

## Yoga for Adult Women with Chronic PTSD: A Long-Term Follow-Up Study

Alison Rhodes, PhD,<sup>1,2</sup> Joseph Spinazzola, PhD,<sup>1</sup> and Bessel van der Kolk, MD<sup>1</sup>

### Abstract

**Introduction:** Yoga—the integrative practice of physical postures and movement, breath exercises, and mindfulness—may serve as a useful adjunctive component of trauma-focused treatment to build skills in tolerating and modulating physiologic and affective states that have become dysregulated by trauma exposure. A previous randomized controlled study was carried out among 60 women with chronic, treatment-resistant post-traumatic stress disorder (PTSD) and associated mental health problems stemming from prolonged or multiple trauma exposures. After 10 sessions of yoga, participants exhibited statistically significant decreases in PTSD symptom severity and greater likelihood of loss of PTSD diagnosis, significant decreases in engagement in negative tension reduction activities (e.g., self-injury), and greater reductions in dissociative and depressive symptoms when compared with the control (a seminar in women’s health). The current study is a long-term follow-up assessment of participants who completed this randomized controlled trial.

**Methods:** Participants from the randomized controlled trial were invited to participate in long-term follow-up assessments approximately 1.5 years after study completion to assess whether the initial intervention and/or yoga practice after treatment was associated with additional changes. Forty-nine women completed the long-term follow-up interviews. Hierarchical regression analysis was used to examine whether treatment group status in the original study and frequency of yoga practice after the study predicted greater changes in symptoms and PTSD diagnosis.

**Results:** Group assignment in the original randomized study was not a significant predictor of longer-term outcomes. However, frequency of continuing yoga practice significantly predicted greater decreases in PTSD symptom severity and depression symptom severity, as well as a greater likelihood of a loss of PTSD diagnosis.

**Conclusions:** Yoga appears to be a useful treatment modality; the greatest long-term benefits are derived from more frequent yoga practice.

### Introduction

**P**OST-TRAUMATIC STRESS DISORDER (PTSD) is a common and chronic condition affecting women at a rate over double that in men (rates of 11.7% and 4.0%, respectively).<sup>1</sup> Women are more likely than men to be exposed to recurring interpersonal violence perpetrated by intimates in childhood and adulthood, such as domestic violence and childhood sexual abuse.<sup>2</sup> PTSD associated with recurring trauma exposure is especially challenging to treat given that this population often faces significant problems beyond PTSD.<sup>3–5</sup> Indeed, research consistently links repeated trauma exposure with a complex constellation of symptoms, including impulsive or aggressive behavior, self-injurious behaviors, anxious arousal, mood disturbances, and dissociative symptoms.<sup>3,6,7</sup> At the core of these problems are self-regulatory deficits.<sup>3</sup>

Difficulties with affect and impulse regulation pose significant challenges for survivors of repeated trauma to tolerate traditional treatment modalities (e.g., cognitive and exposure-based treatments), as evidenced by high rates of drop-out from treatment, PTSD symptom exacerbation during treatment, and worsening symptoms following treatment.<sup>8–13</sup> Essential to the resolution of PTSD and related mental health problems is the extinction of the conditioned fear response. This requires that survivors of recurring trauma learn to stay oriented in the present moment and manage powerful emotions and impulsive reactions that arise in the context of trauma reminders.<sup>14</sup>

Mind-body-oriented therapies such as yoga—the integrative practice of physical postures and movement, breath exercises, and mindfulness—improve self-regulation and the ability to stay focused on present experiences.<sup>15–17</sup> Therefore,

<sup>1</sup>The Trauma Center at Justice Resource Institute, Brookline, MA.

<sup>2</sup>Tufts University Counseling and Mental Health Services, Medford, MA.

they may be a useful component of treatment in survivors of recurring interpersonal trauma.<sup>18,19</sup> Moreover, the direct effect of yoga practice on the stress response system (including downregulation of the hypothalamus-pituitary-adrenal axis and the sympathetic nervous system<sup>15</sup>) could reduce PTSD symptoms and associated problems stemming from prolonged traumatic exposure. In fact, many studies have shown that yoga may be effective in the treatment of a range of mental health problems, including PTSD, anxiety, and depression.<sup>20–23</sup> Furthermore, yoga is a popular activity among women in the general population, making it a feasible and accessible treatment choice.<sup>24</sup> Within this area of study, van der Kolk and colleagues carried out a randomized controlled trial (RCT)<sup>23</sup> assessing the effectiveness of 10 weeks of yoga classes (one per week) for women with chronic, treatment-unresponsive PTSD,\* all with histories of exposure to prolonged interpersonal trauma (e.g., physical abuse, sexual abuse, neglect, domestic violence). They found that yoga was significantly more effective than an attentional control (a seminar on women's health) for reducing symptom severity of PTSD and the likelihood of meeting diagnostic criteria for PTSD. The yoga group also showed greater decreases than the control group in symptoms of depression, dissociation, and engagement in negative tension-reducing activities (e.g., self-injury).

The current study is a long-term follow-up among the women who completed van der Kolk and colleagues' RCT.<sup>23</sup> The goal was to examine whether there are greater changes in long-term mental health outcomes (i.e., PTSD diagnosis and symptom severity, depression symptom severity, dissociative symptom severity, and engagement in tension-reducing activities) for yoga participants versus attentional controls. Additionally, the present study tested the hypothesis that frequency of yoga practice after the study will significantly influence long-term outcomes.

## Materials and Methods

### Participants and procedure

Beginning in 2008, six cohorts completed the yoga RCT<sup>23</sup> during the course of 3 years: three yoga groups ( $n = 31$ ) and three control groups ( $n = 29$ ). Details on recruitment for the original study and the interventions used are described in detail elsewhere.<sup>23</sup> After completing the yoga classes or the women's health seminar, participants were able to join the following cohort in the opposite intervention. For the current study, after institutional review board approval, attempts were made to contact all participants who completed the RCT to invite them to come in to complete the same measures used in the RCT and an additional self-report measure on the frequency of yoga practice since they were last interviewed and any treatment changes that may have occurred.

\*PTSD was established in a screening assessment utilizing the Clinician Administered PTSD Scale and the CAPS F1/I2/Sev65 scoring rules.<sup>26</sup> Chronicity was based on meeting criteria for PTSD in relation to an index trauma that occurred at least 12 years before intake. Treatment unresponsiveness was determined by participants having had at least 3 years of prior psychotherapy treatment focused on trauma issues.

Forty-nine of the 60 original participants completed long-term follow-ups. Independent  $t$  tests were run to assess whether there were any significant differences between those who came in for the long-term follow-up and those who were lost to follow-up in terms of demographic variables and baseline measures of severity of PTSD symptoms, depression symptoms, dissociative symptoms, and problems with tension-reducing activities. No significant differences were found between the two groups on these measures. Table 1 shows demographic characteristics of participants who completed the long-term follow-up.

Participants in the long-term follow up included 26 women from the original study initially randomly assigned to the yoga intervention, 16 assigned to the attentional control group (women's health seminar), and 7 assigned to the control group, who subsequently elected to enroll in a nonrandomized "second round" of the yoga intervention following completion of the attentional control protocol. Long-term follow-up interviews were carried out over 6 months. Depending on which cohort the participants were part of and when they were able to come in for the long-term assessment, there was variability in how long the participants had been out of the RCT at the follow-up assessment (ranging from 0.75 to 2.75 years). Participants were asked not to disclose what treatment group they were in during the RCT or whether they had practiced yoga after treatment until other measures were completed so that the interviewer could remain blind during assessment.

### Measures

**Clinician Administered PTSD Scale (CAPS).** The CAPS is a structured interview assessing the frequency and intensity of the 17 symptoms of PTSD in the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, as experienced in the past month. Each symptom is rated 0–4 for frequency and intensity separately. The scale demonstrates high inter-rater reliability and high internal consistency and correlates highly with other measures of PTSD symptoms.<sup>25</sup> The CAPS F1/I2/Sev65 scoring rules were used to determine whether the participant qualified for PTSD diagnosis at the time of the long-term follow-up.<sup>26</sup> Total CAPS scores at baseline and at the long-term follow-up were used to calculate changes in PTSD symptom severity.

**Dissociative Experiences Scale (DES).** The DES is a 28-item self-report instrument measuring a variety of dissociative experiences, such as "highway hypnosis" and derealization. For each item, participants note how often this happens to them on a scale of 10-point increments ranging from 0 (never) to 100

TABLE 1. DEMOGRAPHIC CHARACTERISTICS

Variable	Data
Race: white (%)	71.4
Marital status: single (%)	46.9
College graduate (%)	71.4
Annual income <\$40,000 (%)	46.9
Employment: full-time (%)	38.8
Mean age $\pm$ SD (y)	42.8 $\pm$ 11.8

SD, standard deviation.

(always). The DES score is calculated as a percentage. The measure shows good test-retest reliability, high internal consistency, and excellent construct validity.<sup>27</sup>

**Beck Depression Inventory (BDI).** The BDI is a 21-item self-report measure assessing the severity of a range of depressive symptoms. Each item has an answer choice ranging from 0 to 3, on a spectrum of less severe to more severe. The measure is scored as the sum of the answers, with higher scores indicating greater depression severity. This measure has high internal reliability, construct validity, and test-retest reliability.<sup>28</sup>

**Inventory of Altered Self Capacities Tension Reduction Activities (IASC-TRA) Subscale.** The IASC is a 63-item self-report measure assessing psychological functioning along seven subscales, including the TRA subscale, which identifies the tendency to respond to internal stress with problematic externalizing behaviors that distract, soothe, or reduce negative internal experiences (i.e., self-injury, sexual activity, food binging). This subscale demonstrates good internal consistency, reliability, and validity.<sup>29</sup>

**Stressful Life Events Screening Questionnaire (SLESQ).** Research shows an association between the number of trauma types experienced and symptom complexity and severity.<sup>30,31</sup> Therefore, the current study controlled for cumulative trauma exposure. The current study used a total score of event exposure from the SLESQ, which is a 13-item clinician-administered questionnaire assessing for lifetime exposure to various traumatic events (e.g., life-threatening accident, physical or sexual abuse, witnessing another person being killed or assaulted). The measure demonstrates good test-retest reliability and adequate convergent validity.<sup>32</sup>

*Data analytic approach*

Dependent variables for all continuous measures were calculated as a measure of change from participants' scores at baseline to participants' scores at the long-term follow-up. Because all participants met diagnostic criteria for PTSD at baseline to qualify for the RCT, this measure was assessed as a dichotomous variable (1 = met PTSD criteria at long-term follow-up; 0 = did not meet PTSD criteria at long-term follow-up). Table 2 shows descriptive data for the measures.

The seven participants randomly assigned to the attentional control condition who elected to enroll in a non-randomized second round of yoga intervention following completion of the control group were compared with the cohort of randomly assigned ("first round") yoga participants on long-term study outcomes. This comparison sought to assess whether the former subset of yoga participants were differentially affected by study procedures and consequently performed differently on study outcomes than first-round yoga participants. Statistical analyses comparing mean change scores on all study outcomes measures revealed no significant differences between first- and second-round yoga participants. Accordingly, all yoga participants were collapsed into a single group to maximize power in regression analyses testing primary study hypotheses. Henceforth, participants who completed the yoga protocol as part of the RCT (both first- and second-round participants)

TABLE 2. DESCRIPTIVE DATA FOR STUDY MEASURES

Variable	Participants (n) or n (%)	Mean ± SD	Range
SLESQ score	49	8.4 ± 2.3	2–15
Time since RCT (y)	49	82.7 ± 26	39–143
Estimated no. of times participant practiced yoga after RCT	49	41.1 ± 57.2	0–275
Frequency yoga practice after RCT	49	1.9 ± .61	1–3
CAPS score			
Baseline CAPS (PTSD)	49	73.8 ± 12.9	52–101
Long-term follow-up CAPS	49	50.8 ± 24.6	11–105
Change in CAPS	49	23** ± 21	–17 to 59
DES score			
Baseline DES (dissociation)	48	16.9 ± 12.1	1.4–60.4
Long-term follow-up DES	48	15.5 ± 12.2	2.1–46.1
Change in DES	47	1.4 ± 11.4	–35.7 to 20.4
BDI score			
Baseline BDI	47	23 ± 11.6	6–51
Long-term follow-up BDI	48	14.9 ± 11.8	0–46
Change in BDI	48	8.6 <sup>a</sup> ± 11.6	–13 to 39
IASC-TRA score			
Baseline IASC-TRA	44	16.2 ± 4.1	10–29
Long-term follow-up IASC-TRA	49	13.2 ± 3.5	9–24
Change in IASC-TRA	44	3.0 <sup>a</sup> ± 3.5	–4 to 9
Treatment changes	49 (100)		
Yes	29 (59)		
No	20 (41)		
Participated in yoga group during RCT	49 (100)		
Yes	33 (67)		
No	16 (33)		
Long-term follow-up PTSD diagnosis present	49 (100)		
Yes	21 (43)		
No	28 (57)		

<sup>a</sup>p < 0.001.

SLESQ, Stressful Life Events Screening Questionnaire; RCT, randomized controlled trial; CAPS, Clinician Administered PTSD Scale; PTSD, post-traumatic stress disorder; DES, Dissociative Experiences Scale; BDI, Beck Depression Inventory; IASC-TRA, Inventory of Altered Self Capacities Tension Reduction Activities.

are referred to as being in the yoga group. Those who completed only the women's health seminar during the RCT and did not participate in yoga during the RCT, even if they chose to pursue the practice of yoga after completion of the study, are referred to as being in the control group.

A questionnaire was administered to gather information on potential treatment changes since the RCT ended, including questions on whether the participant began seeing a new therapist, attended a support group, started new medication, or received any other new type of treatment or body work (e.g., acupuncture, massage, neurofeedback, eye movement desensitization and reprocessing). If the participant answered yes to any the questions, the variable was coded as 1. No treatment changes were coded as 0.

Participants self-reported the number of times they practiced yoga after the study. Because frequency of yoga practice

TABLE 3. CORRELATION MATRIX OF YOGA PRACTICE, GROUP STATUS, TREATMENT CHANGES, AND TRAUMA SYMPTOMS

Variable	1	2	3	4	5	6	7	8
1. SLESQ	1							
2. Treatment changes	-0.042	1						
3. RCT group status	-0.086	-0.136	1					
4. Frequency yoga after RCT	0.147	-0.056	0.313 <sup>a</sup>	1				
5. Change in CAPS	-0.109	-0.205	-0.169	0.236	1			
6. Change in DES	-0.209	-0.068	-0.111	-0.019	0.258	1		
7. Change in BDI	0.014	-0.234	-0.050	0.348 <sup>a</sup>	0.455 <sup>b</sup>	0.085	1	
8. Change in IASC-TRA	0.047	-0.440 <sup>b</sup>	0.030	0.021	0.192	0.480 <sup>b</sup>	0.453 <sup>b</sup>	1
9. LTFU PTSD diagnosis present	0.134	0.216	-0.013	-0.283 <sup>a</sup>	-0.624 <sup>b</sup>	-0.217	-0.208	-0.149

<sup>a</sup> $p < 0.05$ .

<sup>b</sup> $p < 0.01$ .

LTFU, measure at long-term follow-up interview.

after the study was partially dependent on how long the participant had been out of the original study (ranging from 39 to 143 weeks), a ratio variable was created (number of times the participant practiced yoga divided by the number of weeks that had passed since study completion). The variable was positively skewed, and it was recoded into an ordinal variable (1 = no practice after the study; 2 = practiced with a frequency less than an average of one time per week after the study; 3 = practiced more than one time per week on average after the study). This new ordinal variable was normally distributed.

Bivariate correlation analyses among study variables were calculated (Table 3). Hierarchical linear regression analysis was used to examine whether treatment group status in the original RCT and frequency of yoga practice after the study predicted changes in PTSD symptoms, depressive symptoms, dissociative symptoms, or tension-reducing activities from baseline measures to the time of the long-term follow-up assessment while controlling for extent of trauma exposure and other treatment changes. Variables were entered in blocks in the following order: (1) lifetime exposure to traumatic events (SLESQ), (2) whether the participant had any treatment changes since the study ended, (3) treatment group status in the original study (i.e., yoga or control only), and (4) frequency of yoga practice after the study. By entering variables in the same blocks, hierarchical logistic regression was used to test whether group status and frequency of yoga practice after the treatment predicted PTSD diagnosis.<sup>26</sup>

A small amount of missing data appeared at random. Missing data were addressed in the following manner. If an entire measure was missing for a given participant or if more than five items within a given measure were missing, no data were imputed for that participant and the participant's responses were not included in the analysis for that specific outcome measure. For participants for whom fewer than five items were missing, missing values for the imputed item were imputed by carrying forward the last observation for that item. The approach taken was considered the most conservative way to impute missing data but could have underestimated potential change (SPSS Statistics for Windows, Version 21.0. IBM Corp. Released 2012. Armonk, NY: IBM Corp.).

## Results

### Long-term yoga practice descriptors

Following completion of the original study, the majority ( $n = 39$ ) of participants continued or began to practice yoga.

Twenty-three of 26 women randomly assigned to the yoga treatment group continued to practice yoga. Nine of 16 women who completed only the attentional control condition went on to practice yoga, and all 7 participants who elected to enroll in the yoga intervention following randomization to the control condition practiced yoga after the study. Participants' yoga practices ranged in frequency from a few practices up through approximately 275 yoga sessions. They practiced in a range of settings, including at home using a yoga DVD or doing self-guided practices based on what they had learned in classes, and in yoga classes at gyms and yoga studios.

### Bivariate analyses

As indicated in Table 3, bivariate correlation analyses showed that group status in the original study was not significantly associated with any of the outcome variables. Bivariate analysis did indicate, however, that a greater frequency of yoga practice after the study was significantly associated with loss of PTSD diagnosis ( $r = -0.283$ ;  $p < 0.05$ ) and with decreases in depression symptom severity ( $r = 0.348$ ;  $p < 0.05$ ).

### Regression analyses

Hierarchical regression analysis yielded three significant models: decreases in PTSD symptom severity, likelihood of loss of PTSD diagnosis, and decreases in depression symptom severity. No predictors were significant in the models predicting dissociation or tension-reducing activities. Table 4 shows results of hierarchical regression analysis for changes in PTSD symptom severity from baseline to the long-term follow-up interview. None of the variables entered in the first three steps were significant predictors, but frequency of yoga practice after the study significantly added to the model (change in  $R^2$  was 0.11;  $p < 0.05$ ). Greater frequency of yoga practice was associated with greater decreases in PTSD symptom severity from baseline to the long-term follow-up ( $b = 12.24$ ;  $p < 0.05$ ). Additionally, when frequency of yoga practice was added to the model, study group status became significant in the direction of non-yoga attentional control participations exhibiting greater long-term decreases in PTSD symptom severity.

Group differences in post-study frequency of yoga practice were examined post hoc by using independent-sample  $t$  tests. The  $t$  tests were used to compare total practice after

TABLE 4. HIERARCHICAL LINEAR REGRESSION ANALYSIS: PREDICTORS OF CHANGES IN PTSD SYMPTOM SEVERITY (CAPS)

Variable	<i>b</i>	$\beta$	SEB	p-Value
<b>Step 1</b>				
(Constant)	29.43		9.15	0.002
SLESQ	-0.766	-0.109	1.022	0.457
	$R^2 = 0.01$			
	$R^2_{adj} = -0.01$			
	$F(1/47) = .56, p = 0.46$			
<b>Step 2</b>				
(Constant)	35.23		9.87	0.001
SLESQ	-0.829	1.010	-0.118	0.416
Treatment changes	-8.898	6.077	-0.210	0.150
	$R^2 = 0.06$			
	$R^2_{adj} = 0.02$			
	$F(2/46) = 1.4, p = 0.27$			
<b>Step 3</b>				
(Constant)	43.50		11.22	0.000
SLESQ	-0.966	-0.137	1.002	0.340
Treatment changes	-10.155	-0.240	6.059	0.101
RCT group status	-9.449	-0.213	6.368	0.145
	$R^2 = 0.1$			
	$R^2_{adj} = 0.04$			
	$F(3/45) = 1.7, p = 0.19$			
<b>Step 4</b>				
(Constant)	26.66		12.62	0.040
SLESQ	-1.41	-0.199	0.966	0.153
Treatment changes	-10.09	-0.238	5.74	0.086
RCT group status	-14.61	-0.329	6.38	0.027
Frequency yoga practice after RCT	12.24	0.355	4.94	0.017
	$R^2 = 0.21$			
	$R^2_{adj} = 0.14$			
	$F(4/44) = 2.92, p < 0.05$			

SEB, Standard Error of Beta.

treatment, as well as to compare the ratio variable that was created as a measure of the average frequency of practice after the RCT that took into account the variability in time passed after treatment. No significant difference was found between yoga and control groups on total frequency of post-study yoga practice (yoga: mean  $\pm$  standard deviation, 47.18  $\pm$  58.71; control: 28.53  $\pm$  53.59;  $t = 1.07$ ;  $p = 0.29$ ). A nonsignificant trend was observed in the direction of higher frequency of post-study yoga practice in the yoga group when time elapsed was taken into account (yoga: 2.09  $\pm$  0.52; control: 1.69  $\pm$  0.70;  $t = 2.04$ ;  $p = 0.053$ ).

Table 5 shows the results of hierarchical logistic regression for predictors of PTSD diagnosis. None of the variables significantly predicted PTSD diagnosis in the first three steps. However, when frequency of yoga practice was added to the model, the model was significant (chi-square (4) = 9.87;  $p < 0.05$ ). Those who practiced yoga more frequently were less likely to meet diagnostic criteria for PTSD ( $b = -1.579$ ; odds ratio, 0.21;  $p < 0.05$ ).

Table 6 shows the results of hierarchical regression analysis for changes in depression symptom severity. The extent of the participant's trauma history, treatment changes, and group status in the RCT were not significant predictors of changes in depression symptom severity from baseline to the long-term follow-up. However, frequency of yoga practice after the RCT significantly added to the model

(change in  $R^2$ , 0.15;  $p < 0.01$ ), with greater frequency of practice associated with a greater decreases in depression symptom severity ( $b = 7.84$ ;  $p < 0.01$ ).

**Discussion**

The present study further supports the utility of yoga as a component of intervention for women with histories of chronic, treatment-resistant PTSD associated with extensive histories of exposure to interpersonal victimization. Specifically, findings from this study suggest that more frequent yoga practice over extended periods may augment and sustain decreases in symptoms of both PTSD and depression. These findings are particularly promising given that the study population reported persistent mental health problems related to traumatic stressors despite having been in trauma-focused psychotherapy for at least 3 years. Many participants had little relief from their symptoms before engagement in yoga practice during or following study participation.

Participation in the yoga intervention condition during the original study did not have an independent effect on long-term outcomes. This may perhaps be explained by an unexpected byproduct of the study. Namely, most study participants, irrespective of group assignment, elected to continue or initiate yoga practice following cessation of the study, making it

TABLE 5. HIERARCHICAL LOGISTIC REGRESSION ANALYSIS: PREDICTORS OF PTSD DIAGNOSIS (CAPS)

Variable	<i>b</i>	<i>SEB</i>	<i>OR</i>	<i>p-Value</i>
Step 1				
(Constant)	-1.072	0.899	0.342	0.233
SLESQ	0.092	0.099	1.097	0.354
			Chi-square=0.878, df=1, <i>p</i> =0.35	
Step 2				
(Constant)	-1.778	1.058	0.169	0.093
SLESQ	0.106	0.104	1.112	0.310
Treatment changes	0.967	0.624	2.630	0.121
			Chi-square(2)=3.39, <i>p</i> =0.183	
Step 3				
(Constant)	-1.896	1.200	0.150	0.114
SLESQ	0.108	0.105	1.114	0.303
Treatment changes	0.985	0.631	2.678	0.118
RCT group status	0.135	0.643	1.145	0.834
			Chi-square(3)=3.44, <i>p</i> =0.329	
Step 4				
(Constant)	-0.327	1.426	0.721	0.819
SLESQ	0.200	0.126	1.222	0.113
Treatment changes	1.227	0.702	3.409	0.081
RCT group status	0.912	0.789	2.488	0.248
Frequency yoga practice after RCT	-1.579	0.695	0.206	0.023
			Chi-square(4)=9.87, <i>p</i> <0.05	

OR, odds ratio.

TABLE 6. HIERARCHICAL REGRESSION ANALYSIS: PREDICTORS OF DEPRESSION SYMPTOM SEVERITY (BDI)

Variable	<i>b</i>	$\beta$	<i>SEB</i>	<i>p-Value</i>
Step 1				
(Constant)	8.164		5.088	0.115
SLESQ	0.055	0.014	0.571	0.924
		$R^2=0.00$		
		$R^2_{adj}=-0.02$		
		$F(1/46)=0.009, p=0.92$		
Step 2				
(Constant)	11.782		5.485	0.037
SLESQ	0.002	0.001	0.563	0.997
Treatment changes	-5.442	-0.234	3.383	0.115
		$R^2=0.06$		
		$R^2_{adj}=0.01$		
		$F(2/45)=1.3, p=0.28$		
Step 3				
(Constant)	13.705		6.411	0.038
SLESQ	-0.035	-0.009	0.570	0.952
Treatment changes	-5.761	-0.247	3.450	0.102
RCT group status	-2.141	-0.088	3.620	0.557
		$R^2=0.06$		
		$R^2_{adj}=-0.002$		
		$F(3/44)=0.97, p=0.42$		
Step 4				
(Constant)	3.058		6.999	0.664
SLESQ	-0.326	-0.084	0.538	0.547
Treatment changes	-5.784	-0.248	3.196	0.077
RCT group status	-5.512	-0.226	3.553	0.128
Frequency yoga practice after RCT	7.841	0.417	2.727	0.006
		$R^2=0.21$		
		$R^2_{adj}=0.14$		
		$F(4/43)=2.9, p<0.05$		

difficult to isolate effects uniquely attributable to the initial randomization to the yoga intervention group.

Interestingly, group status was significant in predicting decreases in PTSD symptom severity, but only when frequency of yoga practice after the RCT was factored into the model. In this case, those in the control group showed greater long-term decreases in PTSD symptom severity than those who participated in the active treatment condition. This could indicate some interaction between treatment group status and continuing yoga practice; however, small sample size constraints prohibited true tests of interaction effects within the regression models. Results suggested that the treatment group went on to practice marginally more frequently than did the control group. Findings here are equivocal. They could indicate that the shift from no yoga practice in the control condition to some post-study practice was associated with a greater influence on long-term symptom reduction than was accomplished by continued post-study yoga practice by participants who received the active yoga intervention. Another possible explanation was that there was some added benefit of completing the control condition and then going on to practice yoga. Further research would be needed to ascertain the meaning of this finding. The extent of trauma exposure and treatment changes did not significantly predict changes in symptoms from baseline to the long-term follow-up. However, the measures used may not have been robust enough to detect change. Although the number of traumatic events a person is exposed predicts symptom complexity and frequency, other factors, such as who perpetrated violence or the type of trauma that the individual was exposed to, may also be relevant.<sup>30,31</sup> Given the small sample size in the current study, and the associated need to limit the number of control variables that were included in the analysis, it was impossible to include a more complex representation of trauma history. Similarly, some treatment changes may have had a greater effect on symptoms than others, but this level of complexity was not possible to control for in the current study.

Another limitation in the current study is that several measures were based on self-report. There may have been some error in participants' reports of frequency of their yoga practices. Altering this variable into an ordinal measure that considered frequency as an estimation of average practice over time likely helped address some inflation or underestimation of reporting that may have occurred. However, additional research that more systematically monitors the frequency of participants' yoga practices over time is warranted.

The current study raises questions about why a greater frequency of yoga practice helps improve PTSD and depression, but not dissociation or engagement in tension-reducing activities. It is unclear whether yoga is most beneficial in addressing certain types of symptoms or if other factors may account for this finding. Perhaps individuals who struggled more with these particular problems were less capable of engaging in an ongoing way with yoga. This would be consistent with prior studies documenting higher treatment dropout rates among trauma survivors with more severe affect dysregulation.<sup>8</sup> Additional research exploring survivors' experiences of practicing yoga and reasons for sustaining or ending their engagement with yoga could help shed light on this.

It remains unclear precisely how much yoga practice is needed to achieve or maintain benefits. More systematic,

controlled research should seek to ascertain the necessary "dosage" of practice to achieve improved functioning. Additionally, this study did not consider the variations in lengths of practice sessions, and it is unclear whether the length of practice matters. It would also be useful to consider whether the optimal dosage varies with the extent or nature of the participants' trauma history or posttraumatic symptoms and conditions. Finally, this study was unable to examine whether practice setting or style of yoga practice (e.g., vigorous versus gentle) influences mental health outcomes; it is possible, for example, that certain types of yoga or even certain postures may be more beneficial for alleviating particular symptoms or conditions than others.

While additional research is needed, the current study offers strong support for yoga practice as a complement to therapeutic intervention for women struggling with the legacy of prolonged interpersonal trauma. Moreover, it contributes meaningfully to the limited empirical knowledge base on the longer-term mental health effects of sustained yoga practice. Given the low cost of yoga, its wide popularity,<sup>33</sup> and relative ease of access to community-based classes, exploring opportunities with trauma survivors to add yoga to their overall arsenal of healing and wellness practices would seem to be a compelling avenue for therapeutic attention. If yoga practice is ultimately undertaken by trauma survivors in a measured and sustained manner, it may offer potentially substantial benefits.

#### Acknowledgments

The authors thank Kelley Durham for her assistance in data collection in this study.

#### Author Disclosure Statement

No competing financial interests exist.

#### References

1. Kessler RC, Petukhova M, Sampson NA, et al. Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *Int J Methods Psychiatr Res* 2012;21:169–184.
2. Coid J, Petrukevitch A, Feder G, et al. Relation between childhood sexual and physical abuse and risk of revictimisation in women: a cross-sectional survey. *Lancet* 2001;358:450–445.
3. Cloitre M, Stolbach BC, Herman JL, et al. Developmental approach to complex PTSD: childhood and adult cumulative trauma as predictors of symptom complexity. *J Trauma Stress* 2009;22:399–408.
4. Courtois CA. Complex trauma, complex reactions: assessment and treatment. *Psychother Theor Res Pract Train* 2004; 41:412–425.
5. van der Kolk BA. The body keeps the score: memory and the emerging psychobiology of posttraumatic stress. *Harv Rev Psychiatry* 1994;1:253–265.
6. Pelcovitz D, van der Kolk BA, Roth S, et al. Development of a criteria set and a structures interview for disorders of extreme stress. *J Trauma Stress* 1997;10:3–17.
7. van der Kolk BA, Roth S, Pelcovitz D, et al. Disorders of extreme stress: the empirical foundation of a complex adaptation to trauma. *J Trauma Stress* 2005;18:389–399.
8. Ford JD, Kidd P. Early childhood trauma and disorders of extreme stress as predictors of treatment outcome with chronic PTSD. *J Trauma Stress* 1998;18:743–761.

9. Ladwig KH, Marten-Mittag B, Deisenhofer I, et al. Psychophysiological correlates of peritraumatic dissociative responses in survivors of life-threatening cardiac events. *Psychopathology* 2002;35:241–248.
10. McDonagh-Coyle A, Friedman M, McHugo G, et al. Randomized trial of cognitive-behavioral therapy for chronic posttraumatic stress disorder in adult female survivors of childhood sexual abuse. *J Consult Clin Psychol* 2005;73:515–524.
11. Michelson L, June K, Vives A, et al. The role of trauma and dissociation in cognitive-behavioral psychotherapy outcome and maintenance for panic disorder with agoraphobia. *Behav Res Ther* 1998;36:1011–1050.
12. TARRIER N, Pilgrim H., Sommerfield C, et al. A randomized trial of cognitive therapy and imaginal exposure in the treatment of chronic posttraumatic stress disorder. *J Consult Clin Psychol* 1999;67:13–18.
13. Zayfert C, Deviva JC, Becker CB, et al. Exposure utilization and completion of cognitive behavioral therapy for PTSD in a “real world” clinical practice. *J Trauma Stress* 2005;18:637–645.
14. Jaycox LH, Foa EB. Obstacles in implementing exposure therapy for PTSD: case discussions and practical solutions. *Clin Psychol Psychother* 1996;3:176–184.
15. Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med* 2010;16:3–12.
16. Salmon P, Lush E, Jablonski M, Sephton SE. Yoga and mindfulness: clinical aspects of an ancient mind/body practice. *Cogn Behav Pract* 2009;16:59–72.
17. Evans S, Tsao JCI, Sternlieb B, Zeltzer LK. Using the biopsychosocial model to understand the health benefits of Yoga. *J Complement Integr Med* 2009;6:1–22.
18. Telles S, Nilkamal S, Balkrishna A. Managing mental health disorders resulting from trauma through yoga: a review. *Depress Res Treat* 2012;401513:1–9.
19. van der Kolk BA. Clinical implications of neuroscience research in PTSD. *Ann N Y Acad Sci* 2006;1:1–17.
20. Kirkwood G, Rampes H, Tuffrey V, et al. Yoga for anxiety: a systematic review of the research evidence. *Br J Sports Med* 2005;39:884–891.
21. Uebelacker LA., Epstein-Lubow G, Gaudiano BA, et al. Hatha Yoga for depression: critical review of the evidence for efficacy, plausible mechanisms of action, and directions for future research. *J Psychiatr Pract* 2010;16:22–33.
22. Kimbrough E, Magyari T, Langenberg P, et al. Mindfulness intervention for child abuse survivors. *J Clin Psychol* 2010; 66:17–33.
23. van der Kolk BA, Stone L, West J, et al. Yoga as adjunctive treatment for posttraumatic stress disorder: a randomized controlled trial. *J Clin Psychiatry* 2014;76:e559–3565.
24. Birdee GS, Legedza AT, Saper RB, et al. Characteristics of yoga users: results of a national survey. *J Gen Intern Med* 2008;23:1653–1658.
25. Mueser KT, Rosenberg SD, Fox L, et al. Psychometric evaluation of trauma and posttraumatic stress disorder assessments in persons with severe mental illness. *Psychol Assess* 2001;13:110–117.
26. Weathers F, Ruscio AM, Keane TM. Psychometric properties of nine scoring rules for the Clinician Administered Posttraumatic Stress Disorder Scale. *Psychol Assess* 1999; 11:124–133.
27. Dubester KA, Braun BG. Psychometric properties of the Dissociative Experiences Scale. *J Nerv Ment Dis* 1995; 183:231–235.
28. Beck AT, Steer RA, Carbin MG. Psychometric properties of Beck Depression Inventory: twenty-five years of evaluation. *Clin Psychol Rev* 1988;8:77–100.
29. Briere J. Inventory of Altered Self-Capacities Professional Manual. Odessa, FL: Psychological Assessment Resources, 2000.
30. Briere J, Kaltman S, Green BL. Accumulated childhood trauma and symptom complexity. *J Traum Stress* 2008;21: 223–226.
31. Green BL, Goodman LA, Krupnick JL, et al. Outcomes of single versus multiple trauma exposure in a screening sample. *J Traum Stress* 2000;13:271–286.
32. Goodman L, Corcoran C, Turner K, et al. Assessing traumatic event exposure: general issues and preliminary findings for the Stressful Life Events Screening Questionnaire. *J Traum Stress* 1998;11:521–542.
33. Barnes PM, Powell-Griner E, McFann K, et al. Complementary and alternative medicine use among adults: United States, 2002. *Advance Data. Vital Health Stat* 2004; 343:1–19.

Address correspondence to:  
 Alison Rhodes, PhD  
 The Trauma Center  
 at Justice Resource Institute  
 1269 Beacon Street  
 Brookline, MA 02446

E-mail: alison.rhodes@bc.edu