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Post-Traumatic Stress Disorders (K Chard and T Geracioti, Section Editors)

Yoga as an Intervention for PTSD: a Theoretical Rationale and Review of the Literature

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Opinion statement

There is evidence to suggest that yoga may reduce PTSD symptoms. It is unclear at this point, however, whether or not yoga reduces PTSD symptoms any more than a non-specific intervention given inconsistent findings and methodological limitations. Nonetheless, additional research in this area is important because of the high level of interest in and acceptability of yoga. Ultimately, yoga may be most effective when taught using trauma-sensitive guidelines and within a framework that helps the practitioner to apply the experience to coping with symptoms.

Introduction

Posttraumatic stress disorder (PTSD) is a serious mental health condition that follows exposure to a life-threatening or other traumatic event. The lifetime and past-year prevalence estimates for PTSD in the general population have

been found to be 6.8–7.8 and 3.5 %, respectively [1–3], with higher rates in subgroups such as women [1, 4] and military veterans [5–7]. PTSD has been associated with higher rates of physical-health problems [8, 9], depression [10], substance use [11], suicidality [12], and disability [13], as well as decreased quality of life [14] and functional impairment [15, 16]. Given the potentially debilitating effects of PTSD, there is a need for effective treatments.

Excellent psychosocial treatment is available for PTSD, but the need remains for alternative and complementary strategies for managing its symptoms and functional impact. Trauma-focused therapies, such as prolonged exposure (PE) and cognitive processing therapy (CPT), have been identified by multiple organizations as current gold standard treatments for PTSD (ISTSS Treatment Guidelines [17, 18]). Meta-analysis of active PTSD treatments indicated that 56 % of individuals in the intent-to-treat samples and 67 % of treatment completers no longer met criteria for PTSD at posttreatment [19]. Additionally, 44 % of the intent-to-treat samples and 54 % of the treatment completers had author-defined clinically meaningful improvements in their symptoms at posttreatment [19]. Among veteran or active duty military personnel, the response may be attenuated. A recent review found that 49–70 % of individuals receiving PE or CPT had clinically significant reductions in PTSD symptoms [20•] but approximately two thirds of individuals receiving PE or CPT still met criteria for PTSD at posttreatment [20•]. As a result, some patients will continue to need intervention after completion of first-line treatment. In addition, significant numbers of patients will drop out of treatment (observed rates vary from 0 to 54 %) [20•, 21] or never seek treatment [6]. Thus, a need remains for therapies to enhance the effects of existing approaches, act as a gateway into effective treatment, or provide an alternate pathway to reduce symptoms and improve functioning. Out of this need, there has been increasing interest in the application of complementary and alternative medicine (CAM) as well as integrative programs for PTSD. "Complementary" refers to the use of non-conventional treatments in combination with established clinical practices, and "alternative" refers to the use of non-conventional treatments in lieu of typical strategies [22]. Non-conventional treatments are often brought together with traditional medicine into "integrative" programs that combine an array of interventions with the goal of improving well-being more broadly.

CAM use has increased since the 1950s and is projected to continue to rise [23]. Estimates of CAM use vary based on the techniques included and the sampling strategies, but recent estimates of use of CAM in the past year are in the range of 27–57 % depending on the setting, which has included the general population as well as Department of Veterans Affairs (VA) outpatient settings and psychiatric populations [23–28]. Patients with PTSD appear to follow these trends as well. Epidemiological surveys estimate that 12.6–39 % of those with PTSD have pursued CAM for their mental health [29, 30]. Reflecting this trend, many healthcare systems offer CAM treatments in PTSD specialty clinics. In a survey of VA PTSD specialty programs, 96 % reported using at least one form of CAM [31]. After removing CAM techniques that overlap with trauma-focused PTSD treatments (e.g., stress management-relaxation therapy), 88 % still reported using CAM [31].

One form of CAM that is gaining increasing attention from patients and researchers is yoga [24]. There has been a threefold increase in the number of research publications on yoga in the past decade, the majority of which are in the field of mental health [32]. As a result of this interest, yoga is now being offered to target PTSD for veterans, active duty service members, and civilians [31, 33–35]. The reasons for this increased interest in yoga as a PTSD treatment are not fully understood but simply may reflect the national increase in yoga practice [36]. Alternatively, knowledge about the physical and emotional changes associated with yoga may be spurring hope that the practice will bring relief for individuals with PTSD.

The current paper first reviews the rationale for yoga as a PTSD intervention based on known emotional, physiological, and biochemical effects of its components, i.e., physical movement, regulated breathing, and focused attention. This is followed by a review of the intervention studies to date that have examined the use of yoga as a PTSD intervention. Implications of the findings and recommendations for future research are provided.

Rationale for yoga as a PTSD intervention

In modern contexts, yoga practices typically involve a combination of physical postures or movement sequences, conscious regulation of breathing, and

various techniques to foster attention [37]. The emphasis put on each of these components, as well as the way they are integrated into the practice, varies across yoga styles. In regard to movement, yoga postures are generally performed in a slow and controlled fashion that requires balance, coordination, and proprioceptive awareness. In contrast to more vigorous forms of physical exercise, this type of coordinated movement of moderate intensity has been proposed to promote parasympathetic tone [38].

Yoga practice typically pairs movement with breathing. Both Eastern yoga teachings and Western science on respiratory physiology suggest that there are associations between emotional states and breathing patterns and that, consequently, breath regulation can influence emotion [39–41]. Slow and rhythmic breathing with a rate of about six breaths per minute has been reported to decrease chemoreflex sensitivity [42] and oxidative stress [43]. Conversely, it increases cardial-vagal baroreflex sensitivity [44] and promotes the release of prolactin and oxytocin, which is known to be associated with increased feelings of calmness and social bonding [45].

Yoga practices also typically incorporate techniques to develop attentional capacity. These can take the form of focused attention, where the focus is on a single object of concentration such as the breath, or open-monitoring attention, which refers to the practice of observing one's thoughts or sensations while refraining from any cognitive elaboration, analysis, or judgment [46]. Frequently, the emphasis during yoga practice is on attending to bodily sensations and sensory experiences, which develops interoceptive, proprioceptive, kinesthetic, and spatial awareness [47]. Training in body awareness combined with open monitoring may have significance for health and self-regulation, as it can increase the ability to observe bodily signals of emotional states without responding to them negatively [48]. One of the principal mechanisms through which developing attentional capacity is proposed to promote psychological well-being is by decreasing mind wandering [49] and rumination [50] and by allowing a shift to less self-centered and more objective present-moment awareness [51]. On a neural level, this has been proposed to be reflected by disengagement from default mode network (DMN) activity [49].

An important mechanism through which both yogic breath and movement can be hypothesized to impact autonomic regulation is by promoting vagal afference [52]. The vagus nerve is one of the key components of autonomic regulation [53], and its afferent fibers communicate peripheral information about bodily states to the brain [54]. Vagal afference is mediated via the thalamus to brain regions involved in emotion regulation such as the insula, the anterior cingulate cortex, and the prefrontal cortex [55]. Conversely, higher brain regions involved in fear detection, attentional mechanisms, and self-regulatory behaviors are linked via the vagus nerve to the regulation of autonomic functions and metabolic systems [55]. The vagus nerve has phylogenetically evolved to mediate stress responses by regulating cardiac output and influencing engagement/disengagement with the environment [52], and in fact, vagally mediated cardiac function has been associated with physical, affective, cognitive, and social processes [56]. Vagal tone is impacted by slow and rhythmic breathing [40], and the type of movement employed in yoga practices is likely to contribute to this effect by enhancing the depth of the breath and by emphasizing abdominal tone which further promotes peripheral vagal stimulation and afference [57].

In healthy populations, yoga interventions have been associated with physiological effects such as reduced levels of cortisol [58], increased levels of γ-aminobutyric acid (GABA) [59], and measurable changes in various cardiovascular indices including heart rate variability (HRV) which is one of the primary indicators of balanced nervous system activity [60]. Yoga practice has also been shown to correlate with increased levels of mindfulness [61], body awareness [62], and pain tolerance [63], as well as reduced levels of self-reported stress [61]. Lastly, yoga has been related to changes in cognitive functioning in different domains. The reported findings include improved visual attention [64], improved short-term and long-term memory [58], improved problem solving ability [65], more efficient executive functioning [66], and less age-related decline in fluid intelligence, which refers to a set of abilities involved in coping with novel environments and abstract reasoning [37]. Based on this evidence, it is possible to identify a number of mechanisms by which yoga may positively impact PTSD. The increased sense of subjective and physiological calmness and lowered reactivity to emotional states have the potential of counteracting hyperarousal and reducing negative affective states. The observed cognitive changes may support the use of positive coping skills and counteract intrusive thoughts and ruminative thought processes [67, 68]. In the next section, we review the extant trials evaluating yoga in individuals with PTSD to gauge the viability of these hypotheses.

Evidence for yoga as a PTSD intervention

This review includes intervention studies that targeted PTSD, included pretreatment and posttreatment outcomes, and evaluated the effects of a form of yoga that included physical postures. Studies that only utilized other aspects of yoga, such as meditation and intention setting (e.g., [69] or yogic breathing, e.g., [70]), were seen as outside the scope of this review because of their high degree of overlap with meditation/mindfulness and relaxation. In order to identify articles for review, PubMed, PsychInfo, and PILOTS were searched for English-language, peer-reviewed articles using the keywords "yoga," "PTSD," "posttraumatic stress disorder," and "trauma#." The reference lists of each eligible article were also reviewed.

Controlled trials

The largest randomized controlled trial to examine the efficacy of yoga for PTSD included 80 civilians, largely women, who were randomized to Kundalini yoga ($n = 59$, 30 of whom dropped out) or a wait list control ($n = 21$; [71••]). Participants were community members who were recruited from the Greater Toronto area. Participants were allowed to take part in other interventions during the study provided that they were not contemplative in nature; 57 % of the wait list group and 39 % of the yoga group were in other treatments during the study. The intervention was comprised of eight 90-min classes with recommended daily home practice. The practice was "trauma-sensitive," i.e., tailored to enhance the comfort of trauma survivors through using invitatory (as opposed to commanding) language,

providing a space where clients feel less vulnerable (e.g., lighting should not be too dark), allowing patients to opt out of postures, minimizing physical assists until trust is established, and creating an overall welcoming and approachable environment (for further discussion of trauma-sensitive yoga, see [72]). As compared to wait list, the yoga intervention was associated with greater decreases in PTSD symptoms (see Table 1 for cross-trial comparisons of effect size), insomnia, stress, and anxiety as well as increases in positive affect and resilience. No significant changes in depression or negative affect were observed, and participants were not followed after the completion of treatment. The high dropout rate in the yoga group raises concern about bias affecting these results.

Another relatively large yoga trial included 64 women with chronic, treatment-resistant PTSD [73••]. Study participants were required to participate in supportive psychotherapy and continue any medication treatments. These women were randomized to one of two conditions. The yoga condition included 10 weeks of hour-long trauma-sensitive yoga classes that incorporated breathing, postures, and meditation in a trauma-sensitive manner. The control condition consisted of 10 weeks of 60-min women's health-education classes that sought to promote active participation in the group, provide support, increase knowledge about health, and improve self-efficacy about healthcare and bodily issues. The control condition did not include discussion of issues related to trauma. Individuals in the control condition, but not the yoga condition, were allowed to have contact outside of the class [73••]. Assessments, which included a semi-structured clinical interview and self-report measure of PTSD symptoms, were conducted at pretreatment, midtreatment, and posttreatment. Seven percent of individuals withdrew consent prior to randomization, and 12 % withdrew consent prior to treatment [73••]. Dropout rates were reported for those who began treatment and did not differ between the yoga (1.6 %) and control (4.7 %) conditions. Women in both treatment conditions had significant decreases in PTSD symptoms as measured by the Clinician-Administered PTSD Scale (CAPS) from pre- to posttreatment, but the yoga

Table 1. Pre-post effect sizes of yoga interventions in published trials

Author/year	Measure	Cohen's *d*[a]
Jindani et al., 2015	PCL	1.65
Van der Kolk et al., 2014	CAPS	1.07
Mitchell et al., 2014	PCL	0.85
Telles et al., 2010	Fear analog scale	0.49
	Anxiety analog scale	0.42
Thordardottir et al., 2014	PDS	0.52
Johnston et al., 2015	CAPS	0.77
Staples et al., 2013	PCL-M	0.08

[a]To enhance comparability across trials, within-group pre-post Cohen's *d* for the effect of yoga has been reported (when provided by authors) or calculated based on available data. Because of differences in the methods of calculating effect sizes (we have included those reported by authors or, if none were reported, calculated based on available data), they should be understood as a rough estimate of the true effect of yoga intervention

group had significantly larger decreases [73••] (refer to Table 1 for effect sizes). Both groups also had significant decreases in self-reported PTSD symptoms using the Davidson Trauma Scale (DTS) from pre- to midtreatment, but these improvements were not maintained in the control group at posttreatment. At posttreatment, 52 % of individuals in the yoga group no longer met criteria for PTSD compared to 21 % in the control group. As the study design did not include follow-up assessments, it is not known if improvements were maintained after the intervention period.

Mitchell and colleagues [74] conducted a pilot, randomized controlled trial comparing a Kripalu yoga intervention, which emphasized the connection between the mind and body and included both breathing exercises and physical postures, to an assessment-only control group in a sample of 38 civilian and veteran women with full (71 % of the sample) or subthreshold PTSD. The authors did not report if participants were currently engaging in other PTSD treatments, but participants were excluded if they had participated in a yoga class in the past 6 months. Diagnostic status was evaluated at baseline using the PTSD Symptom Scale-Interview (PSS-I), and PTSD symptoms were monitored weekly using the PTSD Checklist-Civilian version (PCL-C). Individuals in the yoga condition attended twelve 75-min sessions of yoga either once weekly for 12 weeks or twice weekly for 6 weeks. The yoga classes followed the trauma-sensitive yoga guidelines as previously described [72]. Individuals in the control condition met once weekly for 12 weeks in groups of four to five women to complete assessments [74]. Dropout rates were the same for the yoga and control groups; however, noncompleters had marginally significantly higher baseline PCL scores than completers [74]. Individuals in both groups had clinically significant decreases on the PCL from baseline to postintervention and from baseline to 1-month follow-up; however, there was no significant difference between the two conditions [74]. Post hoc analyses revealed that re-experiencing and hyperarousal symptoms decreased significantly, but there were no group differences [74]. Diagnostic status was not assessed at posttreatment or follow-up.

Thordardottir and colleagues [75] conducted a non-randomized controlled trial comparing hatha yoga to a wait list control for PTSD in a sample of 66 Icelandic earthquake survivors. Individuals were not allowed to participate in another yoga class during the study, but it was not reported if individuals were allowed to engage in other PTSD treatments. Individuals did not need to meet criteria for PTSD but needed to report symptoms of distress or stress at the time of recruitment. Participants were assigned to one of the two conditions based on residential convenience. The yoga condition involved 60-min twice-weekly classes for 6 weeks. The yoga consisted of mild to moderate physical poses, yogic breathing, relaxation, mindfulness, and meditation. Self-reported PTSD symptoms were assessed at pre- and posttreatment using the Icelandic version of the Posttraumatic Stress Diagnostic Scale (PDS). Quality of life was assessed using the Icelandic Quality of Life Scale (IQL) at pre- and posttreatment. Sixteen percent of individuals in the yoga group dropped out of treatment and 9 % dropped out of the wait list condition. Individuals in the yoga and wait list groups had significant decreases in PTSD symptoms and improvements in quality of life from pre- to posttreatment, but there were no significant differences between the two

groups. Additionally, diagnostic status was not established at pretreatment so it is unknown if the interventions impacted diagnosis.
Telles and colleagues [76] examined the effectiveness of a Patanjali yoga program compared to a wait list control in a sample of 22 male flood survivors in India who were living in a temporary camp. The authors did not indicate if individuals were participating in other treatment during the study. The Screening Questionnaire for Disaster Mental Health (SQD) was used to screen for PTSD symptoms. Participants were randomized to one of two groups, yoga or an assessment-only control. The yoga group attended daily 60-min yoga sessions for 7 days and were not allowed to practice yoga at other times. The yoga classes included loosening exercises, physical postures, breathing techniques, and guided relaxation. The control group engaged in their normal daily routines in the camp. Participants in the control group were given the option to learn yoga after the study was completed. Visual analog scales of fear, sadness, anxiety, and disturbed sleep were used to assess PTSD symptoms because the participants had less than 7 years of education [76]. No significant group difference was found on any of the four outcomes.

Open trials

Johnston and colleagues [77••] conducted a single-arm study with a benchmarking comparison examining responses to Kripalu yoga, a form of hatha yoga, for 12 active duty personnel or veterans with PTSD. Participants were allowed to participate in psychotherapy or use medications while participating in the study but were excluded if they utilized more than 1 hour per week of yoga-related mind-body therapies. The authors did not report how many participants were currently engaged in other treatments. Individuals' index traumas included combat, military sexual trauma, and motor vehicle accidents. PTSD diagnosis was assessed at pre- and posttreatment. The yoga intervention was comprised of 90-min yoga classes twice weekly for 10 weeks that included physical poses, breathing strategies, meditation, and relaxation [77••]. Individuals also were asked to do 15 min of yoga each day at home. Results indicated that the average decrease in CAPS scores from pre- to posttreatment was 18.2, which is statistically and clinically significant [77••]. The effect size for treatment was $d = 0.768$, which did not meet the aggregated treatment benchmark of 1.074. Additionally, the average CAPS score at posttreatment was 52.2, which suggests continued moderate PTSD. Forty percent of participants demonstrated a clinically significant drop of 15 points or more on the CAPS, and 60 % had a clinically significant reduction of 10 points on the CAPS [77••].
The effectiveness of a yoga intervention for military-related PTSD also was evaluated in a single-arm pilot study of 12 veterans [78]. The authors did not indicate if participants were in concurrent PTSD treatment. The yoga intervention utilized a form of yoga based on the Krishnamacharya Healing and Yoga Foundation that uses a meditative focus and links breath with physical movement. The intervention was designed to decrease stress, increase perceived control of thoughts and feelings, and increase feeling safe [78]. Yoga classes were offered for 1 hour, twice weekly for 6 weeks, and were comprised of checking in with oneself, physical postures, breath awareness,

and a guided relaxation. PTSD symptoms were assessed pre- to posttreatment with the PCL-Military version (PCL-M). Quality of life was assessed using Outcome Questionnaire 45.2 that assesses three domains: symptom distress, interpersonal functioning, and social role. There were no significant pre-post differences on the PCL-M total score, re-experiencing, or avoidance subscales, but there was a significant reduction in hyperarousal symptoms. Additionally, there were no significant differences from pre- to posttreatment for quality of life. However, participants did indicate on program evaluation forms that the program was helpful in improving quality of life.

Summary

Current data do not provide strong support for yoga as a first-line PTSD intervention. Although two randomized studies found yoga to outperform a control group (72, 74), three other smaller studies did not [74–76]. Pre-post effect sizes of the yoga interventions range from 0.08 to 1.65 (refer to Table 1). Although four studies show a large effect size for yoga, it is likely not as effective as first-line approaches (e.g., yoga was not as effective as an aggregated PTSD treatment benchmark [77••]). The reasons for the large range of estimated effect sizes are unclear but likely reflect the limitations discussed below. Three of the four studies with the highest observed effect sizes employed trauma-sensitive yoga guidelines, which suggest that this framing of the practice may be useful.

Limitations of the existing literature can be categorized in three classes: (1) inadequate assessment, (2) heterogeneity of interventions, and (3) methodological limitations. Gold standard assessment of PTSD should include psychometrically validated measures of symptomatology administered by blinded personnel. The current yoga literature frequently does not meet these standards. Many studies rely only on self-report measures, and some have not used validated PTSD measures. All lack data on longer term effects of the intervention. The nature of the yoga interventions is extremely difficult to ascertain from the published descriptions and likely varies widely. Yoga researchers should be encouraged to manualize interventions and make those available for replication or, at a minimum, to quantify the components of their interventions using tools such as the Essential Properties of Yoga Questionnaire [79]. Similarly, it is generally unclear to what extent participants were engaging in other types of PTSD interventions. Future research should quantify intervention outside the study protocol using a tool such as the Emory Treatment Resistance Interview for PTSD [80] so that the reader may understand if the intended use of yoga is complementary (i.e., augmenting another treatment targeting PTSD), alternative (i.e., the primary PTSD treatment believed to be driving change), or integrative (i.e., part of a comprehensive PTSD program). In addition, future studies should employ active control groups to control for non-specific treatment effects, particularly given that many studies fail to find that yoga groups lead to significantly greater improvements in PTSD symptoms than do control conditions. Finally, the current literature in this growing field of study is limited to preliminary studies with small sample sizes and lack of or inadequate control groups. Building on this foundation,

future studies should utilize adequately powered, randomized controlled designs. Despite these limitations, the large effect sizes from four studies are a sufficient positive signal for the need for more research.

Future directions

Typical practice of yoga in the West focuses on physical postures, but this is a minor part of traditional yoga practice [81]. The ancient yoga tradition emphasizes spiritual practices, using the physical postures simply as one means to develop higher consciousness [82]. Traditional yoga emphasizes insight, devotion, and service [82]. Thus, the physical practice is contextualized within a broader quest for well-being. In its full form, yoga is not a short-term intervention but rather an enduring way of life. Similarly, we suggest that effective yoga interventions for PTSD would contextualize the physical practice within a model of PTSD and aim to create a long-term practice as opposed to a limited time intervention.

Mindfulness has been used as a vehicle to support therapeutic change as part of several empirically supported cognitive-behavioral approaches (e.g., dialectical behavioral therapy, acceptance and commitment therapy, mindfulness-based cognitive therapy; [83]). We suggest that yoga could similarly be used to help to address the pathological processes that maintain PTSD and may be more palatable to some patients than seated meditation. Some limited data suggest that yoga may affect hyperarousal [74, 78], so a regular yoga practice may be a way to enhance parasympathetic functioning [38], counteracting autonomic changes related to PTSD [84]. In addition, change in PTSD symptoms has been linked to anxiety sensitivity, which can be defined as a fear of fear-related sensations [85]. Yoga practice, through open monitoring, may provide experience in differentiating pain from discomfort and choosing whether or not to react to discomfort. These lessons have direct applicability to tolerating anxiety or sadness related to a traumatic event. Yoga may promote learning to tolerate normal emotional reactions to trauma, rather than fighting against unwanted internal experiences, which is known as experiential avoidance and has been linked to PTSD [86]. PTSD is characterized by negative appraisals of the self, others, and the world [87, 88]. By emphasizing process over outcome, yoga may help to counteract negative judgments. Finally, early evidence suggests that yoga may increase attentional control and executive functioning, which have been theorized to play a role in the ability to manage intrusive thoughts and to engage in good coping behaviors [67].

Conclusion

Extant data suggest that establishing a yoga practice may prove to be an effective strategy for reducing PTSD symptoms and improving functioning. Several studies now show large effect-size changes related to the practice of yoga, leading to optimism about the ultimate utility of yoga for PTSD. Features that are likely to enhance the usefulness of yoga are trauma-sensitive teachings and a yoga practice that is taught within a framework that incorporates principles to

help practitioners apply what they learn from yoga to managing their PTSD symptoms. A PTSD-informed framework could be applied within yoga classes; yoga teachers could directly link messages throughout the class (e.g., approaching uncomfortable sensations within the body) to management of PTSD symptoms. Future research should continue to evaluate the efficacy of yoga as a stand-alone intervention for PTSD but also as an adjunct to current trauma-focused PTSD treatments.

6. Notes

1. The original article did not report if this was a significant difference, so we conducted a chi-square analysis and the difference in dropout between conditions was not significant, $p = .35$.

Compliance with Ethical Standards

Conflict of Interest
Stephanie Y. Wells, Ariel J. Lang, Laura Schmalzl, Erik J. Groessl, and Jennifer Strauss declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent
This article contains one referenced article by co-author Dr. Groessl that included human subjects. All participants provided informed consent and the research was approved by the institutional review board.

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