Mind-Body Practices for Posttraumatic Stress Disorder

Sang Hwan Kim, PhD,† Suzanne M. Schneider, PhD,* Len Kravitz, PhD,* Christine Mermier, PhD,* and Mark R. Burge, MD†‡*

Background: Mind-body practices are increasingly used to provide stress reduction for posttraumatic stress disorder (PTSD). Mind-body practice encompasses activities with the intent to use the mind to impact physical functioning and improve health.

Methods: This is a literature review using PubMed, PsycINFO, and Published International Literature on Traumatic Stress to identify the effects of mind-body intervention modalities, such as yoga, tai chi, qigong, mindfulness-based stress reduction, meditation, and deep breathing, as interventions for PTSD.

Results: The literature search identified 92 articles, only 16 of which were suitable for inclusion in this review. We reviewed only original, full text articles that met the inclusion criteria. Most of the studies have small sample size, but findings from the 16 publications reviewed here suggest that mind-body practices are associated with positive impacts on PTSD symptoms. Mind-body practices incorporate numerous therapeutic effects on stress responses, including reductions in anxiety, depression, and anger, and increases in pain tolerance, self-esteem, energy levels, ability to relax, and ability to cope with stressful situations. In general, mind-body practices were found to be a viable intervention to improve the constellation of PTSD symptoms such as intrusive memories, avoidance, and increased emotional arousal.

Conclusions: Mind-body practices are increasingly used in the treatment of PTSD and are associated with positive impacts on stress-induced illnesses such as depression and PTSD in most existing studies. Knowledge about the diverse modalities of mind-body practices may provide clinicians and patients with the opportunity to explore an individualized and effective treatment plan enhanced by mind-body interventions as part of ongoing self-care.

Key Words: mindfulness, exercise, breathing, yoga, tai chi, posttraumatic stress disorder

(*J Investig Med* 2013;61: 827–834)

Posttraumatic stress disorder (PTSD) is an anxiety problem that may develop in some people after exposure to extremely traumatic events, such as combat, crime, an accident, or a natural disaster.[1] In any given year, 7.7 million Americans older than 18 years are diagnosed with PTSD,[2] a debilitating disorder that is often comorbid with other diseases.[3] Individuals with PTSD suffer substantial social and interpersonal problems, as well as impaired quality of life stemming from the long-term presence of the intrusive, avoidant, and hyperaroused symptoms that characterize the disease. Concomitantly, patients with PTSD show characteristics of higher sympathetic and lower parasympathetic activity at basal levels compared to healthy individuals[4] as measured by low heart rate variability (HRV).[5] Although conventional pharmacologic and psychotherapeutic interventions have shown some proven efficacy in the treatment of PTSD,[6] residual symptoms and therapeutic efficacy remain problematic. Recently, a variety of integrative mind-body intervention modalities have emerged that are increasingly used in the treatment of PTSD. This growing body of evidence has shown that mind-body interventions have a positive impact on quality of life, stress reduction, and improvement of health outcomes among individuals with PTSD.[7–17] In 2010, 39% of individuals with PTSD reported using complementary and alternative medicine interventions, including mind-body practices that incorporate various types of stretching movements and postures combined with deep breathing (eg, yoga, tai chi, qigong, and meditation).[3] Furthermore, there is emerging evidence that supports the neural and biological mechanisms underlying mind-body practices for the management of stress-related illness.[18–21] Studies have shown that stress-related disorders may be induced by allostatic load,[22] the "body cost" for maintaining homeostasis, and imbalance in the autonomic nervous system (ANS), with overactivity of the sympathetic nervous system (SNS) and underactivity of the parasympathetic nervous system (PNS).[5] Streeter and colleagues[5] proposed that mind-body interventions such as yoga may be associated with reduction of PTSD symptoms by normalizing the imbalance in ANS and increasing PNS activity.

The purpose of this article, therefore, was to review the evidence that evaluates the effectiveness of mind-body practices as complementary and/or alternative treatment for individuals with PTSD. Although there are overlaps between the methods used in conventional therapies and mind-body practices (ie, breathing techniques, relaxation, imagery, and hypnosis), for the sake of this review, we define mind-body practices as interventions with components of interaction among the mind, body, and behavior, with the intent to integrate these three components in the pursuit of improved physical functioning, and mental and physical health.[23]

MATERIALS AND METHODS

Scope of the Review

We searched for peer-reviewed original journal articles in English on the effects of mind-body practices as interventions to treat PTSD. Mind-body practices were defined to include physical activities that focus on interaction among brain, body, and behavior, including yoga, tai chi, qigong, mindfulness-based stress reduction (MBSR), meditation, and deep breathing. We included demographics, PTSD symptoms (eg, intrusive thought, flashback, avoidance, numbness, and hyperarousal), and HRV as topics of interest.

Search Strategy

Our literature searches of PubMed/MEDLINE, EBSCO/PsycINFO, and the Published International Literature on Traumatic

From the *Department of Health, Exercise, and Sports Sciences, †Clinical and Translational Science Center, and ‡Department of Internal Medicine, University of New Mexico, Albuquerque, NM.
Received May 6, 2012, and in revised form February 26, 2013.
Accepted for publication February 28, 2013.
Reprints: Mark R. Burge, MD, Department of Internal Medicine, University of New Mexico, Albuquerque, NM 87131.
E-mail: mburge@salud.unm.edu.
Supported by National Institutes of Health Grants 5KL2RR031976-02 and 5UL1RR031977-02.

ISSN: 1081-5589
DOI: 10.231/JIM.0b013e3182906862

Stress database took place on June 27, 2012. We used combinations of the search terms "mindfulness" or "mind-body," and "exercise" or "yoga" or "tai chi" or "qigong" or "meditation," and "posttraumatic stress disorder" or "PTSD."

Inclusion Criteria

We initially screened abstracts published in English that included human participants with PTSD. Those abstracts included randomized control trials, comparative studies, and observational studies that evaluated the efficacy of mind-body interventions on PTSD symptom changes. For articles that passed the initial screening, we retrieved the full articles to assess eligibility.

RESULTS

We screened 92 English language abstracts and selected for review a total of 16 articles that met the inclusion criteria (Fig. 1). Six randomized controlled trials (RCTs), 1 randomized noncontrolled study (RT), 8 nonrandomized studies, and 1 observational noncontrolled study with a total of 1065 participants were selected for review (Table 1). Seventy-five publications did not meet the inclusion criteria: 34 articles were unrelated to the study subject, 9 were from book chapters, 7 were dissertations, 22 were editorials or reviews, and 3 journals were unavailable. Twenty-six articles overlapped across more than 2 search engines. Two articles were available only in PubMed. One article was not included in the review due to the large number of simultaneous interventions (ie, diet changes, lifestyle modification, and other forms of physical activity) conducted in addition to the mind-body intervention, making it impossible to identify which changes were attributable solely to mind-body practices. Of the 16 studies reviewed, 9 did not have a control group, 4 examined a mind-body intervention as adjunct to treatment as usual, and 12 as a monotherapy. Two studies examined the effects of yoga; 5 evaluated the effects of meditation, or meditation and relaxation; 1 the effects of tai chi and qigong; 3 the efficacy of MBSR; 1 the effect of a portable practice of repeating a mantram; 1 the effects of relaxation, or relaxation plus deep breathing, or relaxation plus deep breathing and thermal biofeedback; and 3 studies examined the effects of mind-body skills (a combination of various mindfulness-based approaches). Twelve studies reported significant positive effects of mind-body interventions on reduction of PTSD symptoms via regulation of the SNS and/or PNS (Table 2).

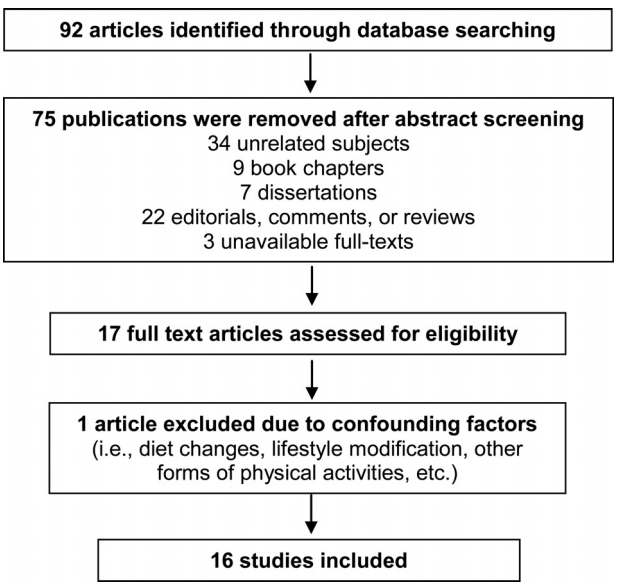

FIGURE 1. Flow of the systematic review process.

Studies on PTSD Symptom Severity

Although there were several common elements in the reviewed studies, such as mindfulness, exercise, meditation, and deep breathing, the outcome parameter for assessing "changes in PTSD symptom severity" varied. The common measures of symptom severity were performed using self-rated instruments such as the PTSD CheckList (PCL), the post-Vietnam Stress Disorder (PVSD), the Harvard Trauma Questionnaire (HTQ), the Impact of Event Scale, the UCLA PTSD Index for *DSM-IV* (UPID), the PTSD Reaction Index, and the Child PTSD Symptom Scale. Of the 16 reviewed studies (Table 1), 3 studies showed no statistically significant outcomes,[24–26] 2 studies collected only qualitative data,[27] and 11 studies showed a significant decrease of PTSD symptom severity because of participation in a mind-body interventions.[7–12,14–17,28] In the 10 studies that incorporated follow-up testing ranging from 3 to 15 months after intervention, positive results were maintained.[7,8,10–17] Six studies reported decreases in specific PTSD symptom clusters including reexperiencing, avoidance and numbing, and hyperarousal.[8,10,12,14,17,24]

The 5 RCTs shared common mindfulness-based components of relaxation, meditation, and deep breathing. Watson and colleagues[24] compared relaxation, relaxation plus deep breathing, and relaxation plus deep breathing and thermal biofeedback. The authors reported pretest PTSD Index scores of 95.4, 98.1, and 90.5 and posttest PTSD Index scores of 95.0, 97.8, and 89.4 for relaxation, relaxation plus deep breathing, and relaxation plus deep breathing and thermal biofeedback, respectively, but they found no significant difference between groups ($P > 0.05$) (Table 2). Conversely, Catani and colleagues[10] found that a short-term meditation-relaxation intervention may reduce PTSD symptoms. The investigators randomized 31 children (mean age, 12 years) into meditation-relaxation (MED-RELAX) or Narrative Exposure Therapy (KIDNET) interventions 1 month after the Tsunami in the North-Eastern region of Sri Lanka. After 6 sessions conducted during a 2-week period, participation in the MED-RELAX program was associated with a significant reduction in PTSD symptoms (UPID scores of 36.58 and 12.59, pretest and posttest, respectively, Cohen d = 1.83) (Table 2). More importantly, these results were as effective as the conventional KIDNET PTSD therapy (UPID scores of 37.94 and 12.41, pretest and posttest, respectively, Cohen d = 1.76). Furthermore, the 6-month follow-up UPID scores were 9.75 (80% recovery rate) and 12.3 (70% recovery rate) for MED-RELAX and KIDNET, respectively, demonstrating the long-term effectiveness of MED-RELAX.

An RT conducted in 1981 on Vietnam veterans[28] found a significant positive treatment effect for transcendental meditation in comparison with traditional psychotherapy on the symptoms of PTSD ($F_{1,14} = 5.26$, $P < 0.05$). This study also revealed a significant decrease in anxiety, depression, alcohol consumption, insomnia, and family problems in the meditation group. Rosenthal and collegues[16] also reported that transcendental meditation had a significant positive impact on alleviating PTSD symptoms among veterans returning from Operation Enduring Freedom or Operation Iraqi Freedom with combat-related PTSD. All subjects (n = 5) showed significant mean reductions in the Clinician Administered PTSD Scale and the PTSD Checklist-Military Version with decreases of 31.4 points ($P = 0.02$) and 24.00 points ($P < 0.02$), respectively. Similarly, the RCT conducted in 2008 by Gordon and colleagues[12] showed

TABLE 1. Studies of Mind-Body Interventions in Patients With PTSD

Author, Year, Study Site	Study Design	Mean Age (SD), y; Sex, %	Intervention, Time Frame, Sample Size	PTSD Outcomes, Magnitude of Symptom Change
Descilo et al.,[7] 2010, United States	NRS	Adult, 30.8; female, 85	Yoga breathing, 5 wk, n = 183	60% decrease in PTSD symptom severity at weeks 6 and 24, ΔPCL-17 = −42.5
Staples et al.,[8] 2011, Gaza	NRS	13.3; female, 37	Mind-body skills, 5 wk, n = 129	Significant effect of time for PTSD subscales, ΔCPSS = 16.8
Telles et al.,[26] 2010, India	RCT	Adult, 31.5 (7.5); male, 100	Yoga, 1 wk, 60-min daily, n = 22	No significant changes in the HRV, ΔpNN50 = 7.83
Stankovic,[27] 2011, United States	NRS	Adult, 61; not specified	Meditation (iRest), 8 wk, 40-min weekly, n = 16	Subjective rating of permanence of positive symptom changes = 3.27 of 1 (temporary) to 5 (permanent)
Watson et al.,[24] 1997, United States	RCT	Adult, 45.6; male, 100	Relaxation, breathing, and biofeedback, 10 sessions, n = 90	Moderate effect of relaxation, but not breathing and/or biofeedback in PTSD treatment, ΔPTSD-I = −0.4
Branstrom et al.,[25] 2011, Sweden	RCT	Adult, 51.8 (9.86); female, 99	MBSR, 8 sessions, 2-h weekly, n = 71	No significant changes in overall PTSD symptoms but avoidance, ΔIES = −6.42 at 6-mo follow-up
Bormann et al.,[9] 2011, United States	RCT	Adult, 56.1 (9.60); male, 97	Mantram, 6 sessions, 90-min weekly, n = 136	Significant PTSD symptom reduction, ΔPCL-C = −6.3
Catani et al.,[10] 2009, Sri Lanka	RCT	Children, 11.95; male, 54.8	Meditation-relaxation, 2 wk, 6 sessions, n = 31	Significant PTSD symptom reduction, ΔUPID = −23.99 at week 2
Gordon et al.,[11] 2004, Kosovo	NRS Pilot	Adolescents, 16–19 (88%); male, 54	Mind-body skills, 6 wk, n = 139	Significant PTSD symptom reduction at posttest, ΔPTSD-RI = −2.2
Gordon et al.,[12] 2008, Kosovo	RCT	Adolescents, 16.3; female, 62	Mind-body skills, 6 wk, twice weekly, n = 82	Significant decrease in PTSD symptom severity, ΔHTQ = −0.5 and −0.4 at weeks 6 and 12
Grodin et al.,[13] 2008, United States	OBS Case study	Adult (foreign patients), 23, 30, 44, and 47; male, 75	Tai chi and qigong, >1 y, n = 4	Decreased reexperiencing, flashbacks, anxiety, and stress; increased equanimity; improved pain; soothing effect.
Waelde et al.,[14] 2004, United States	NRS	Adult, 49 (11); female, 85	Meditation, 8 wk, daily 30 min, n = 20	Significant decrease in PTSD symptom and stress coping, ΔPCL-S = −6.03
Brooks and Scarano,[28] 1985, United States	RT	Adults, 33.3; male, 100	Meditation, 3 mo, n = 18	Significant decrease in symptoms of PVSD the intervention group, ΔPVSD = −3.90
Kimbrough et al.,[15] 2010, United States	NRS	Adult, 45 (10.8); female, 89	MBSR, 8 wk, n = 27	PTSD symptom severity improved by 31% after 8-wk MBSR, Δ-C = −14.5
Rosenthal et al.,[16] 2011, United States	NRS	Adult, 41.5 (16.6); male, 100	Meditation, 8 wk, 20 min, twice a day, n = 5	Significant improvement in PTSD symptom severity, ΔCAPS = −31.4, ΔPCL-M = −24.00
Kearney et al.,[17] 2012, United States	NRS	Adult, 51 (10.6); male, 75	MBSR, 8 wk, n = 92	Significant improvement in PTSD symptom severity, ΔPCL-C = −9

Data are shown as mean (SD) for quantitative variables and mean (%) for sex.

CAPS indicates the Clinician Administered PTSD Scale; CPSS, Child PTSD Symptom Scale; IES, Impact of Event Scale; NRS indicates prospective nonrandomized studies; OBS, observational noncontrolled study; PCL-C, PTSD Checklist-Civilian Version; PCL-M, PTSD Checklist-Military Version; PCL-S, PTSD Checklist-Specific Version; pNN50, the percentage of successive normal cardiac interbeat intervals greater than 50 milliseconds; PTSD-RI, PTSD Reaction Index; RT, randomized noncontrolled trial.

TABLE 2. Changes in PTSD Symptom Severity

		Symptom Severity			
Author	**Instrument/Dependent Variable**	**Preintervention**	**Postintervention**	**Changes in Mean**	***P***
Descilo et al.[7]	PCL-17/PTSD symptoms	66.5	23.9	−42.5	<0.001
Staples et al.[8]	CPSS total	30.0 (6.8)	13.2 (7.3)	−16.8	0.0001
	CPSS subscales				
	Reexperiencing	8.3 (2.8)	3.9 (2.7)	−4.4	
	Avoidance	12.3 (3.0)	5.3 (3.4)	−7.0	
	Arousal	9.4 (2.6)	3.9 (2.9)	−5.5	
Telles et al.[26]	HRV	LF: 56.54	LF: 55.76	LF: −0.78	>0.05
	Vagal activity	HF: 43.40	HF: 44.19	HF: −0.79	
		LF/HF: 1.23	LF/HF: 1.77	LF/HF: −0.54	
		pNN50: 13.33	pNN50: 21.16	pNN50: −7.83	
Stankovic[27]	Weekly questionnaire	Difficulty distinguishing between simple and complex emotions (eg, numbing)	Increased awareness and physical mobility	Subjective rating of symptom changes = 3.27	
	iRest worksheet				
	Recorded in-class discussion		Reduced physical pain, anxiety, anger, and self-judgment		
	Final questionnaire				
	PTSD symptoms	Long-term guilt, grief, and rage	Improved ability to relax		
		Lack of hope			
Watson et al.[24]	PTSD-I/PTSD symptoms	Rx: 95.4	Rx: 95.0	Rx: −0.4	>0.05
		RxBr: 98.1	RxBr: 97.8	RxBr: −0.3	
		RxBrTb: 90.5	RxBrTb: 89.4	RxBrTb: −1.1	
Branstrom et al.[25]	IES/PTSD symptoms	IES-intrusion: 13.28 (7.07)	IES-intrusion: 11.81 (6.36)	IES-intrusion: −1.47	>0.05
		IES-avoidance: 10.55 (6.79)	IES-avoidance: 7.88 (7.65)	IES-avoidance: −2.67	
		IES-hyperarousal: 9.50 (5.51)	IES-hyperarousal: 7.22 (5.24)	IES-hyperarousal: −2.28	
Bormann et al.[9]	PCL-C/PTSD symptoms	61.8 (11.50)	55.5 (11.20)	−6.3	0.02
Catani et al.[10]	UPID/PTSD symptoms	36.58 (14.9)	12.59 (11.06)	−23.99	0.0001
Gordon et al.[11]	PTSD-RI/PTSD symptoms	Group I: 8.3	Group I: 6.1	−2.2	<0.001
		Group II: 10.8	Group II: 5.8	−5.0	<0.001
		Group III: 11.4	Group III: 5.5	−5.9	<0.001
Gordon et al.[12]	HTQ	2.5 (0.3)	2.0 (0.3)	−0.5	<0.001
	% of subjects with PTSD				
	Reexperiencing	100	47	−53 (%)	0.001
	Avoidance/numbing	100	24	−76 (%)	<0.001
	Arousal	100	68	−32 (%)	0.24

Grodin et al.[13]	Qualitative interview	Sleep problems Nightmares Flashbacks Decreased energy Helplessness Hypervigilance Anxiety	Decrease in: Reexperiencing Physical pain Anxiety and stress Increase in: Equanimity Soothing effect		
Waelde et al.[14]	PCL-S total	36.60 (9.97)	30.57 (9.75)	−6.03	<0.01
	PCL-S subscales				
	Reexperiencing	8.79 (2.99)	7.33 (2.53)	−1.46	<0.05
	Avoidance	14.99 (5.59)	13.40 (4.21)	−1.59	>0.05
	Hyperarousal	12.74 (4.54)	9.80 (3.84)	−2.94	<0.01
Brooks and Scarano[28]	PVSD	9.70 (2.98)	5.80 (4.26)	−3.90	<0.05
Kimbrough et al.[15]	PCL/PTSD symptoms	46.8 (2.7)	32.3 (1.9)	−14.5	<0.0001
	Reexperiencing	13.1 (1.0)	10.0 (0.8)	−3.1	<0.001
	Avoidance/numbing	19.4 (1.0)	13.0 (0.7)	−6.4	<0.001
	Hyperarousal	14.3 (1.0)	9.5 (0.6)	−4.8	<0.001
Rosenthal et al.[16]	CAPS/PTSD symptoms	71	39.6	−31.4	0.02
	PCL-M	57.8	33.8	−24.0	<0.02
Kearney et al.[17]	PCL-C total	52.4 (16.3)	41.9 (16.8)	−10.5	<0.001
	PCL-C subscales				
	Reexperiencing	14.2 (5.8)	11.0 (5.3)	−3.2	<0.001
	Avoidance	5.7 (2.6)	4.8 (2.5)	−0.9	0.003
	Numbing	15.7 (5.6)	12.6 (5.5)	−3.1	<0.001
	Hyperarousal	16.9 (5.2)	13.4 (5.3)	−3.5	<0.001

Data are shown as mean (SD).

AN indicates avoidance and numbing; Ar, arousal; CAPS, the Clinician Administered PTSD Scale; CPSS, Child PTSD Symptom Scale; IES, Impact of Event Scale; PCL-17, PTSD Checklist; PCL-C, PTSD Checklist-Civilian Version; PCL-M, PTSD Checklist-Military Version; PCL-S, PTSD Checklist-Specific Version; pNN50, the percentage of successive normal cardiac interbeat intervals greater than 50 milliseconds; PTSD-I, Posttraumatic Stress Disorder Interview; PTSD-RI, PTSD Reaction Index; Re, Reexperiencing; Rx, Relaxation; RxBr, Relaxation plus Breathing; RxBrTb, Relaxation plus Breathing and Thermal Biofeedback.

decreases in PTSD symptoms in postwar Kosovar adolescents. The authors randomized 82 high school students into a 12-session mind-body skills program or a wait-list control group and measured the changes in PTSD symptoms using HTQ. The first 16 items of HTQ are widely used for assessment of PTSD and the cutoff score of 2.5 is generally considered positive for PTSD with the higher scores more likely to be symptomatic. The study has shown that the HTQ scores improved significantly (2.5 and 2.0, pretest and posttest, respectively, $P < 0.001$). These findings were consistent with the results from their previous pilot study in 2004 (Table 1). Furthermore, they reported that all 3 PTSD symptom clusters were significantly reduced after MBSR intervention: reexperiencing ($P = 0.001$), avoidance and numbing ($P < 0.001$), and hyperarousal ($P = 0.001$).

Kearney and colleagues[17] reported that 40% of veterans (n = 92) who practiced MBSR showed clinically significant reduction >in PTSD symptom severity at 2 months, and symptom improvement was maintained at the 6-month follow-up. On the other hand, Staples and colleagues[8] reported that individuals with higher baseline scores of symptom severity showed greater improvement in response to the mind-body skills intervention, but the gains did not entirely persist at follow-up. Branstrom and colleagues[25] also found that an 8-week MBSR intervention did not have a significant impact on PTSD symptom reduction at 6-month follow-up among patients with a previous cancer diagnosis, but reported a significant reduction in avoidance symptoms.

A recent study reported a positive effect of repeating a mantram (ie, a sacred word or phrase) on PTSD symptoms. Bormann and colleagues[9] conducted a 6-week RCT (n = 136) with a portable practice of repeating a mantram among veterans with military trauma, and found a significant reduction in PTSD symptoms with mean PCL-C scores reduced from 61.8 at baseline to 55.3 at 6-week postintervention ($P = 0.02$). However, the results of the study did not reach a level of clinical significance suggesting that some mind-body interventions may best be considered as an adjunct to treatment as usual. Interestingly, Telles et al.[26] conducted a yoga study in which the visual analog scales were used to measure self-rated indicators of PTSD symptoms including fear, anxiety, disturbed sleep, and sadness. The visual analog scale is an analog scale with a 10-cm-long doubly anchored scale, with one end (score = 0) indicating the lowest intensity of a feeling of a symptom of PTSD and the other end (score = 10) of the scale indicating the highest intensity of a feeling of a symptom of PTSD. Using the Screening Questionnaire for Disaster Mental Health (SQD) which includes subscales on PTSD (9 items) and depression (6 items), the authors assessed 1089 flood victims in Bihar, India, determined the scores for PTSD and depression 2 days before their study, and randomized 22 participants into a yoga group and a non–yoga wait-list control group. The mean baseline SQD scores of the 22 participants was 4.5 (SQD score of 9-6, severely affected with possible PTSD; 5-4, moderately affected; 3-0, slightly affected with little possibility of PTSD). After 7 days of yoga training, the yoga group showed a significant decrease in sadness (mean [SD], 7.12 [3.21] vs 5.98 [3.58], $P < 0.05$), and the non–yoga group showed increased anxiety (mean [SD], 4.76 [2.69] vs 4.88 [3.15], $P < 0.05$).

Studies on Vagal Activity

Heart rate variability is the cyclic beat-to-beat variation in heart rate generated by the interplay between sympathetic and parasympathetic neural activity at the sinus node of the heart.[4] It is used as an index to measure changes in the ANS,[29] and is a reliable marker of vagal (parasympathetic) activity of the heart, as well as stress vulnerability.[4,30] In general, decreased HRV reflects increased sympathetic regulation and stress,[31] and is associated with increased PTSD symptom severity.[32] One study that examined the relationship between mind-body intervention and HRV during the stress response after a natural disaster showed no improvement in HRV among individuals with anxiety.[26] After a month of natural disasters in north India, Telles et al.[26] assessed 1089 disaster victims using the SQD to obtain scores for PTSD and depression. Twenty-two participants were randomized into yoga therapy or wait-list control groups. Researchers collected HRV data using frequency domain analysis for very low frequency band (0.0–0.04 Hz), low frequency (LF) band (0.5–0.15 Hz), and high frequency (HF) band (0.15–0.50 Hz), as well as the LF/HF ratio (Table 2). They also recorded time domain HRV analysis using pNN50, the percentage of successive normal cardiac interbeat intervals greater than 50 milliseconds.[26] No significant changes were found in the HRV between the groups.

DISCUSSION

There is evidence that multiple components of mind-body practices provide beneficial therapeutic effects for relief of PTSD symptoms, as reflected in the reviewed studies.[7–13,24,26] The observed therapeutic effects in clinical outcome measures were generally sustained at follow-up. Although one study raises a question regarding the strength of the conclusions that can be drawn from only five subjects without a control group,[16] 12 of the 16 studies showed positive impacts of a mind-body approach and demonstrated significant improvements in PTSD symptom severity. Importantly, the broad range of geographic and demographic elements in the selected studies suggests that mind-body interventions are beneficial across a wide variety of populations.

Time and Age Factors for PTSD Treatment

It has been suggested that the total time spent in meditation practice is positively associated with greater improvement in PTSD symptom severity.[14] These studies indicate that early intervention with mind-body practices may foster greater impacts on symptom management in PTSD, but this does not preclude the effective use of interventions at a later stage. However, in an adult population with 99% female PTSD patients, Branstrom and colleagues[25] found that an 8-week MBSR intervention resulted in reduced avoidance symptoms, but not other symptom clusters, and that the effect was not maintained at 6-month follow-up. Although a number of studies have demonstrated that the amount of meditation practice is positively associated with a beneficial reduction in PTSD symptom severity, the finding by Branstrom et al. that the initial effect was not maintained may indicate that mindfulness alone might not be sufficient to induce a therapeutic effect but that persistent practice may be necessary. Another possible explanation is that the initial positive impact may have been due to something other than the effect of mindfulness (ie, placebo effect or group support).

Age is also a factor that may affect the outcomes associated with mind-body intervention. One study showed that individuals with higher baseline scores showed greater improvements in PTSD; that higher baseline PTSD symptoms were correlated with the degree of previous trauma exposure but not with age; and that older children showed greater improvement in PTSD symptom reduction than younger children.[8]

In summary, it is likely that a longer duration of practice may have a greater impact in PTSD symptom reduction; that interventions should be prescribed based on individual trauma history, age, and sex; and that continued regular practice may

be required for significant positive effects after the end of the program.

Parasympathetic Regulation

Posttraumatic stress disorder symptom severity is inversely associated with HRV and HRV is closely related to the rate of breathing.[32] Fast breathing stimulates the SNS, whereas slow breathing activates the PNS. Studies have suggested that yoga practice may stimulate the vagus nerves and increase PNS activity and HRV, which may be associated with reduction of PTSD symptoms.[5] For example, yoga breathing practice has shown therapeutic effects on women who had been victims of abuse and intimate partner violence.[33] One study we reviewed, however, did not find a significant effect of yoga practices on HRV. In that study,[26] the absence of change in HRV may have been due to the nature of the exercise protocol which included a combination of fast and slow breathing. An intervention consisting only of slow breathing practice may have increased parasympathetic function and HRV.

Considering the circumstances in which the research was conducted, 1 month after the natural calamity of a monsoon in the north of India, it is presumable that one week of daily 1-hour yoga practice sessions may not have been sufficient to increase HRV. According to the author, some of the difficulties encountered during the study included the challenges of setting up a temporary laboratory, getting people to participate when they were preoccupied with their own concerns and in distress, and the constant influx and movement of the people in the disaster zone (personal communication).

Jerath and colleagues[34] stated that deep breathing decreases oxygen consumption, heart rate, and blood pressure and increases parasympathetic activity, leading to a calming effect on the mind and a sense of control of the body. The authors proposed that voluntary slow deep breathing resets the ANS and causes shifts in the autonomic equilibrium toward parasympathetic dominance, increasing the frequency and duration of inhibitory neural signals through activation of stretch receptors in the lungs during inhalation, and inducing hyperpolarization currents through the stretching of connective tissue, thereby synchronizing neural elements in the heart, lungs, limbic system and cortex.[34] Further investigation regarding the effect of mind-body practices and deep breathing may clarify the relationship between the frequency and depth of breath and parasympathetic regulation.

Clinical Implications of Mind-Body Interventions

Evidence presented in this review supports mind-body practices as an efficacious adjunct therapy for the treatment of PTSD. Mind-body practices may contribute to decreasing PTSD symptoms by offering participants opportunities to reduce stress levels, improve mood, reduce the intensity of PTSD arousal symptoms, and observe what they experience from a more relaxed state with less fear and more equanimity.[8] In one of the earliest randomized comparisons between transcendental meditation and traditional psychotherapy, researchers found that the meditation group reported significant reductions in numbness, anxiety, depression, insomnia, alcohol consumption, and family problems, whereas psychotherapy group participants reported little change.[28] Individuals with PTSD increasingly use mind-body interventions as an alternative or adjunct to conventional care for PTSD. Clinicians should discuss mind-body interventions with their patients and educate them about the potential benefits of mind-body practices to maximize the diversity of treatment options.[3] Knowledge of modalities of mind-body interventions, and of providers in the community who can direct mind-body intervention, may provide patients with the opportunity to explore individualized self-care therapies. Further studies are warranted to assess the comprehensive effects of mind-body practices as an adjunct to treatment as usual on managing comorbid diseases and improving quality of life in individuals experiencing PTSD.

Safety Matters

Although there may be physical and mental health risks associated with the use of mind-body practices for PTSD sufferers, adverse reactions may be minimized through the use of interventions that are culturally appropriate and that take into account other mental health conditions.[35] Additionally, physical injuries or the presence of cardiopulmonary disease may present a barrier to participation in trauma survivors.[36] Finally, there is evidence of the potential increased levels of anxiety associated with relaxation therapy: intrusive thoughts (15%), fear of losing control (9%), muscle cramps (4%), and disturbing sensory experiences (eg, sexual arousal linked to the therapist; 4%) lead to noncompliance or termination of treatment by up to 3% of clients.[37] Potential barriers to compliance can be mitigated by individualizing interventions, communicating openly with the participant regarding needs and expectations,[36] and adapting therapy programs to the unique responses of the individual patient.[38]

Limitations

The research methods included in this review were heterogeneous, and the quality of the studies varied widely. Because of differences in design, intervention methods, and study duration, as well as the presence or absence of control groups, we were unable to conduct a true meta-analysis. The studies by Grodin and colleagues[13] and Stankovic[27] were the only qualitative research studies included in this review. Despite the lack of quantitative outcomes, we included the studies because of the long study duration (>1 year) and the detailed descriptions of the study outcomes. Most of the studies we reviewed for potential inclusion in the study did not have a control group, and 2 of the reviewed articles had a large amount of missing data.[8] Attrition was problematic in 1 study, with 31% of the study participants dropping out after baseline data were collected.[7] Additionally, the mean ages of study participants ranged from 12 to 56 years in the reviewed studies, with predominantly male subjects or a mixture of both sexes. Future studies need to include younger or older populations to examine whether efficacy may be generalized to those groups, and particularly to female subjects.

CONCLUSIONS

Future studies need to replicate these findings in other cultural settings with varied populations, preferably with larger samples and additional outcome measures such as biomarkers (ie, cortisol, adrenocorticotropic hormones, epinephrine, norepinephrine, stress-related neuropeptides, and cytokines). Elucidation of the relationships between changes in psychological symptoms and changes in the biomarkers, as well as the pathways activated by specific mind-body modalities, will advance our understanding of the nonpharmacologic psychobiological mechanism(s) of mind-body practices for clinical application. The insights gained from such integrated research could further our knowledge and enable us to develop comprehensively therapeutic yet individually specific treatment strategies which, together with other lifestyle modifications and psychotherapies, will become a part of the standard treatment regimen for PTSD in the future.

ACKNOWLEDGMENT

The authors thank Ingrid Hendrix, the Nursing Services Librarian at the University of New Mexico Health Sciences Library and Informatics Center, for assisting in identifying the literature.

REFERENCES

1. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders DSM-IV-R*. Revised 4th ed. Washington, DC; 2000.
2. National Institute of Mental Health. The Numbers Count: Mental Disorders in America. 2011; http://www.nimh.nih.gov/site-info/contact-nimh.shtml. Accessed March 6, 2011.
3. Libby DJ, Pilver CE, Desai R. Complementary and alternative medicine use among individuals with posttraumatic stress disorder. *Psychol Trauma*. 2012, in press.
4. Blechert J, Michael T, Grossman P, et al. Autonomic and respiratory characteristics of posttraumatic stress disorder and panic disorder. *Psychosom Med*. 2007;69(9):935–943.
5. Streeter CC, Gerbarg PL, Saper RB, et al. 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(5):571–579.
6. Cukor J, Spitalnick J, Difede J, et al. Emerging treatments for PTSD. *Clin Psychol Rev.* 2009;29(8):715–726.
7. 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(4):289–300.
8. Staples JK, Abdel Atti JA, Gordon JS. Mind-body skills groups for posttraumatic stress disorder and depression symptoms in Palestinian children and adolescents in Gaza. *Int J Stress Manag*. 2011;18(3):246–262.
9. Bormann JE, Liu L, Thorp SR, et al. Spiritual wellbeing mediates PTSD change in veterans with military-related PTSD. *Int J Behav Med*. 2012;19(4):496–502.
10. Catani C, Kohiladevy M, Ruf M, et al. Treating children traumatized by war and Tsunami: a comparison between exposure therapy and meditationrelaxation in North-East Sri Lanka. *BMC Psychiatry.* 2009:9.
11. Gordon JS, Staples JK, Blyta A, et al. Treatment of posttraumatic stress disorder in postwar Kosovo high school students using mind-body skills groups: a pilot study. *J Trauma Stress*. 2004;17(2):143–147.
12. Gordon JS, Staples JK, Blyta A, et al. Treatment of posttraumatic stress disorder in postwar Kosovar adolescents using mind-body skills groups: a randomized controlled trial. *J Clin Psychiatry.* 2008;69(9):1469–1476.
13. Grodin MA, Piwowarczyk L, Fulker D, et al. Treating survivors of torture and refugee trauma: a preliminary case series using qigong and t'ai chi. *J Altern Complement Med*. 2008;14(7):801–806.
14. Waelde LC, Uddo M, Marquett R, et al. A pilot study of meditation for mental health workers following Hurricane Katrina. *J Trauma Stress*. 2008;21(5):497–500.
15. Kimbrough E, Magyari T, Langenberg P, et al. Mindfulness intervention for child abuse survivors. *J Clin Psychol*. 2010;66(1):17–33.
16. Rosenthal JZ, Grosswald S, Ross R, et al. 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(6):626–630.
17. Kearney DJ, McDermott K, Malte C, et al. 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(1):101–116.
18. 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(11):1145–1152.
19. Brown RP, Gerbarg PL. Yoga breathing, meditation, and longevity. *Ann N Y Acad Sci*. 2009;1172:54–62.
20. Bernardi L, Gabutti A, Porta C, et al. Slow breathing reduces chemoreflex response to hypoxia and hypercapnia, and increases baroreflex sensitivity. *J Hypertens*. 2001;19(12):2221–2229.
21. 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(3):250–254.
22. McEwen BS. Allostasis and allostatic load: implications for neuropsychopharmacology. *Neuropsychopharmacology.* 2000;22(2):108–124.
23. NCCAM. What is Complementary and Alternative Medicine? 2012; http://nccam.nih.gov/health/whatiscam. Accessed July 5, 2012.
24. Watson CG, Tuorila JR, Vickers KS, et al. The efficacies of three relaxation regimens in the treatment of PTSD in Vietnam War veterans. *J Clin Psychol*. 1997;53(8):917–923.
25. Branstrom R, Kvillemo P, Moskowitz JT. A randomized study of the effects of mindfulness training on psychological well-being and symptoms of stress in patients treated for cancer at 6-month follow-up. *Int J Behav Med*. 2012;19(4):535–542.
26. Telles S, Singh N, Joshi M, et al. Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: a randomized controlled study. *BMC Psychiatry.* 2010;10:18.
27. 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(21):23–37.
28. Brooks JS, Scarano T. Transcendental meditation in the treatment of post-Vietnam adjustment. *J Couns Dev.* 1985;64(3):212–215.
29. Song BA, Yoo SY, Kang HY, et al. Post-traumatic stress disorder, depression, and heart-rate variability among North Korean defectors. *Psychiatry Investig*. 2011;8(4):297–304.
30. Porges SW. Cardiac vagal tone: a physiological index of stress. *Neurosci Biobehav Rev.* 1995;19(2):225–233.
31. Dishman RK, Nakamura Y, Garcia ME, et al. Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. *Int J Psychophysiol*. 2000;37(2):121–133.
32. Cohen H, Kotler M, Matar MA, et al. Analysis of heart rate variability in posttraumatic stress disorder patients in response to a trauma-related reminder. *Biol Psychiatry.* 1998;44(10):1054–1059.
33. Franzblau SH, Echevarria S, Smith M, et al. A preliminary investigation of the effects of giving testimony and learning yogic breathing techniques on battered women's feelings of depression. *J Interpers Violence*. 2008;23(12):1800–1808.
34. Jerath R, Edry JW, Barnes VA, et al. Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. *Med Hypotheses*. 2006;67(3):566–571.
35. Gerbarg PL, Wallace G, Brown RP. Mass disasters and mind-body solutions: evidence and field insights. *Int J Yoga Therap*. 2011(21):97–107.
36. Kim SH, Kravitz L, Schneider SM. PTSD & exercise: what every exercise professional should know. *IDEA Fitness J.* 2012;9:20–23.
37. Edinger JD, Jacobsen R. Incidence and significance of relaxation treatment side effects. *Behav Ther.* 1982;5:137–138.
38. Carlson CR, Nitz AJ. Negative side effects of self-regulation training: relaxation and the role of the professional in service delivery. *Biofeedback Self Regul.* 1991;16(2):191–197.