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Yoga for Warriors: An Intervention for Veterans with Comorbid Chronic Pain and PTSD

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Abstract

Objective: Comorbid chronic pain and PTSD is common in veterans; this co-morbidity is associated with increased severity and poorer prognosis when compared to each outcome alone. Yoga has been shown to be effective for chronic pain and promising for PTSD, but yoga for comorbid pain/PTSD has not been examined. This manuscript offers empirical support for a yoga intervention for comorbid chronic pain/PTSD in a veteran population.

Method: Results are presented from a four-year pilot yoga intervention for comorbid chronic pain/PTSD at a large, urban Veterans Affairs Medical Center. Based on the Fear Avoidance Model of pain, the intervention used a cross-sectional, open-trial design with pre- and post-measures. T-test analyses were conducted on program completers ($N = 49$; out of 87 initially enrolled, 44% attrition rate), who were primarily African-American (69%), male (61%), mean age 51.41 (SD = 11.32).

Results: Results indicated trend-level reductions in overall PTSD symptoms, as measured by the PCL-5 ($p = .02$; $d = .38$), and in subscales of negative alterations of cognitions/mood ($p = .03$; $d = .36$) and arousal/reactivity ($p = .03$; $d = .35$). Veterans reported significant improvement in ability to participate in social activities ($p < .001$; $d = .44$) and significant reductions in kinesiophobia (fear of movement/physical activity, $p < .001$; $d = .85$). On a satisfaction measure with a range of 1 (quite dissatisfied) to 4 (extremely satisfied), mean rating was 3.74 (SD = .33).

Conclusion: Yoga is a feasible and effective intervention for veterans with comorbid chronic pain and PTSD.

Keywords

yoga; PTSD; chronic pain; complementary and integrative health; Veterans

Introduction

Chronic pain and posttraumatic stress disorder (PTSD) represent a frequent, complicated comorbidity, particularly for individuals in Veterans Health Administration treatment (Bosco, Gallinati, & Clark, 2013; Otis, Keane, & Kerns, 2003). Studies in veteran samples report 66–80% of patients with PTSD also report chronic pain (e.g., back pain, osteoarthritis, joint pain; Beckham et al., 1997; Shipherd et al., 2007). This is a much higher rate compared to estimates of chronic pain alone ranging from 11–40% (Dahlhamer et al., 2018) in U.S. epidemiological samples and rates of 46% in civilian psychiatric outpatients

(Villano, Rosenblum, Maguar, & Fong, 2007). This comorbidity impacts functioning and quality of life (Palyo & Beck, 2005), resulting in increased pain-related disability and poorer response to pain treatment (Sherman, Turk, & Okifuji, 2000). This comorbidity also increases the severity of anxiety and depression (Gerrits et al., 2012), yet the chronic pain and PTSD literature is limited by overlooking comorbid psychiatric conditions (Tunks, Crook, & Weir, 2008). Considering how frequently chronic pain and PTSD co-occur, the literature addressing their treatment is sparse, which may be related to the tendency to isolate conditions for treatment.

Complementary and integrative health (CIH) treatments have received increased attention broadly and in Veterans Affairs Medical Centers (VAMCs). In 1998, the National Institutes of Health (NIH) launched the National Center for Complementary and Integrative Health (NCCIH; originally called the National Center for Complementary and Alternative Medicine) to research the usefulness and safety of integrative interventions. The name change reflects that most individuals in the United States use integrative approaches *in addition to* rather than *instead of* traditional practices. Given the current opioid epidemic, there has also been an emphasis on developing non-pharmacological (i.e., CIH) approaches to chronic pain. Approximately two-thirds of chronic pain patients eventually turn to non-pharmacological treatments, including CIH, for relief (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006; Penney, Ritenbaugh, DeBar, Elder, & Deyo, 2017). Active duty service members and veterans are at increased risk of developing chronic pain due to the challenging physical conditions in which they operate. This fact is reflected in the NCCIH website, which includes a section dedicated to non-pharmacological approaches to managing chronic pain in service members and veterans (https://nccih.nih.gov/health/military-veteran), and in the 2018–2019 VA Strategic Plan, which includes an emphasis on CIH and modalities by which veterans can enhance their well-being.

Yoga, an established CIH approach, has demonstrated initial, promising effects for addressing chronic pain and PTSD separately. Yoga encompasses linking breath with movement and a meditative component (NCCIH, 2019). A 2012 U.S. survey found that 30% of adults use integrative health techniques. Yoga was the third most common approach, used by nearly 10% of respondents, an increase from 6% in 2007 (Clarke, Black, Stussman, Barnes, & Nahnin, 2015). Research exists on the positive effects of yoga on chronic pain, specifically low back pain (see meta-analysis by Cramer, Lauche, Haller, & Dobos, 2013). Groups such as the American Pain Society and the College of Family Physicians of Canada have identified CIH as a legitimate chronic pain management strategy (Houze, El-Khatib, & Arbour, 2018).

More recently, attention has been given to the use of yoga with mental health conditions (Mitchell et al., 2014; Staples, Hamilton, & Uddo, 2013; van der Kolk et al., 2014). A meta-analysis of 10 studies found yoga-based interventions had statistically significant effects as an adjunct treatment for psychiatric disorders (Cabral, Meyer, & Ames, 2011). To date, few studies have examined PTSD specifically, and were primarily conducted in female civilian samples (Jindani, Turner, & Khalsa, 2015; Mitchell et al., 2014; van der Kolk et al., 2014). In veteran samples, five studies have been published (Carter et al., 2013; Johnston et al., 2015; Reinhardt et al., 2018; Seppala et al., 2014; Staples, Hamilton, & Uddo, 2013). Two

were small (N = 12 for each), single-arm studies with no active comparison: one found yoga reduced PTSD symptoms (Johnston et al., 2015), and the other demonstrated improvement in symptoms of hyperarousal specifically, but not overall PTSD symptoms (Staples, Hamilton, & Uddo, 2013). The other three were small RCTs (Ns ranged from 15–31); all found significant reductions in PTSD over time. Two found reductions in PTSD in the yoga groups compared to control groups (Carter et al., 2013; Seppala et al., 2014), while the third found no significant difference between the yoga and the control group (Reinhardt et al., 2018). Many VA PTSD programs now include some type of yoga programming, but there is a lack of consistency (Libby, Reddy, Pilver, & Desai, 2012).

Various theories exist regarding potential mechanisms underlying the comorbidity of chronic pain and PTSD, which are connected based on shared cognitive, affective, physiological, and behavioral features (Shipherd et al., 2007). Individuals with chronic pain often develop negative, maladaptive beliefs combined with avoidance behaviors, as illustrated by the Fear Avoidance Model of Pain (Vlaeyen & Linton, 2012), which posits that activity-limiting chronic pain is maintained due to fear of pain; this encourages additional avoidance of physical activities. Maladaptive beliefs are maintained because avoidance acts as a reinforcer. The term *kinesiophobia* describes fear of movement; this fear that movement will cause pain, and the ensuing avoidance, is an important pathway by which pain becomes chronic (Vlaeyen & Linton, 2012). Similarly, avoidance is a central behavior for individuals with PTSD. Thus, the Fear Avoidance Model has been adapted to PTSD (Foa, Hembree, and Rothbaum, 2007), and provided the underlying theory for the current intervention (see Supplemental Figure 1). Yoga is theorized to aid with reducing chronic pain and PTSD symptoms by encouraging individuals to attend to, rather than avoid, sensations, thoughts, and feelings and to aid with self-regulation (van der Kolk et al., 2014).

Despite increased interest, several limitations exist in the extant literature on chronic pain and PTSD. Only one attempt has been made to develop an integrated treatment program for comorbid PTSD and pain (Otis, J.D., Keane, T.M., Kerns, R.D., Monson, C., & Scioli, E., 2009). This is a 12-session cognitive therapy intervention; while evidence exists of its potential benefits, there was a 50% dropout rate in the pilot group. To date, support for the benefits of yoga for PTSD in veterans is limited due to the number of studies. Further, most studies fail to operationalize key terms, provide little description of the type of yoga offered or training of the instructor, and lack standardized protocols for replication/dissemination (Wells, Lang, Schmalzl, Groessl, & Strauss, 2016). However, additional research in this area is important because of the high level of interest in and acceptability of yoga (Wells et al., 2016).

The purpose of this program evaluation project was to evaluate the feasibility and acceptability of a yoga intervention in a veteran population with comorbid chronic pain/PTSD and to examine the effects on PTSD and chronic pain symptoms, mood, and social engagement. This study aims to extend the literature on yoga for PTSD by examining the effectiveness of a structured, systematic yoga program, administered by a registered yoga teacher in a demographically diverse (i.e., age, sex, race) veteran population. To our knowledge, this is the first study using a yoga intervention in a comorbid chronic pain and PTSD sample. We hypothesized the intervention would be feasible, acceptable, and result in

symptom improvement as well as decreases in kinesiophobia and improved functional outcomes.

Methods

Participants and procedures

Participants represent patients enrolled at a mid-Atlantic Veterans Affairs medical center who were referred from the following clinics: primary care, mental health, PTSD, physical medicine and rehabilitation, and the Polytrauma Network Site, from August 2014 until December 2018. Inclusion criteria consisted of: 1) diagnosis of chronic pain by a medical provider and PTSD by a licensed independent clinician; 2) ability to stand from sitting on the floor independently; 3) ability to ambulate community distances without an assistive device; 4) active sensation in lower extremities; and 5) medical clearance by a physician. Exclusion criteria included: 1) fall risk; 2) pregnancy; 3) joint replacement within the past 12 months; 4) active substance abuse or dependence; 5) psychotic disorder or hospitalization with psychotic symptoms in the past three months without also being in treatment with a mental health provider for that condition; and 6) active homicidal ideation.

The current study represents participants enrolled in 10 treatment cohorts. Prior to starting the group, an orientation session occurred, including an overview of the program and informed consent. All assessment measures, described below, were completed at the orientation session (pre-treatment) and again at completion of the group (post-treatment). The PTSD Checklist-5 was not administered for the first cohort. The average size of groups was approximately nine; groups were mixed gender. In total, 87 patients enrolled, with 49 completing the group, representing a 44% attrition rate. The primary study analyses were conducted on treatment completers ($n = 49$). A treatment completer was defined as a participant who remained in the group and was present for administration of post-treatment measures. Thus, number of sessions attended varied, and post-treatment scores are only available for completers.

Intervention outline and description

Yoga for Warriors initially consisted of 12 weekly, 90 minute classes. Following the first cohort ($n = 10$ enrolled, $n = 7$ completed), due to time and access considerations, the format changed to 10 weekly, 60 minute classes for the second cohort ($n = 11$ enrolled, $n = 7$ completed). Beginning with the third cohort and all groups following, the format again changed, for the same reasons, to eight weekly, 60 minute classes ($n = 66$ enrolled, $n = 35$ completed). These cohort groupings did not differ across baseline measures. Examination of differences in outcome measures suggested that different group lengths were not associated with differences in outcome (post-treatment) measures, with three exceptions: Cohort one (12 sessions) had greater anxiety scores than cohort two (10 sessions) and lower social role functioning scores than the remaining cohorts (8 sessions); Cohort two had higher physical functioning scores than the remaining 8-session cohorts. Given the minimal differences, and the finding that the longest treatment had poorer scores, groups were analyzed together.

The class was designed for beginners and no prior experience was required. The style of yoga was broadly Hatha Yoga, an alignment-focused practice linking breath with movement. In addition to emphasizing good alignment, each class began with a motivational theme or quotation (e.g., a quote from Joseph Campbell, "We must be willing to let go of the life we planned so as to have the life that is waiting for us") linked to the practice of yoga. For example, participants might have goals for their practice but find that pain limits them during a particular session. Instead of ruminating on this, they are encouraged to accept their practice for what it provides that day. This encouragement is designed to address beliefs that may be sustaining kinesiophobia. Each class ended with a final relaxation. Participants were provided with options to make poses more or less intense. Blocks used for pose modifications were available and modifications were demonstrated. The eight sessions were standardized for each group (i.e., session one always included the same theme and series of poses). Each class built toward a pinnacle pose, and the eight classes built in intensity so participants built their practice over time. The yoga instructor was both a registered yoga teacher and licensed clinical psychologist with experience offering evidence-based treatments for PTSD. Trauma-informed modifications included no hands-on adjustments, use of English terms for poses, and room set up that allowed for additional personal space between participants as well as the option to clearly view all entrances and exits.

Study measures

***PTSD Checklist-5* (*PCL-5*; Weathers et al., 2013).—**Presence of PTSD symptoms in the past 30 days was assessed using the PCL-5, a 20-item questionnaire corresponding to the *DSM-5* criteria for PTSD. A total symptom severity score (range 0–80) is obtained by summing all items. The PCL-5 has good psychometric properties, with high test-retest reliability (r = .82), and convergent validity ((r's = .74 to .85; Blevins, Weathers, Davis, Witte, & Domino, 2015). Chronbach's alpha in the present study was high (α = .94). Cluster scores were also examined: intrusions (α = .86); avoidance (α = .82); negative alterations of cognitions/mood (α = .88); and arousal/reactivity (α = .85). The PCL-5 was not administered until the second cohort, resulting in a slightly lower n for this measure.

Patient Reported Outcomes Measurement Information System (PROMIS®).—The PROMIS measures are self-report measures created to assess outcomes in a psychometrically sound manner to enhance communication between clinicians and patients in research and clinical settings. They monitor three domains: physical, mental, and social health in both adult and pediatric populations. Several adult version measures from each domain was administered. The number of items in each measure is noted in the measure title. Measures were scored by obtaining a summed score for each measure. As recommended, raw scores were converted to T-scores based on the scoring tables provided. All PROMIS measures demonstrated good internal consistency, with Chronbach's alpha for all measures > .87.

***PROMIS Short Form v1.0 Anxiety—8a*. (Pilkonis et al., 2011).:** Assesses anxiety symptoms over the past seven days using a 1 to 5 Likert-type rating scale.

***PROMIS Short Form v2.0 Ability to Participate in Social Roles and Activities—6a.* (Hahn et al., 2014).:** Assesses perceived ability to perform usual activities and social roles on a 1 to 5 Likert-type scale, which is reverse scored. Higher scores indicate better ability to participate. There is no specific time frame participants are asked to consider.

***PROMIS Short Form v1.1 Anger—5a*. (Pilkonis et al., 2011).:** Assesses perceived feelings of anger over the past seven days on a 1 to 5 Likert-type scale.

***PROMIS Short Form v1.0 Depression—8a.* (Pilkonis, et al., 2011; Pilkonis, et al., 2014).:** Assesses depressive symptoms over the past seven days using a 1 to 5 Likert-type scale.

***PROMIS Short Form v1.0 Pain Intensity—3a*. (HealthMeasures, 2019).:** Assesses perceived intensity of pain over both the past seven days and at the time of completion using a 1 to 5 Likert-type scale.

***PROMIS Short Form v1.0—Pain Interference 8a*. (Amtmann et al., 2010).:** Assesses perceived consequences of pain on various life domains over the past seven days using a 1 to 5 Likert-type scale.

***PROMIS Short Form v2.0 Physical Function—4a*. (Rose, Bjorner, Becker, Fries, & Ware, 2008).:** Assesses perceived ability to perform daily activities using a 1 to 5 Likert-type scale. There is no specific time frame participants are asked to consider.

***Client Satisfaction Questionnaire-8* (Attkisson & Zwick, 1982).—**Satisfaction was measured at the end of treatment using a global measure of participant satisfaction. Although not specifically developed to measure treatment satisfaction, this measure asks participants to rate satisfaction/helpfulness on a scale of 1 to 4, with higher ratings indicating higher levels of satisfaction. It was augmented by open-ended questions to solicit qualitative feedback.

***Tampa Scale of Kinesiophobia* (TSK-11; Woby, Roach, Urmston, & Watson, 2005).—**This 11-item measure assesses pain-related fear associated with physical activity, rated on a 1 to 4 Likert-type scale, and a sum score is obtained. Higher scores indicate higher levels of kinesiophobia. The TSK-11 has demonstrated good reliability compared to the original, 17-item scale (Woby et al., 2005). Internal consistency for this measure was adequate (α = .71)

Data Analysis

Analyses were conducted using SPSS (version 26; Armonk, NY: IBM Corp.). Prior to conducting primary analyses, data was inspected for normality and outliers: all variables were normally distributed, and there were minimal outliers. The primary analysis consisted of a series of paired *t* tests, with completers only, to analyze changes in symptom scores from baseline to post-intervention. Bonferroni correction was used to adjust for multiple testing. The data was also re-analyzed with the full sample using the last-observation carry-

forward for non-completers to determine if results were maintained. Cohen's *d* was calculated for primary analyses to determine effect size estimates. Follow-up analyses were conducted to examine the separate subscales of the PCL-5 and examine the potential association of a change in kinesiophobia impacting outcome. We note that for the PROMIS measures, it is recommended that T-scores are used; thus, we present results of the *t* tests using both the raw scores and the scaled T-scores. However, for examining PROMIS measures in combination with other measures (e.g., the PCL-5), raw scores were used for these analyses (e.g., correlations).

Results

Of the 87 veterans who initially enrolled in the program, 49 completed, representing a 44% attrition rate. As detailed in Table 1, treatment completers ($n = 49$) did not significantly differ from non-completers ($n = 38$) on any demographic variables (all ps > .20), nor on any of the symptom measures (ps > .15) with the exception of anger ($p = .03$) and kinesiophobia ($p = .004$). Those who dropped out of the group reported greater anger (mean T score = 18.51, SD = 4.01) and kinesiophobia (mean = 45.77, SD = 5.40) at baseline compared to those who completed (mean T score = 16.33, SD = 4.76; mean = 41.64, SD = 6.38, respectively). The average number of sessions completers attended was 5.90 (SD = 1.58) out of 8 sessions (for Cohorts 3–10 that received the revised 8 session protocol). High levels of satisfaction were reported; on a scale of 1–4, the mean score was 3.74 (SD = .33).

Table 1 presents demographic information on the sample. Correlations of study measures at baseline are presented in Table 2. As expected, PTSD and other mental health symptom measures (anxiety, depression, and anger) were strongly, positively correlated and moderately, inversely correlated with the functional measures of social roles and physical functioning. Further, pain measures were strongly, positively correlated with PTSD and strongly, inversely correlated with the functional measures. Kinesiophobia was positively associated with pain measures and PTSD and inversely associated with the functional measures.

Detailed results of the *t* tests are presented in Table 3. While all symptom measures decreased from baseline to post-treatment and all functional measures increased, the only significant differences existed for an increase in social role functioning ($t(45) = 3.90$, $p < .001$, $d = .44$) and a decrease in PTSD symptoms ($t(33) = -2.36$, $p = .02$, $d = .38$), kinesiophobia ($t(42) = -7.46$, $p < .001$, $d = .85$), depression ($t(48) = -2.20$, $p = .03$, $d = .27$), and anxiety ($t(47) = -2.10$, $p = .04$, $d = .25$). However, the reduction in PTSD symptoms and depression and anxiety symptoms did not survive Bonferroni adjustment for multiple testing (.05/9 tests, $p = .006$). The same pattern of findings held when T-scores were analyzed (see Table 3). Analyses were also conducted with the full sample, using baseline scores for all non-completers. All results remained consistent, with significant findings remaining (see Supplemental Table 1).

Follow-up analyses of changes in PTSD symptom clusters were also conducted (presented in Table 3). Results indicated significant differences in the negative alterations of cognitions/mood symptom cluster and the arousal/reactivity symptom cluster but not the intrusions nor

the avoidance clusters. However, the significant results were not robust to multiple testing correction. Follow-up exploratory analyses to examine the potential impact of kinesiophobia as a mechanism of change in treatment outcomes were conducted by examining correlations of post-treatment and change scores in kinesiophobia and significant study outcomes (PCL-5 and social roles). Post-treatment kinesiophobia was inversely correlated with post-treatment social roles ($r = -.46$, $p = .002$), and there was a trend towards its association with lower post-treatment PCL-5 scores ($r = .32$, $p = .06$). Kinesiophobia change scores were not associated with changes in social roles ($r = -.12$, $p = .45$), PCL-5 scores ($r = .17$, $p = .35$), nor pain measure scores (intensity, $r = -.05$, $p = .76$; interference, $r = .22$, $p = .16$).

Discussion

The goal of this program evaluation was to extend the literature on yoga as an intervention for comorbid chronic pain/PTSD in a veteran population. This project evaluated the feasibility/acceptability of the intervention and examined its effects on decreasing symptoms and improving functioning. Results support the acceptability of this intervention, as participants endorsed high levels of satisfaction. With regard to feasibility, the 44% attrition rate is high, but not out of the range found in treatment programs for PTSD (Gutner, Gallagher, Baker, Sloan, & Resick, 2016). It is comparable to existing yoga studies and better than some (cf., Reinhardt et al., 2018). Such findings further support the literature that yoga is well-tolerated and acceptable to a range of populations. In our sample, participants had both PTSD and chronic pain, perhaps increasing the likelihood of attrition given increased overall severity and poorer prognosis associated with the comorbidity. However, there were no significant differences on PTSD or pain symptom severity between completers and those who dropped out. Non-completers did, however, report significantly higher levels of anger and kinesiophobia at baseline. Higher levels of anger may be associated with reduced ability to tolerate a group intervention, specifically one focused on slowing down and attending to internal processes. Likewise, individuals with higher levels of kinesiophobia are likely to be more concerned about the potential harmful effects of activity. Future studies might consider providing additional education prior to initiating a yoga group to individuals who report higher levels of anger and/or kinesiophobia to assess whether such education mitigates factors associated with attrition.

Although the interpretation of effectiveness findings related to PTSD symptom reductions should be made with caution, as results were not robust to multiple testing adjustment, the current study extends the literature on the effectiveness of yoga in the treatment of PTSD in a diverse, comorbid patient population. The lack of robust, statistically significant findings, in contrast to PTSD-only yoga programs, highlights the additional severity in a medically-complex patient population. Suggestive reductions in total PCL scores as well as on the subscales associated with negative alterations of cognitions/mood and arousal/reactivity symptoms were found without directly addressing PTSD or the antecedent trauma(s). These improvements may be attributable to the calming effects of yoga (Hurst et al., 2018). The lack of significant reductions in the other subscales may be attributable, in part, to the overlap of avoidance of PTSD triggers and pain triggers with regard to avoidance behaviors, as well as to the fact that yoga does not specifically address re-experiencing symptoms, which may require specific treatment focus. It is also possible that the Fear Avoidance

Model may have been more consistent with earlier categorizations of PTSD as an anxiety disorder, compared with the current classification of PTSD in DSM 5, and understanding of its notable heterogeneity in presentation (Friedman, 2013). The Fear Avoidance Model may therefore apply to only some individuals with PTSD. Regardless, future research will be needed to determine if these results strengthen with a better-powered sample, which would suggest that yoga may be beneficial as an initial treatment or as an adjunct treatment alongside a trauma-focused intervention.

Participants in this study also improved their social role functioning, despite the lack of significant improvement in PTSD avoidance scores. This finding deserves further exploration, particularly since it is increasingly recognized that for many, PTSD can have lingering effects on quality of life, even after symptom remission (Bryant et al., 2016). It is possible that the social engagement of participating in a yoga group, and the effects of leaving the home, may have contributed to this finding. Although this improvement occurred in the absence of comparable improvement to physical functioning, this lack of change may be explained by the measure itself, with a possible ceiling effect; alternative measures of physical functioning may be preferred. One of the primary goals of the group was to increase functioning and ability to participate fully in activities with friends and family, in which it succeeded. Future work may benefit from measuring quality of life more broadly.

Unlike some earlier studies that found significant reductions in chronic pain when yoga is provided, as measured by a visual numeric pain scale and measure of severity (Groessl et al., 2008) and a measure of back-related dysfunction (Sherman et al., 2011), this study did not. One possible reason for the lack of change is the heterogeneity of the chronic pain experienced by group members. Most published yoga interventions addressing pain have focused on lower back pain, the type of chronic pain found to be most strongly decreased by yoga in meta-analytic work on yoga and pain (Coeytaux et al., 2014). The current sample had a wide range of chronic pain issues. While more generalizable, it suggests that future research should address specific types of chronic pain and examine which are more treatment responsive. Exploration of different styles of yoga is also recommended (Groessl et al., 2019). Another reason for lack of change on pain scores may be the number of sessions in the group; previous research (Groessl et al., 2008) found that greater pain reductions resulted when participants attended more sessions, though there is an ongoing question in the literature regarding what comprises the proper “dose” of treatment needed for positive effects while also considering feasibility.

It has been proposed that it would be more efficient to treat comorbid chronic pain and PTSD in an integrative manner (Otis et al., 2009). There is reason to believe that this might be effective, as PTSD and chronic pain share symptoms and behaviors such as irritability, reactivity, isolation, depression, anxiety, vigilance, insomnia, and negative beliefs and expectations. They also share overlapping neuroanatomy and neurobiology (Scioli-Salter et al., 2015). Future research might consider whether neurobiological changes that result from treatment interventions mediate cognitive, behavioral, and symptomatic changes in pain and PTSD. Another potential advantage of yoga is that it is usually associated with wellness, which may help alleviate the stigma associated with mental health treatment participation.

The Fear Avoidance Model (Vlaeyen & Linton, 2012) provided the underlying theory for Yoga for Warriors (see Supplemental Figure 1). Consistent with this theory, kinesiophobia decreased over the course of the intervention. However, given the study design, it is unknown whether changes in kinesiophobia mediated PTSD symptom decreases and/or increased social role functioning. Further work examining kinesiophobia as a mediator will add to our understanding of the etiology of these comorbid conditions and inform future interventions.

Study findings should be considered in the context of a number of limitations, many of which inform future research directions. The primary limitation is the lack of randomization and a control group, as the initial goal was program evaluation. Groups differed in length, as cohorts one and two were offered 12 and 10-week sessions, respectively; however, the majority of participants participated in an eight-session group. Reducing the number of sessions reflected time and resource constraints. Determining the optimal “dose” of yoga is an important question for future research. Measurement of outcomes at additional time points would address the question of the appropriate “dose” of yoga for pain improvement, as well as allow for examination of the mechanism of action and maintenance of benefits after group cessation. An additional limitation is that, while inclusion criteria included an existing diagnosis of PTSD in the medical chart, this diagnosis was not formally assessed, and only self-report measures were used, as compared to diagnostic clinical interviews. As this was a clinical intervention with a program evaluation component, type and number of trauma(s) experienced (i.e. interpersonal vs. combat-related) were not assessed, nor were participants asked what concurrent treatments they were receiving. Future studies would benefit from gathering this data and examining whether these variables are associated with differential outcomes, as well as other potentially important factors such as group size and composition (e.g., sex). Finally, while the study demographics are generalizable with regard to a wider veteran population, and did not exclude other comorbid psychiatric conditions, the impact of existing comorbidities was not able to be examined; It is unknown whether treatment success would extend to a civilian population.

To our knowledge, this study represents the first attempt to treat comorbid chronic pain and PTSD with yoga overall and within a veteran population more specifically. The study extends our knowledge of treating PTSD with an integrative health approach that may prove more palatable to potential participants than trauma-focused treatment. Should future research find that yoga can successfully treat specific types of chronic pain (e.g., lower back pain) simultaneously with PTSD, such an approach would represent an integrative, highly efficient treatment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Clinical Impact Statement

This study offers support for the benefits of yoga for veterans who have both chronic pain and posttraumatic stress disorder (PTSD). Although prior studies demonstrated improvements in chronic pain or PTSD, this is the first to consider the effects of yoga when both conditions are present. After the intervention, veterans reported reductions in PTSD symptoms, less fear of physical activity, and improved ability to participate in activities with family and friends. Veterans also reported high levels of satisfaction with the program, suggesting it may be possible to use yoga more widely with veterans who have both chronic pain and PTSD.

Table 1.

Demographic characteristics of full sample (N = 87), completer sample (n = 49), and non-completer sample (n = 38).

	Full sample	Completer sample	Non-completer sample	
Variable	**N (%)/Mean (SD)**	**N (%)/Mean (SD)**	**N (%)/Mean (SD)**	***p*-value***
Demographic information				
Age	50.33 (11.32)	51.41 (10.42)	48.95 (12.38)	.32
Sex (ref: male)	54 (62.1)	30 (61.2)	24 (63.2)	.85
Race				.15
White/European American	20 (23.5)	10 (20.8)	10 (27.0)	
Black/African American	58 (68.2)	33 (68.8)	25 (67.6)	
Other	7 (8.3)	5 (10.4)	2 (5.3)	
Marital Status				.40
Married/partnered	48 (55.8)	27 (55.1)	21 (55.3)	
Divorce/separated	21 (24.4)	9 (18.4)	12 (31.6)	
Widowed	2 (2.3)	2 (4.1)	0 (0)	
Never married	15 (17.2)	10 (20.4)	5 (13.2)	
Working Status (ref: not working)	61 (70.9)	37 (75.5)	24 (64.9)	.28
Clinical Measures at Baseline				
Functional measures				
Social Roles T score	41.36 (5.45)	41.20 (5.39)	41.11 (5.84)	.94
Physical Functioning T score	41.60 (7.23)	41.60 (7.29)	38.95 (6.05)	.08
Pain measures				
Pain Interference T score	60.93 (7.39)	60.93(7.39)	63.79 (6.78)	.07
Pain Intensity T score	51.07 (7.02)	51.20 (7.01)	53.80 (8.23)	.12
PTSD	47.79 (15.38)	44.97 (15.47)	51.48 (14.71)	.09
Other mental health measures				
Anger T score	61.83 (10.73)	61.83 (10.73)	66.23 (10.07)	.04
Depression T score	59.16 (8.75)	59.16 (8.75)	24.67 (7.12)	.08
Anxiety T score	63.04 (7.93)	63.22 (7.95)	24.86 (6.11)	.23
Kinesiophobia	43.33 (6.30)	41.64 (6.38)	45.77 (5.40)	.004

Note:

* = p value for t-tests comparing completers to non-completers. All PROMIS measures are reported as T scores, per recommendations.

Table 2.

Correlations of study measures at baseline in full sample (N = 87).

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Social Roles	--								
2. Physical Functioning	.43**	--							
3. Pain Interference	−.58**	−.69**	--						
4. Pain Intensity	−.31**	−.56**	.75**	--					
5. PTSD	−.39**	−.39**	.50**	.42**	--				
6. Anger	−.21	−.30**	.36**	.25*	.63**	--			
7. Depression	−.48**	−.37**	.53**	.35**	.64**	.61**	--		
8. Anxiety	−.45**	−.27*	.39**	.18	.63**	.52**	.85**	--	
9. Kinesiophobia	−.45**	−.50**	.52**	.33**	.42**	.33**	.48**	.46**	--

Note:

* = p > .05,

** = p > .01. The PROMIS measures are reported in raw scores, not T-scores

Table 3.

Pre-post t-test results, in the completer sample (n = 49). Raw sum score results are first presented; for PROMIS measure items, T-score results are presented directly below in italics.

	Pre-Test Mean (SD)	**Post-Test Mean (SD)**	***t* (post-test – pre-test)**	***df***	***p***	**Cohen's *d***
Social Roles	15.57 (4.44)	17.52 (4.52)	3.90	45	**<.001**	.44
T-score	*41.36 (5.45)*	*43.92 (5.94)*	*5.01*		***< .001***	
Phys. Functioning	14.63 (3.82)	14.94 (3.37)	.80	48	.43	.09
T-score	*41.60 (7.23)*	*41.32 (5.81)*	*−.38*		*.71*	
Pain Interference	24.06 (8.11)	23.02 (7.80)	−1.14	48	.26	.13
T-score	*60.93 (7.39)*	*60.20 (6.67)*	*−.89*		*.38*	
Pain Intensity	8.75 (2.35)	8.70 (2.24)	−.18	47	.86	.02
T-score	*51.07 (7.02)*	*50.73 (6.41)*	*−.32*		*.75*	
PTSD total	43.88 (14.04)	38.41 (14.60)	−2.36	33	**.02**	.38
Re-experiencing	11.67 (4.22)	10.50 (4.46)	−1.66	35	.11	.27
Avoidance	4.66 (2.04)	4.13 (2.32)	−1.67	37	.10	.24
Neg. cog/mood	14.19 (5.65)	12.11 (5.88)	−3.98	36	**.03**	.36
Hyperarousal	13.65 (5.01)	11.89 (5.05)	−3.33	36	**.03**	.35
Anger	16.33 (4.76)	15.35 (4.22)	−1.57	47	.12	.22
T-score	*61.83 (10.73)*	*59.67 (9.24)*	*−1.55*		*.13*	
Depression	21.63 (7.61)	19.71 (6.57)	−2.20	48	**.03**	.27
T-score	*59.16 (8.75)*	*57.84 (7.02)*	*−1.36*		*.18*	
Anxiety	24.67 (6.78)	23.04 (6.47)	−2.10	47	**.04**	.25
T-score	*63.04 (7.93)*	*61.38 (7.16)*	*−1.97*		*.06*	
Kinesiophobia	41.86 (6.45)	36.63 (5.81)	−7.46	42	**< .001**	.85

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