levels: a randomized controlled MRS study. *J Altern Complement Med* 2010; 16: 1145–52.
58. Carmody J, Baer RA: Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *J Behav Med* 2008; 31: 23–33.
59. Libby DJ, Reddy F, Pilver CE, Desai RA: The use of yoga in specialized VA PTSD treatment programs. *Int J Yoga Therap* 2012; 22: 79–87.