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Yoga for Veterans With PTSD: Cognitive Functioning, Mental Health, and Salivary Cortisol

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Abstract

Objective: Research indicates that cognitive functioning is negatively impacted by exposure to chronic stress due to overactivation of the stress response. Yoga has demonstrated benefits when practiced by individuals diagnosed with posttraumatic stress disorder (PTSD). This quasi-experimental pilot study examined the impact of a yoga intervention on cognitive functioning, symptoms of PTSD, and the biological stress response in Veterans diagnosed with PTSD.

Method: Cognitive functioning, self-report measures of mental health symptoms, and salivary cortisol were measured within two weeks prior to beginning and following completion of a 10-week yoga protocol. Veterans with PTSD participated in gender-specific groups of the yoga intervention. Paired *t* tests and correlational analyses were used to analyze quantitative data.

Results: Statistically significant improvements were observed between baseline and postintervention scores on measures of response inhibition, PTSD, depression, sleep, quality of life, and subjective neurocognitive complaints. Positive correlations were found between baseline and postintervention changes in sleep and depression, and between change in cortisol output and a measure of life satisfaction. Statistically significant differences (baseline to postintervention) for other objective measures of cognitive performance and cortisol were not detected.

Conclusions: Results provide preliminary support for the practice of yoga to improve cognitive functioning (response inhibition) related to symptoms of PTSD while also improving mental health symptoms, sleep, and quality of life. Positive correlations affirm the role of sleep in mood symptoms and indicate the need for further examination of the role of cortisol in life satisfaction.

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Keywords

Veterans; trauma; cognitive functioning; trauma sensitive yoga; cortisol

Posttraumatic stress disorder (PTSD) is associated with global impairments in inhibitory responses—cognitive processes that impact the regulation of neuropsychological and emotional functioning (Wrocklage et al., 2016). These impairments may be mediated by dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis, which is common in PTSD and other mental health conditions (Morris, Compas, & Garber, 2012; Wichmann, Kirschbaum, Böhme, & Petrowski, 2017). Activation of the HPA axis (the primary physiological mediator of the body's stress response) results in the secretion of the adrenal hormone cortisol (Wichmann et al., 2017). In Veterans, high levels of cortisol are associated with impairments in cognitive performance (e.g., executive functions, processing speed, and response inhibition), but the effects of cortisol on cognition in PTSD is complex and less is known about the relationship among PTSD symptoms, cortisol, and cognitive performance (i.e., response inhibition; Franz et al., 2011; Wingenfeld & Wolf, 2015).

Cognitive-based psychotherapies and pharmacotherapies are effective PTSD treatments (Watts et al., 2013). However, research indicates that 60%–72% of patients retain a diagnosis of PTSD following cognitive processing therapy or prolonged exposure, and dropout rates in these therapies can be high (Steenkamp, Litz, Hoge, & Marmar, 2015). Mind–body interventions (e.g., acupuncture, meditation, and yoga) are receiving increasing empirical attention and support as alternatives. Recent systematic reviews and meta-analyses of yoga studies indicate that, although only seven randomized controlled trials have been conducted to date, results for yoga are promising—in some cases with effect sizes comparable to psychotherapeutic and psychopharmacologic approaches (Cramer, Anheyer, Saha, & Dobos, 2018, Jindani et al., 2108, Mitchell et al., 2014; Reinhardt et al., 2018; van der Kolk et al., 2014). Within this larger body of evidence examining yoga as an adjunctive therapy for PTSD, a smaller number of studies use trauma-sensitive (also called trauma-informed) yoga (TSY) or use physiological outcome measures (Kelly, Evans, Baker, & Taylor, 2018; Nolan, 2016). A key proposed benefit of yoga is the down-regulation of physiological arousal including HPA axis activation, but less is understood about the stress mechanisms associated with TSY therapeutic benefits (Kelly et al., 2018).

The current pilot study used TSY that was a hatha-based yoga with modifications for trauma sensitivity made to instruction style (e.g., using language of invitation and inquiry and omission of hands-on adjustments), class setup (e.g., use of a semicircle so all participants can see one another and teacher remains at the front of the classroom), and postures used in class (e.g., omission of adrenal-activating poses; Emerson, Sharma, Chaudhry, & Turner, 2009). The overall goal was to examine the effects of TSY on response inhibition (as an indicator of cognitive performance), PTSD symptoms, and cortisol levels (as an indicator of the stress response) among Veterans diagnosed with PTSD. It was hypothesized that TSY would improve response inhibition, reduce posttraumatic stress symptoms, and have a positive impact on cortisol production. To our knowledge, this is the first Veterans Affairs

(VA) facility study to examine the effect of TSY on measures of mental health changes accompanying PTSD using a prepost design that incorporated measures of cortisol.

Method

Overview

This quasi-experimental pilot study used a prepost design to examine the impact of TSY on cognitive performance, self-reported symptoms of PTSD, and salivary cortisol levels in Veterans diagnosed with PTSD. The research was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) and approved by the Institutional Review Board at the Veteran Affairs Portland Health Care System (VAPORHCS).

Participants

Seventeen of the 27 enrolled Veterans completed the intervention and postintervention assessment. Participants who were diagnosed with PTSD (determined by medical chart review) and had attempted some form of trauma therapy previously (but were not currently engaged in a trauma processing therapy) were referred by their providers. Participants were recruited from mental health clinics of the VAPORHCS.

Measures

At baseline, participants completed a form requesting information on age, gender, race, ethnicity, service era, service branch, history of military sexual trauma, years of education, and comorbidity of other psychiatric conditions. Cognitive performance and mental health symptoms were assessed at baseline (preintervention) and postintervention. Descriptions, references, and psychometric properties of all measures, along with the scores/scales used for analyses, can be found in the online supplemental materials. The Delis-Kaplan Executive Function System, Color Word Interference Test (DKEFS-CWIT; Delis, Kaplan, & Kramer, 2001), Digit Span (DS) from the Wechsler Adult Intelligence Scale—Fourth Edition (Wechsler, 2008), and the Trail Making Test A & B (TMT-A & - B; Army Individual Test Battery, 1944) were administered to assess cognitive performance. Self-report symptom questionnaires, the PTSD Checklist for *DSM–5* (PCL-5; Weathers et al., 2013), the Beck Depression Inventory—Second Edition (BDI-II; Beck, Steer, & Brown, 1996), the Multiple Sclerosis Neuropsychological Questionnaire (MSNQ; Benedict et al., 2004), the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), and the Satisfaction with Life Scale (SLS; Diener, Emmons, Larsen, & Griffin, 1985) were used to measure mental health symptoms and quality of life. Cognitive performance measures and symptom questionnaires were scored and interpreted in accordance with their instruction manuals. To evaluate participants' perceptions of the yoga intervention, the Perceived Benefits of Yoga Questionnaire (see Baker et al., 2015) and a questionnaire developed by the study team were administered postintervention to collect feedback about the yoga intervention. Participant feedback is presented in the online supplemental materials.

Cortisol Measurement

Saliva samples (~0.5 mL per sample) were obtained using Salivette for Cortisol Testing tubes (Starstedt, Germany). Veterans were provided verbal instructions and practice demonstrations on saliva collection methods; they were given an instructional take-home sheet with pictures and a description of the saliva collection procedure. Veterans were instructed to refrigerate collected samples and to keep them refrigerated until they were ready to bring to the VA lab where samples were processed and stored according to the manufacturer's instructions. Refrigeration of samples was a precaution taken although salivary cortisol samples are relatively stable at a variety of storage conditions and at room temperature (Nalla, Thomsen, Knudsen, & Frokjaer, 2015). Veterans collected three saliva samples from the same day (waking, 30 min. post-waking, and bedtime) pre- and postintervention. Cortisol awakening response (CAR), area under the curve with respect to increase (AUCi; an indicator of cortisol reactivity), and area under the curve with respect to the ground (AUCg; an indicator of total systemic cortisol output) were calculated (Clow, Thorn, Evans, & Hucklebridge, 2004; Pruessner, Kirschbaum, Meinlschmid, & Hellhamer, 2003). Baseline samples were collected within two weeks prior to starting TSY (M = 4 days, SD = 4.98); postintervention samples were collected within two weeks of completing the final class (M = 12 days, SD = 6.06). Saliva samples were analyzed in triplicate for cortisol levels using enzyme-linked immunosorbent assay (ELISA) kits per manufacturer's instructions (high sensitivity EIA kits; Salimetrics, LCC, State College, Pennsylvania).

Intervention

The TSY intervention protocol consisted of 10 weekly, 60-min sessions; groups were separated by gender and received identical yoga protocols. The facilitator of the yoga intervention was a recreational therapist and a registered yoga teacher with additional TSY training.

Statistical Analyses

Paired t tests were used to examine the treatment effect for all outcome measures. Due to the small sample size, no corrections for multiple analyses were performed. Effect sizes were measured using Cohen's d (Cohen, 1988). Pearson's correlations using change scores (calculated by subtracting the postintervention score from the baseline score except on the SLS, where a lower score postintervention indicated improvement) were performed to examine associations between outcome measures. Analyses were performed using STATA 14.2 and SPSS Version 14.2. p values less than 0.05 were considered statistically significant.

Results

Twenty-seven men and women Veterans with PTSD were enrolled. Of the final sample (N = 17), 41% endorsed military sexual trauma (85% of women and 10% of men). Of participants who completed postintervention assessment (male n = 10 and female n = 7), 11 attended eight or more classes, four attended five to seven classes, and two attended three classes. Table 1 summarizes baseline and postintervention outcome measures. Statistically significant improvements were found for DKEFS-CWIT (p = .04), PCL-5 (p = .02), BDI-II

(p = .00), PSQI (p = .01), SLS (p = .01), and MSNQ (p = .01). Statistically significant differences for the other cognitive measures (TMT-B and DS) and cortisol were not detected.

A correlation matrix was generated to examine the relationships among changes in outcome measures (Table 2 in the online supplemental materials). Improvements in sleep correlated significantly with improvements in symptoms of depression (r = .66; p < .05), supporting the known relationship between sleep and depression. An exploration of the cortisol variables found that change in total cortisol output (AUCg) was positively correlated with improvements in life satisfaction (r = .73; p < .01). As would be expected since both are indicators of cortisol change over time, changes in cortisol measure AUCi correlated with changes in CAR, r = .66, p < .01. Significant correlations were not found between cortisol variables and measures of cognitive performance (supplemental Table 2). Qualitative results are reported in supplemental Tables 3 and 4.

Discussion

The results of this pilot study support TSY as a feasible, acceptable intervention for Veterans with PTSD. Improvements in quality of life, attendance, and the qualitative responses of the completers support the acceptance of this intervention for Veterans of various service eras and branches. It was hypothesized that TSY would improve response inhibition, reduce self-reported symptoms of PTSD, and improve cortisol output and reactivity. Statistically significant improvements in response inhibition (but not other measures of cognitive performance) and self-reported symptoms of PTSD were found. Reported improvements in sleep and depression may have contributed to better performance on cognitive tasks of response inhibition. Future studies should use adjusted models controlling for the effects of these covariates on treatment outcomes while controlling for demographic variables (e.g., age and education).

Significant changes in response inhibition, sleep, and depression following TSY were not accompanied by statistically significant changes in cortisol, but there was a statistically significant relationship between the change in AUCg and self-reported improvement in life satisfaction. Cortisol production can be difficult to measure and interpret. One of the challenges in using salivary cortisol as a biomarker is the large number of confounding factors that can affect cortisol measurements (e.g., differences in circadian regulation, comorbid mental and physical health conditions, and other factors; Clow et al., 2004). Veterans' diurnal cycles show different patterns than non-veterans (Wahbeh & Oken, 2013). Furthermore, individuals with PTSD trend toward lower salivary cortisol levels than controls (Pan, Wang, Wu, Wen, & Liu, 2018). Sample collection frequency and timing are also important considerations. In the current study, the number of samples collected may have contributed to a lack of statistically significant differences in cortisol. Given the scope of this pilot study, additional saliva sample collection was not feasible.

Other studies have used yoga as an intervention to examine functional outcomes correlated with reductions in PTSD symptomatology, especially hyperarousal, in Veterans populations. Findings of a randomized, longitudinal study correlated reductions in eyeblink startle with reductions in hyperarousal symptoms after practicing breathing-based yoga (Seppälä et al.,

2014). In a pilot study, Veteran participants reported fewer symptoms of hyperarousal, which correlated with improved sleep quality after participating in a yoga intervention (Staples, Hamilton, & Uddo, 2013). This study adds to the existing body of literature by examining the relationship of another type of yoga intervention (TSY), proposed to downregulate physiological arousal, and improvements in functional outcomes (Jindani, Turner, & Khalsa, 2015; Reinhardt et al., 2018). Given the heterogeneity in the content of different yoga interventions used in trauma populations, more research is needed to determine which intervention type(s) are most efficacious in reducing PTSD symptoms and regulating stress responses/HPA axis function with correlated improvements in functioning.

Results of this study are limited by a small sample size, potential self-report bias, demand characteristics that may have affected posttreatment responses, practice effects on the DKEFS-CWIT, reliance on historical diagnosis of PTSD, and potential lack of compliance with collection and storage of saliva. Statistical methods and other elements of the study design were selected keeping such limitations in mind and in an attempt to address them where possible. This project focused on Veterans with PTSD; thus, results are not necessarily generalizable to a non-veteran population.

Despite the limitations, this pilot study adds to existing literature and indicates that yoga interventions, like TSY, may improve response inhibition, PTSD symptoms, sleep quality, depression symptoms, and subjective cognitive complaints.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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performance validity, comorbidities, and functional outcomes. Journal of the International Neuropsychological Society, 22, 399–411. 10.1017/S1355617716000059 [PubMed: 26892753]

Clinical Impact Statement

Individuals with PTSD report social, emotional, and cognitive problems related to living with this disorder. Overactivity of the stress response contributes to these problems. Research examining the therapeutic effects of yoga identifies positive changes to the stress response that are associated with improvements in daily functioning (e.g., sleep, memory, concentration). The current study offered trauma-sensitive yoga to Veterans with PTSD and found improvements in response inhibition, depression, sleep, and life satisfaction after participating in yoga. These findings add to the body of literature supporting yoga as a promising intervention for symptoms of trauma with widespread benefits to functioning.

Table 1

Evaluation of Outcome Measures Following TSY Intervention in Veterans With PTSD

Outcome[†]	Baseline Mean (*SD*)	Post-intervention Mean (*SD*)	*t*	Cohen's *d*	*P*
		Cognitive Variables			
CWIT-Inhibition[*]	65.88 (17.86)	60.35 (11.55)	2.20	0.37	0.04
TMT-B	46.94 (15.25)	49.00 (9.22)	−0.61	0.16	0.55
DS[*]	24.35 (4.6)	24.65 (4.39)	−0.38	0.07	0.71
		Mental Health Symptoms			
PCL-5[*]	44.24 (12.70)	36.76 (16.80)	2.63	0.50	0.02
BDI-II[*]	28.06(11.72)	18.88 (13.07)	3.63	0.74	0.00
MSNQ[*]	33.59 (9.91)	29.29 (9.43)	3.06	0.44	0.01
SLS[*]	14.00 (6.65)	18.41 (8.25)	−3.02	0.59	0.01
PSQI	13.88 (4.87)	12.06 (4.98)	3.00	0.37	0.01
		Cortisol Measures[**]			
Waking Level, μg/dL	0.33 (0.25)	0.42 (0.32)	−1.06	0.31	0.31
CAR	0.17 (0.09)	0.21 (0.17)	−0.79	0.29	0.44
AUCg	271.67 (129.08)	312.38 (184.36)	−0.80	0.26	0.43
AUCi	77.38 (62.31)	138.00 (160.56)	1.47	0.50	0.16

[†]Descriptions and psychometric properties of measures are provided in the online supplemental materials.

[*]Total, raw score.

[**]Absolute values used for analyses.