



Naturalistic Evaluation of an Adjunctive Yoga Program for Women with Substance Use Disorders in Inpatient Treatment: Within-Treatment Effects on Cravings, Self-efficacy, Psychiatric Symptoms, Impulsivity, and Mindfulness

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Tashia Petker¹, Christine Yanke², Liah Rahman¹, Laurel Whalen², Karen Demaline², Kari Whitelaw², Debbie Bang², Katherine Holshausen³, Michael Amlung¹ and James MacKillop^{1,4} 

¹Peter Boris Centre for Addictions Research, McMaster University/St. Joseph's Healthcare Hamilton, Hamilton ON, Canada. ²Womankind Addiction Services, St. Joseph's Healthcare Hamilton, Hamilton, ON, Canada. ³St. Joseph's Healthcare Hamilton, Hamilton, ON, Canada. ⁴Homewood Research Institute, Guelph, ON, Canada.

ABSTRACT: Addiction continues to be a major public health concern, and rates of relapse following currently-available treatments remain high. There is increasing interest in the adjunctive use of mindfulness-based interventions, such as yoga, to improve treatment outcomes. The current study was a preliminary naturalistic investigation of a novel trauma-informed yoga intervention in an inpatient treatment program for women with substance use disorder (SUD). Changes and differences in somatic symptoms, psychiatric symptoms, and psychological mechanisms were evaluated in women receiving treatment-as-usual ($n = 36$) and treatment-as-usual plus the yoga intervention ($n = 42$). For both groups, statistically significant within-subjects changes were present for somatic and psychiatric symptoms, cravings, self-efficacy, and multiple facets of impulsivity and mindfulness. Compared to standard treatment alone, participants in the treatment plus yoga condition significantly improved in range of motion and the Lack of Premeditation facet of impulsivity. Although most domains were not selectively affected, these initial within-treatment findings in this naturalistic evaluation suggest some promise for adjunctive yoga and a need for further evaluation, especially using larger samples and longer term follow-up.

KEYWORDS: Substance use disorder, treatment, yoga, mindfulness, impulsivity

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CORRESPONDING AUTHOR: James MacKillop, Peter Boris Centre for Addictions Research, McMaster University/St. Joseph's Healthcare Hamilton, 100 West 5th Street, Hamilton, ON L8P 3R2, Canada. Email: jmackill@mcmaster.ca

Highlights

- An adjunctive yoga intervention in residential addiction treatment was evaluated for within-treatment effects
- Treatment as usual significantly improved craving, psychiatric symptoms, self-efficacy, impulsivity and mindfulness.
- The addition of yoga significantly improved range of motion and premeditation (i.e., ability to consider consequences prior to acting).

Introduction

Addiction remains a major public health problem. The problematic use of substances, known as substance use disorder (SUD) in the current diagnostic criteria,¹ poses numerous challenges for individuals, families, society, and the public health and justice systems. According to a recent analysis of data from the Canadian Community Health Survey on Mental Health, the 12-month incidence of SUD is estimated at 4.4%, with about 25% of those also meeting criteria for at least 1 concurrent disorder (eg, bipolar disorder, generalized anxiety disorder). The same study found that compared to people with

a mood or anxiety disorder, individuals with SUD were less likely to report that existing mental healthcare services met their needs, and were more reliant on informal services, such as peer-support groups.²

For nearly a century, the most ubiquitous and accessible treatments for SUD have been peer-support groups practicing the 12-Step model of recovery (eg, Alcoholics Anonymous, Narcotics Anonymous). More recently, the use of other treatment approaches such as cognitive behavior therapy (CBT), dialectical behavioral therapy (DBT), and Motivational Interviewing (MI) have been integrated into models of care. Although these existing interventions work for some, they are not effective for a significant subset of individuals. Post-treatment relapse rates remain as high as 60% in the year following treatment³⁻⁶ and those with greater severity of substance-related problems and concurrent disorders experience the highest rates of relapse and comorbidity.^{7,8} Given the suboptimal effectiveness of existing services in meeting the needs of people with addiction, there remains a high need to improve the treatment of SUD.



To this end, the last decade has seen a surge of interest in alternative therapies. So-called “third-wave behavior therapies,” such as Mindfulness-Based Relapse Prevention⁹ and Acceptance and Commitment Therapy (ACT),¹⁰ are built on principles of mindfulness, the practice of attending to the present moment with acceptance and equanimity.¹¹ Rather than seeking to identify and change unhealthy thoughts, behaviors, and feelings (as in CBT), a goal in mindfulness is to become aware of and accept experiences, even uncomfortable ones.¹² In doing so, the internal experience is attended to instead of avoided, which has been found to consequently reduce problematic substance use.^{9,13,14} Complementary emerging evidence suggests that mindfulness-based interventions improve self-regulation in women with substance dependence,^{15,16} providing rationale for their inclusion within substance use treatment programs.

One mindfulness-based approach that has been used in treatment of SUD is yoga. There is evidence that yoga can improve emotion regulation,¹⁷ and yoga-based interventions have been found to have similar efficacy to standard psychotherapy for treating a number of mental disorders.¹⁸ In healthy adults, long-term practice of yoga has been associated with structural and functional changes in the hippocampus, insula, and prefrontal cortex.¹⁹ Disruption in these regions is also evident in SUD (eg, Liang et al²⁰), although neural changes from yoga have not yet been studied in this population. Reviews of randomized controlled trials (RCTs) conclude that despite preliminary support for the efficacy of yoga in treating SUD, the evidence to date is of poor quality due to methodological issues, such as limited scope of outcome variables and lack of comparison groups.²¹⁻²⁴ These reviews collectively note a gap in current literature regarding the accurate assessment of yoga’s potential to improve SUD treatment outcomes.

To contribute to understanding the potential promise of yoga in addiction treatment, the current study conducted a naturalistic evaluation of an adjunctive yoga program in an inpatient SUD treatment program for adult women. Specifically, the existing treatment followed a standard program cycle and the yoga curriculum was included in the program alternating cycles, creating naturalistic intervention and control groups. Other than the yoga program and assessments, no other aspect of the treatment program was modified. The focus of the study was short-term impacts over the course of treatment, from admission to discharge; post-discharge data were not available. Given limited measurement scope in previous studies, the current investigation used a broad range of outcomes, including addiction-specific outcomes (ie, cravings, self-efficacy), common psychiatric symptoms (eg, depression, anxiety, and PTSD symptoms), somatic functioning (ie, somatic symptoms, range of motion, pain), and a multidimensional assessment of self-regulation and mindfulness.

Methods

Participants

Participants were patients enrolled in Womankind Addiction Service’s primary treatment program, a residential inpatient program for adult women with SUD in Hamilton, Ontario, Canada. A total of 124 women were recruited, of whom 75 participants completed both baseline and discharge assessments (Figure 1). Participants were in 1 of 2 conditions: treatment plus yoga (n=42) and treatment only (n=33). The final sample is described in Table 1, comprising a group of primarily white, adult females age 17 to 65 (Mean = 37.7 [11.33]) reporting low household income (Median = \$15 000-\$30 000). The 2 groups did not differ significantly on demographic characteristics. Most participants reported daily levels of tobacco use and alcohol use, with varying degrees of other substance involvement (eg, cannabis, cocaine, heroin).

Procedure

The study recruited participants over the course of treatment cycles between February 2018 and November 2019. Treatment cycles alternated offering treatment-as-usual plus yoga and treatment-as-usual only, such that all participants within a given cohort received the same treatment condition. Pre-treatment assessments were administered on approximately the second day of the Womankind treatment program (or when the patient was appropriately stable), and all measures except for those pertaining to demographics and substance use were repeated in the post-treatment assessment, which was administered on the penultimate day of programming (ie, 34th day of treatment). Patients were randomized to the extent that no assignment was made with regard to when they enrolled in treatment, but no formal randomization process was used. The study was a quality improvement investigation of a clinical innovation at Womankind, not a clinical trial and therefore was not registered in a clinical trial database. The study was approved by the Hamilton Integrated Research Ethics Board (protocol #10944).

Addiction program (treatment-as-usual)

The inpatient program operated with a maximum of 8 patients in a closed delivery model, where all clients entered and completed the 5-week program at the same time. The program was structured to include therapeutic groups and activities aimed at supporting the following treatment goals: exploration of self, identifying maladaptive behaviors and relationship patterns, practicing healthy coping skills, exploring codependency, improving emotional regulation and self-efficacy, practicing self-acceptance, personalized recovery management plans, relapse prevention planning, and increasing social supports. To achieve these goals, staff used techniques from existing

Womankind YogaFit CONSORT Flow Diagram

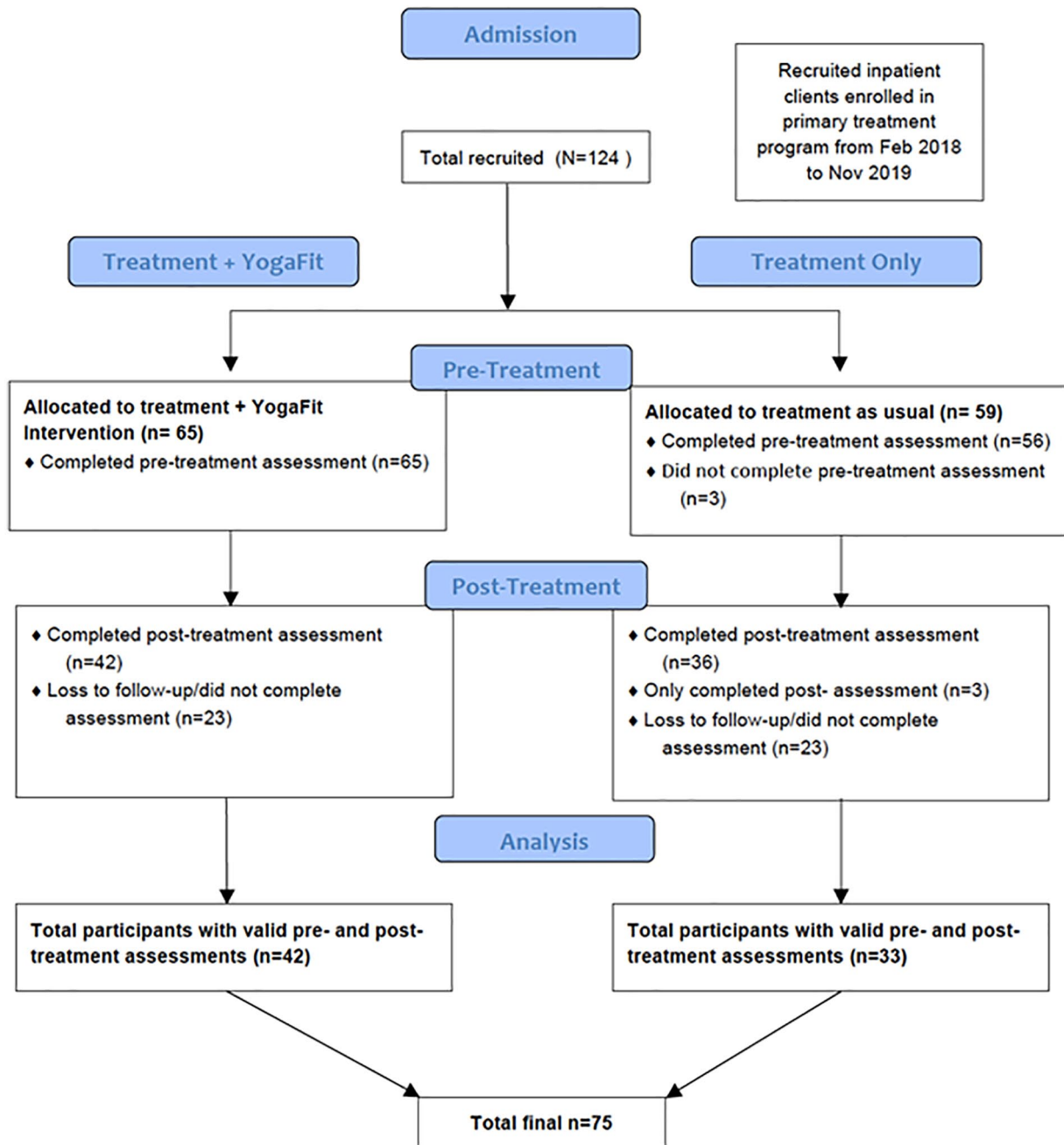


Figure 1. CONSORT diagram of participant flow and assessment completion.

treatment modalities including CBT, DBT, ACT, and MI. Psycho-educational and process groups were facilitated by staff Addiction Attendants, and self-help and peer support groups were facilitated by community partners. The Addiction Attendants are direct care social service workers and constitute a relatively heterogeneous group of clinical staff. The qualifications required are: (1) a 2-year community college diploma in a health or social service program, with an addiction concentration; (2) related experience working with women with

substance use issues; and (3) good knowledge of community resources, the substance use treatment network and evidence-informed practices for women with substance use and trauma. Formal training in those psychotherapy modalities is received during formal training programs or continuing education, but varies by clinician. No structured or manualized psychotherapy training was provided for treatment-as-usual by the current study. Clients participate in a total of 144 hours of scheduled therapeutic sessions during the 5-week program.

Table 1. Baseline assessment characteristics (N=75).

CHARACTERISTIC	TREATMENT + YOGA (N=42)	TREATMENT ONLY (N=33)	DIFFERENCE
	MEAN (SD)		T (P)
Age	36.62 (11.72)	39.24 (10.81)	0.99 (.32)
Ethnicity (%)			4.15 (.25)
White/European ancestry	36 (85.7)	31 (93.9)	
Black/African ancestry	0 (0)	1 (3.0)	
First Nations/Inuit/Metis ancestry	2 (4.8)	0 (0)	
More than 1 population group	4 (9.5)	1 (3.0)	
Years education	13.54 (2.96)	13.46 (2.88)	-0.12 (.91)
Annual household income (%)			5.14 (.49)
≤\$15000	19 (45.2)	13 (39.4)	
\$15000 < \$30000	14 (33.3)	9 (27.3)	
\$30000 < \$45000	2 (4.8)	4 (12.1)	
\$45000 < \$60000	1 (2.4)	3 (9.1)	
\$60000 < \$75000	3 (7.1)	2 (6.1)	
\$75000 < \$90000	0 (0)	0 (0)	
\$90000 < \$105000	0 (0)	0 (0)	
\$105000 < \$120000	2 (4.8)	0 (0)	
\$120000+	1 (2.4)	2 (6.1)	
Substance use involvement	10.57 (5.29)	9.12 (4.41)	-1.27 (.21)
Drug cravings	17.21 (8.99)	15.58 (8.37)	0.81 (.42)
Self-efficacy (BSCQ)	49.56 (27.87)	53.00 (23.43)	-0.58 (.57)
Range of motion	36.61 (8.84)	41.03 (6.41)	-2.51 (.01)
Somatic symptoms	9.66 (4.53)	7.59 (3.72)	2.18 (.03)
Anxiety symptoms	12.34 (5.83)	12.06 (5.44)	0.21 (.83)
PTSD symptoms	46.00 (18.99)	45.10 (13.09)	0.15 (.88)
Brief pain inventory	33.93 (33.56)	27.59 (29.79)	0.87 (.39)
Impulsive personality traits			
Negative urgency	2.01 (0.84)	1.78 (0.54)	1.56 (.12)
Lack perseverance	2.88 (0.69)	3.11 (0.67)	-1.44 (.15)
Lack premeditation	2.53 (0.71)	2.73 (0.71)	-1.21 (.23)
Sensation seeking	2.42 (0.79)	2.53 (0.80)	-0.59 (.55)
Positive urgency	2.45 (0.88)	2.65 (0.64)	-1.18 (.24)
Delay discounting	12.14 (2.08)	12.52 (1.75)	-0.85 (.40)
Mindfulness (MAIA)			
Noticing	3.73 (0.92)	3.61 (0.90)	0.53 (.60)

(Continued)

Table 1. (Continued)

CHARACTERISTIC	TREATMENT + YOGA (N=42)	TREATMENT ONLY (N=33)	DIFFERENCE
	MEAN (SD)		T (P)
Not distracting	1.90 (0.96)	1.69 (0.84)	1.00 (.32)
Not worrying	2.59 (1.01)	2.31 (0.96)	1.22 (.23)
Attention regulation	2.71 (0.89)	2.78 (0.94)	-0.34 (.74)
Emotional awareness	3.72 (0.82)	3.80 (1.03)	-0.37 (.71)
Self-regulation	2.47 (1.00)	2.56 (0.91)	-0.41 (.68)
Body listening	2.03 (1.32)	2.16 (1.22)	-0.44 (.66)
Trusting	2.46 (1.11)	2.39 (1.26)	0.24 (.81)

Abbreviations: BSCQ, Brief Situational Confidence Questionnaire; MAIA, Mindfulness and Interoceptive Awareness Scale; PTSD, post-traumatic stress disorder; S-UPPS-P, short UPPS scale.

Yoga intervention

YogaFit for Warriors is a yoga approach originally created for military veterans and first responders with PTSD by Lt. Col Shaye Molendyke in 2013. To be certified in this approach, yoga trainers must have completed a minimum of 200 hours of yoga teacher training, and an additional enhanced qualifications of at least 100 hours of trauma-sensitive teacher training. YogaFit for Warriors uses traditional poses and breathing techniques from Hatha yoga, with some key differences in approach that are trauma-informed. First, a trauma-safe environment is created, which could include arranging the space so participants face a door, choosing calming instrumental music, and avoiding the use of any yoga aids that could be triggering to those with a history of trauma (eg, straps). Trainers are taught to use invitational language to ask participants to join in a particular posture, which is less confrontational than the commanding instruction style typical of most yoga classes. Similarly, the trainer does not use physical touch to correct a posture, a practice common among more traditional yoga instruction; rather they encourage the participant attend to their bodily sensations. Lastly, YogaFit for Warriors places emphasis on teaching emotional grounding skills by practicing bodily awareness and breathing techniques. Instructors monitor for signs of emotional distress from participants and provide support as needed. For example, if a participant experienced anxiety during a breathing exercise using short rapid breaths, the instructor modified the exercise to encourage deep, slower breathing. One-hour sessions were facilitated 3 days per week by a master trainer, for a total of 14 sessions during the treatment program. The trainer only delivered the yoga program and was not part of the existing staff. The postures in each session were modified as needed by the trainer to suit the needs and physical abilities of participants in attendance, but otherwise followed a standard, 3-part format that provided a safe and consistent progression throughout the class: a warm-up phase beginning with

awareness of breath and easy movements, then larger movements followed by poses for strength and flexibility, and lastly a cool-down with deep stretching and relaxation. No control activity was offered during treatment cycles when yoga was not available.

Self-report assessments

A demographic questionnaire asked participants to provide their current age, identified ethnicity, household annual income, and years of education. Past 12-month substance use frequency was assessed using the NIDA-modified version of the World Health Organization's Alcohol Smoking Substance Involvement Screening Test (ASSIST).²⁵ Participants indicated how often in the past year they used tobacco, alcohol, cannabis, cocaine, methamphetamine, ecstasy, heroin, and prescription stimulants and painkillers (taken not as prescribed). Substance use frequencies were summed, with higher total scores indicating greater substance involvement. Detailed frequencies for substances are provided in the Supplemental Materials.

Psychiatric symptom severity was measured as follows. Severity of anxiety symptoms over the past 2 weeks was assessed using the Patient Health Questionnaire (PHQ) section on Generalized Anxiety Disorder ($\alpha = .91$) (GAD-7).²⁶ This diagnostic screening tool asks participants to indicate how often in the last 2 weeks they have experienced symptoms consistent with GAD. Responses were summed for a total anxiety symptom score. Severity of symptoms related to post-traumatic stress disorder (PTSD) was assessed using the PTSD Checklist for DSM-5 ($\alpha = .93$) (PCL-5),²⁷ a 20-item diagnostic screening instrument. Participants were asked to indicate how much in the past month they were bothered by experiences. Responses were summed to generate total PTSD Symptom severity scores. The PCL-5 was added to assessments at the 11th treatment cycle; therefore only a subset of participants completed this measure ($n = 32$).

Somatic symptoms and range of motion were measured as follows. Severity of somatic symptoms over the past 4 weeks was assessed using the Somatic Symptom section of the PHQ ($\alpha = .75$).²⁸ This measure includes 15 somatic complaints, to which participants indicated the degree to which each symptom has bothered them. Responses were summed for a total Somatic Symptoms score. An 8-item questionnaire was created by investigators to assess the range of motion experienced in various bodily joints over the past week. This measure was created to serve as an indicator of whether the yoga intervention affected joint flexibility. For example, questions about range of motion asked questions such as, “How is the range of motion in your shoulders?” and “How is the range of motion in your ankles?” These questions covered the major bodily joints, and participants were asked to rate the quality of range of motion for each joint, ranging from “Very poor” to “Excellent.” Responses were summed for a total score ($\alpha = .90$). A short version of the Brief Pain Inventory ($\alpha = .956$) (BPI)²⁹ measured the presence and severity of physical pain within the past 24 hours. Participants indicated areas of the body affected by pain, intensity range of pain, medications taken for pain, and the degree of functional impairment from pain. Overall severity of physical pain was calculated by summing responses.

Mechanisms of addiction were measured as follows. Drug and alcohol cravings were measured using the Penn Craving Scale ($\alpha = .94$) (PCS),³⁰ a 5-item measure assessing frequency, duration, and severity of drug cravings over the past week. Perceived self-efficacy in drug-related situations was assessed using the Brief Situational Confidence Questionnaire ($\alpha = .92$) (BSCQ).³¹ In this questionnaire, participants are asked to imagine themselves in a series of resolve-testing scenarios, and to rate their own ability to resist using substances on a sliding scale, with responses averaged for a mean self-efficacy score. Scenarios included experiencing physical and emotional discomfort, testing control over use of drugs, interpersonal pressures, and drug urges/cravings.

Impulsivity and mindfulness were assessed as follows. A short version of the UPPS-P Impulsive Behavior Scale³² was used to evaluate 5 facets of impulsive behaviors. The short version includes 20 statements, and participants indicate the degree to which each item describes them. Subscales include: Negative Urgency (ie, impulsive behavior during negative affect), Lack of Perseverance (ie, gives up easily on difficult tasks), Lack of Premeditation (ie, failure to consider consequences before acting), Sensation Seeking (ie, preference for highly stimulating/high-risk activities), and Positive Urgency (ie, impulsive behavior during positive affect) (subscale α 's = .72–.84). Preference for immediately available rewards over larger, delayed rewards (a behavioral economic measure of impulsivity) was assessed by an adapted version of the 27-item Monetary Choice Questionnaire (MCQ).³³ The adapted task consisted of the 9 items using medium-sized delayed rewards (ie, \$50, \$55, \$60) from the full MCQ.

Participants were asked to choose between a smaller amount of money available immediately, and a greater amount of money available after some delay in time (eg, “Would you rather have \$25 today or \$60 in 14 days?”). A delay discounting rate (k -value) was assigned to each participant based on their pattern of choices, where larger k -values indicate steeper devaluation of delayed rewards.

Mindfulness was assessed using the Multidimensional Assessment of Interoceptive Awareness (MAIA).³⁴ This 32-item questionnaire assesses 8 facets: Noticing (ie, ability to identify bodily sensations), Not Distracting (ie, willingness to experience discomfort), Not Worrying (ie, not becoming upset by discomfort), Attention Regulation (ie, able to attend to bodily sensations despite external distraction), Emotional Awareness (ie, noticing how body responds to emotions), Self-Regulation (ie, ability to find inner calmness), Body Listening (ie, seeking emotional information from bodily sensations), and Trusting (ie, feeling safe in one's body) (subscale α 's = .73–.91).

Data analysis

Missing data and invalid responses were evaluated. In instances when an individual provided <50% of the responses for a measure, the missing items were assigned the mean for the participant's responses that were present (ie, within-measure mean imputation where at least half or more of the responses were present). In instances when a participant had $\geq 50\%$ missing responses for a measure, the participant was excluded on a per-variable basis from analyses. Distribution normality was then evaluated for baseline variables, and skewness was addressed for the Negative Urgency subscale of the short UPPS-P using a square-root transformation. T -tests were performed to evaluate baseline differences between groups (see Table 1), and significant differences were found for Somatic Symptoms ($t = 2.167$, $P < .05$) and Range of Motion ($t = -2.509$, $P < .05$). Zero-order correlations were performed to examine relationships among baseline variables and demographic characteristics, and to identify potential covariates for further analyses. Primary analyses were performed with the aim of evaluating how standard treatment and the yoga intervention impacted outcome variables. Repeated-measures analyses of variance (ANOVAs) were performed for each outcome measure with time as the within-subjects variable, and treatment group (ie, treatment plus yoga vs treatment only) as the between-subjects factor. Given the financial nature of monetary delay discounting tasks, income was added as a covariate for evaluating k -values.

Results

Preliminary analyses

Zero-order correlations for the baseline measures of the full sample are reported in Supplemental Materials. Higher degrees

of substance involvement were associated with greater somatic, anxiety, and PTSD symptoms (r 's = .295–.449, P 's < .01), more severe drug cravings ($r = .267$, $P < .05$), greater impulsivity on all UPPS-P subscales (r 's = -.227 to -.381, P 's < .05), poorer self-efficacy ($r = -.380$, $P = .001$), and lower mindfulness on a number of indices (r 's = -.239 to -.373, P 's < .05). Higher severity of anxiety symptoms and drug cravings were both associated with several measures indicating greater impulsivity (r 's = -.258 to -.361, P 's < .05) and lower mindfulness (r 's = -.275 to -.356, P 's < .05).

Primary analyses

A significant main effect of time was observed for all domains of psychopathology assessed (Table 2). Significant decreases from pre- to post-treatment assessments were found in anxiety and PTSD Symptoms (Figure 2). There were no significant effects of group or interaction of time and group.

There was a significant main effect of time for physical symptoms (Table 2). Significant decreases over time were observed for somatic symptoms, whereas range of motion increased. A significant time by group interaction was also found for range of motion, such that individuals in the treatment plus yoga condition, but not those in the treatment only condition, experienced a significant improvement (Figure 3). There were no significant main effects or interaction observed for physical pain.

A significant main effect of treatment was found for drug cravings, Negative Urgency, and Lack of Premeditation, and increases over time for self-efficacy, Noticing, Not Worrying, Attention Regulation, Self-Regulation, Body Listening, and Trusting (Table 2).

A significant treatment by group interaction was found for Lack of Premeditation, such that individuals who were in the treatment plus yoga condition, but not treatment only, experienced significant improvement in the Lack of Premeditation facet of impulsive behavior (Figure 3).

Discussion

The goal of the current study was to evaluate the impact of an adjunctive yoga program in inpatient treatment for SUDs. Although the program had some specific effects, the most common pattern of findings was the general within-subjects effects of significant changes over time. Specifically, significant pre-post changes reflected improvements in numerous addiction-related outcomes, with the most robust effect observed for the Negative Urgency facet of impulsivity (ie, decreases in acting out during intense negative affect). It is possible these changes were attributable to participation in treatment-as-usual, although because the study did not use a waitlist or no-treatment control group, that inference cannot be made definitively. Reduced impulsivity may be a welcomed outcome, as recent meta-analyses have found greater trait impulsivity

predictive of poorer treatment response and higher rates of relapse following treatment.^{35,36} Of the UPPS-P impulsive personality traits, Negative Urgency and Lack of Premeditation have particularly been found to be the strongest predictors of poor SUD treatment outcomes.^{37,38}

Similar to reductions in Negative Urgency, significant increases were detected in all 6 domains of mindfulness, with the largest effects being for the Attention Regulation, Self-Regulation, Body Listening, and Trusting subscale of the MAIA. These results are complementary to the impulsivity findings, as a recent meta-analysis of mindfulness and impulsivity identified a moderate to large inverse relationship between mindfulness and Lack of Premeditation, and small to moderate effects for Negative Urgency, Positive Urgency, Sensation-Seeking, and Lack of Perseverance.³⁹ This is the case also for this study when considering the correlations among the measures. In other words, impulsivity and mindfulness appear to be considered “2 sides of the same coin.” Considered collectively, patients exhibited improvements over time in self-regulatory capacities related to both impulse control and mindful awareness.

From admission to discharge, robust decreases in drug craving and improved perceptions of self-efficacy to abstain from substances. Both drug craving and self-efficacy have been independently identified as important predictors for treatment outcome and risk of relapse,^{40,41} (p. 4) and the relationship between these 2 indices could be especially important for maintained abstinence. For example, the experience of intense cravings may weaken the ability to resist substances in early recovery. Alternatively, a person's belief that they are unable to control their substance use could limit their ability to resist cravings when they arise. Additionally, severity of PTSD, anxiety, and somatic symptoms all decreased over the course of the treatment program. This is consistent with other studies that found improvements in these psychiatric symptoms in response to SUD-focused treatment.⁴²⁻⁴⁴ Overall, pronounced decreases were observed for psychiatric symptoms and cravings, and pronounced increases were observed for psychological mechanisms that are considered supportive of post-treatment abstinence. These admission-to-discharge changes may be related to the treatment program, but, as noted, the extent to which that is the case cannot be determined in the absence of a non-treatment control group.

With regard to the yoga program, improvements were observed for Lack of Premeditation (ie, lack of propensity to consider future consequences before acting). Although the effect size was modest, it is nonetheless preliminary evidence that yoga may impact a form of impulsivity that most treatment programs fail to address. Elevations in this form of impulsivity have been linked to poorer treatment outcomes, and it has been proposed that relapse rates could be reduced if addiction treatments successfully strengthen premeditative thinking skills.³⁸ The current yoga program may therefore be

Table 2. Mixed analyses of variance examining effects of time and treatment group on treatment outcomes.

VARIABLES	MAIN EFFECT: TIME			MAIN EFFECT: TREATMENT GROUP			INTERACTION: TIME × GROUP		
	F	P	η_p^2	F	P	η_p^2	F	P	η_p^2
Drug cravings	89.09	<.01	0.55	0.01	.93	0.00	3.47	.07	0.05
Self-efficacy (BSCQ)	42.10	<.01	0.37	0.00	.99	0.00	1.67	.20	0.02
Anxiety symptoms	53.14	<.01	0.43	0.07	.80	0.00	1.06	.31	0.01
PTSD symptoms (n=25)	17.84	<.01	0.44	0.41	.53	0.02	0.60	.45	0.03
Range of motion	6.28	.01	0.08	3.64	.06	0.05	4.07	.05	0.05
Somatic symptoms	30.91	<.01	0.30	5.49	.02	0.07	0.02	.89	0.00
Brief pain inventory	8.69	<.01	0.11	1.32	.26	0.02	0.06	.81	0.00
Impulsivity (SUPPS-P)									
Negative urgency	131.44	<.01	0.64	1.72	.19	0.02	1.94	.17	0.03
Lack of perseverance	1.55	.22	0.02	2.71	.10	0.04	0.06	.811	0.00
Lack of premeditation	15.58	<.01	0.18	0.08	.77	0.00	4.50	.04	0.06
Sensation seeking	2.09	.15	0.03	0.29	.59	0.00	0.00	.95	0.00
Positive urgency	2.89	.09	0.04	1.39	.24	0.02	0.01	.92	0.00
Delay discounting	.06	.80	0.00	1.72	.20	0.02	2.23	.14	0.03
Mindfulness (MAIA)									
Noticing	6.56	.01	0.08	0.73	.40	0.01	0.25	.62	0.00
Not distracting	.38	.54	0.01	0.21	.65	0.00	0.81	.37	0.01
Not worrying	4.43	.04	0.06	0.24	.63	0.00	2.01	.16	0.03
Attention regulation	15.24	<.01	0.18	0.01	.92	0.00	0.26	.61	0.00
Emotional awareness	2.76	.10	0.04	0.00	.95	0.00	0.50	.48	0.01
Self-regulation	33.73	<.01	0.32	0.18	.67	0.00	1.84	.18	0.02
Body listening	30.39	<.01	0.30	0.01	.93	0.00	0.72	.40	0.01
Trusting	34.55	<.01	0.32	0.57	.45	0.01	0.50	.48	0.01

Abbreviations: BSCQ, brief situational confidence questionnaire; MAIA, Mindfulness and Interoceptive Awareness Scale; PTSD, post-traumatic stress disorder; S-UPPS-P, short UPPS scale.

a good candidate as a complementary therapy that reduces risk of relapse due to impulsivity. It is worthwhile to note that this finding is preliminary, and more research is needed to replicate this effect and to determine whether improvements in premeditation actually correspond to reduced relapse rates following treatment. Of note, the yoga program was also associated with a significant increase in range of motion, although the 2 groups differed on that measure at baseline and the impact brought the yoga group's performance to equivalence with the control group. It is important also to note that the significance values for both intervention effects would not survive correction for multiple comparisons.

Collectively, the selective impacts of the yoga intervention should be interpreted cautiously.

More generally, the findings from the current study should be interpreted with consideration of design strengths and limitations. The study was a naturalistic evaluation of an adjunctive yoga intervention, favoring external validity compared to internal validity. In other words, it emphasized the evaluation the implementation of the yoga program in the context of real-world practice, but did not emphasize holding the features of the background treatment program constant or including a control condition matched for time or attention. This is why, other than the yoga program and the

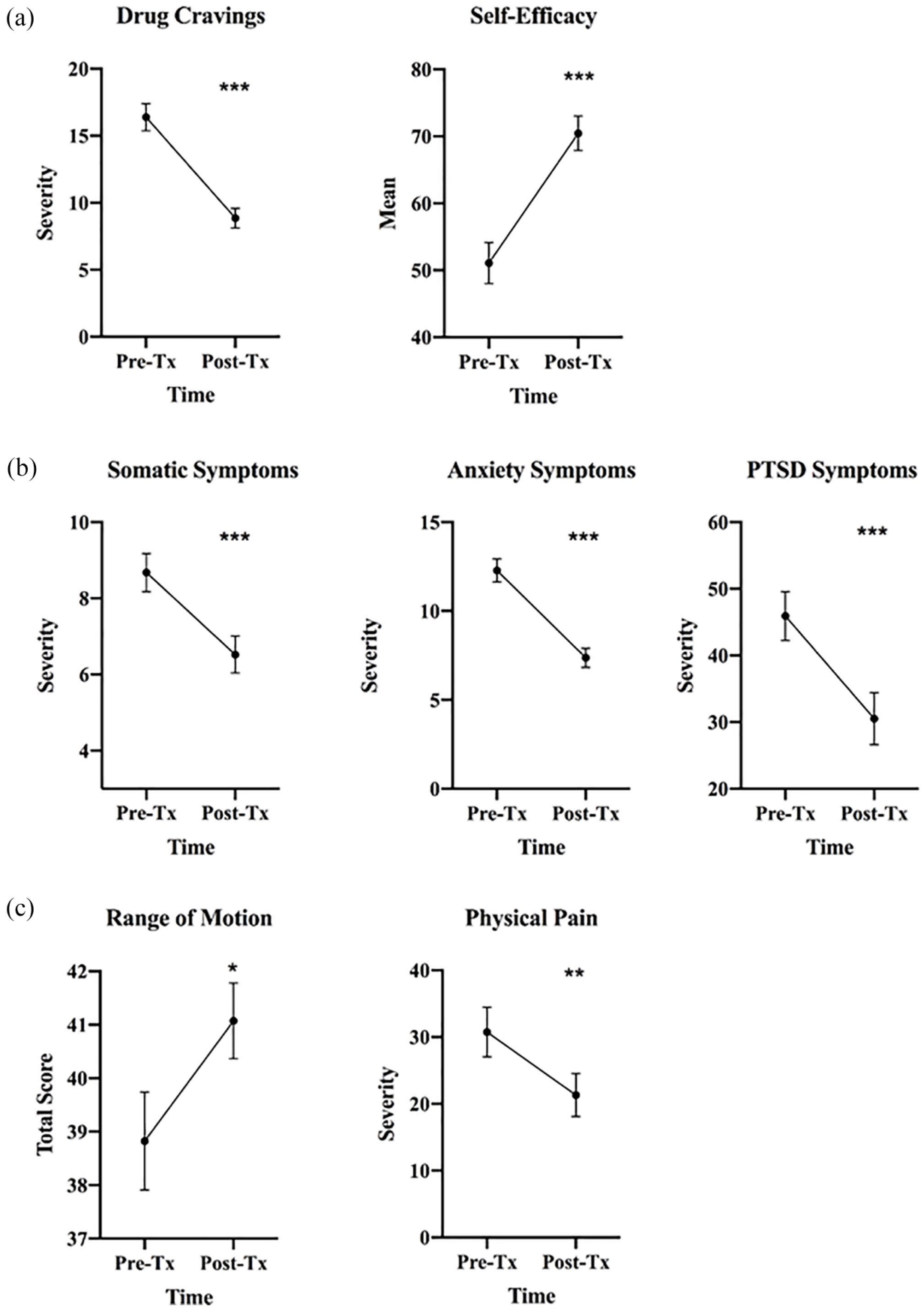


Figure 2. (Continued)

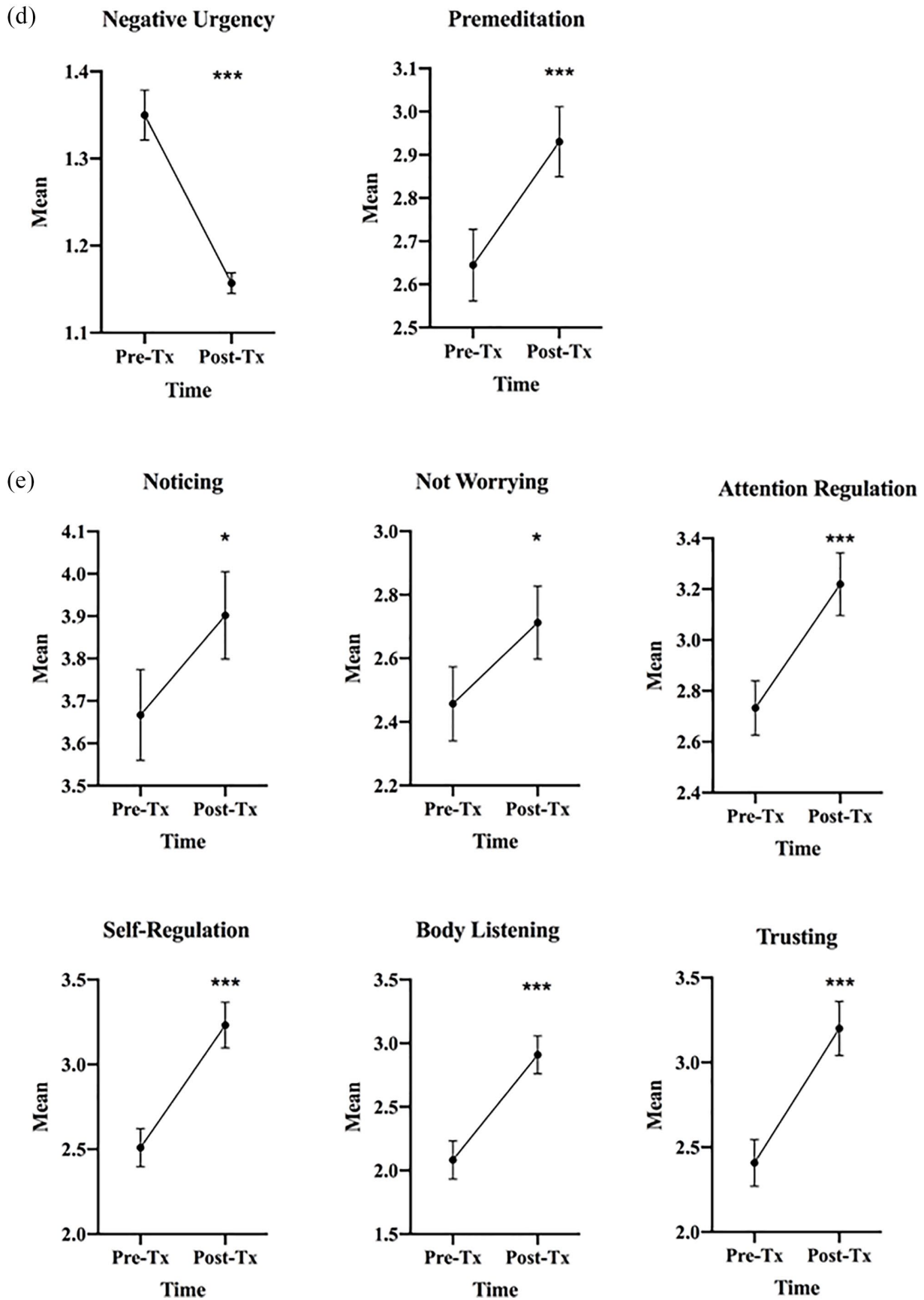


Figure 2. Estimated marginal means for significant main effects of time on outcome measures: (a) craving and self-efficacy, (b) psychiatric symptoms, (c) physical symptoms, (d) UPPS-P impulsivity subscales, and (e) MAIA mindfulness subscales.
 * $P < .05$. ** $P < .01$. *** $P < .001$.

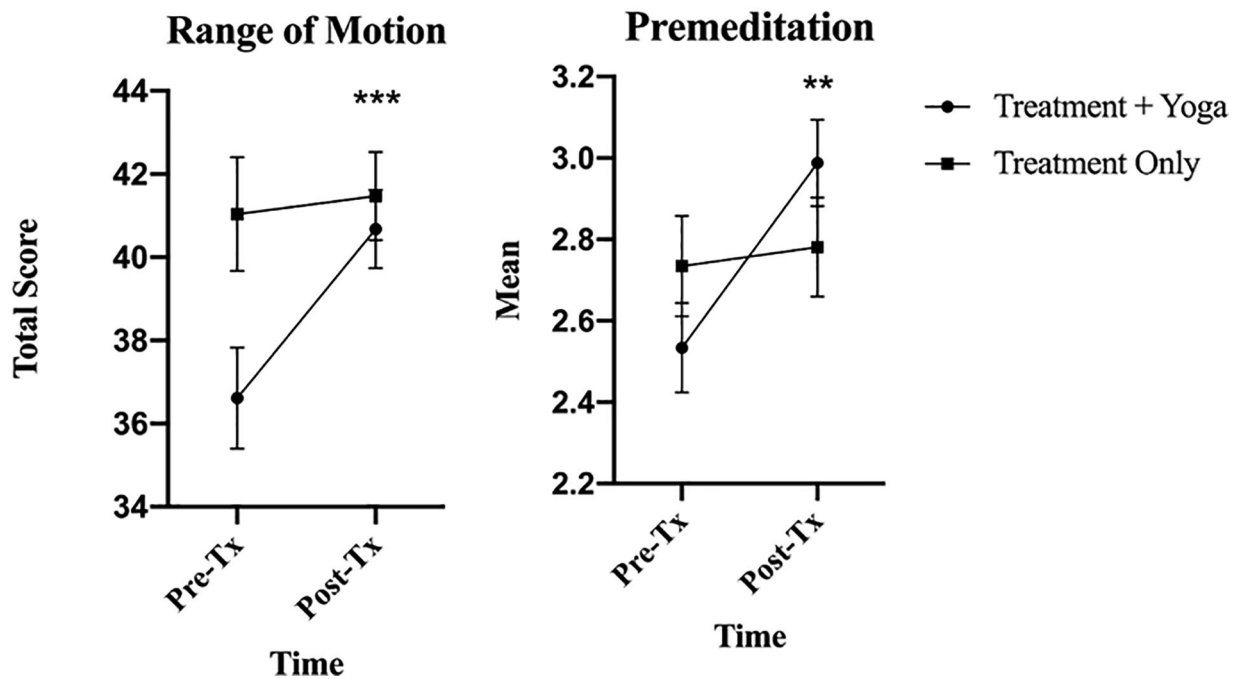


Figure 3. Estimated marginal means for significant interaction of time by group for range of motion and premeditation. ** $P < .01$. *** $P < .001$.

assessments, no other program changes were made and why there was no waitlist assessment or other non-treatment group. There are benefits and limitations to a design such as this. On one hand, a design with higher external validity may have greater generalizability to other clinical settings because it uses ongoing standard practice as a platform for intervention evaluation. On the other, a design with higher internal validity permits greater inference of specificity of impact from the intervention and would be expected to generate larger effect sizes by controlling more nuisance variables. A clear example of this in the current study is that the observed improvements from admission to discharge cannot be said to be caused by the treatment program, since the improvements could also be due to a general period of abstinence from substance use, independent of treatment. A further possibility for the high degree of external validity is that it is possible that there were unmeasured factors of treatment-as-usual that could have contributed to the results.

A number of other limitations and considerations bear mentioning. A sizeable proportion of women who were enrolled in the study and completed pre-treatment assessments dropped out of treatment, reducing the final group sizes. Substantial loss to follow-up is common in substance use treatment settings, as these voluntary inpatient treatment programs see high levels of participant drop-out or failure to complete treatment for other reasons. High drop-out rates were one of the considerations in planning this study to continue over a number of treatment cycles to maintain adequate sample sizes. Thus, despite being small, the final sample size was similar to, if not larger than, comparable studies of yoga in SUD treatment. That being said, the sample size was nonetheless small

and thus the study was only powered for relatively large intervention effect sizes. As the treatment program served only females, these results may not generalize to males. Another limitation is the late introduction of PTSD symptom assessment, which subsequently hampered the interpretability of those findings for the whole sample. Although representative of the local community, the patient sample was not ethnically diverse and therefore findings may not generalize to populations in other treatment programs. Lastly, another limitation was that there were no post-discharge follow-up assessments to evaluate long-term outcomes of treatment. While not a limitation per se, a consideration is whether the treatment program may have been sufficiently intense that adding another component might not be able to confer additional benefit. This is possible, although the measures used indicate that there was still room for improvement and do not suggest the outcomes were at asymptote.

Several strengths are also to be noted which address limitations in yoga treatment studies that have been commonly-identified in reviews (eg, Posadzki et al²²). One strength of the study design was the use of the existing treatment program as an active control, with temporal separation of cohorts in either condition. This allowed for the use of an active comparison group while maintaining participant blinding, which would not have been possible in treatment programs with rolling admissions where newly-admitted participants would soon find out that select clients are invited to do yoga. The yoga intervention was structured, having a standardized set of elements consistently provided in all sessions. This reduced the heterogeneity of yoga between sessions and between cohorts of participants, another common issue in similar studies. In addition, it

increased the transportability of the intervention into future studies and other settings. Lastly, the assessment battery was broad and included measures not commonly used in primary treatment settings (ie, impulsivity, delay discounting, mindful interoception), providing unique insights to the treatment effects on addiction-relevant personality mechanisms.

In terms of new knowledge for the field, the current study reveals positive impacts of adjunctive yoga in terms of pre-meditation (a predictor of poor prognosis) and range of motion, implying that if those outcomes are a priority (and resources are available), it is a viable add-on. In addition, these findings add to the growing literature documenting within-treatment changes in impulsivity and other mechanisms of behavior change. Collectively, these findings contribute to the small literature on the clinical utility of yoga in SUD treatment and suggest the need for further investigation in this area, especially in larger samples and with follow-up follow-ing discharge.

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Author Contributions

The evaluation was designed by TP and JM; the intervention and data collection was orchestrated by CY, LW, KD, KW, and DB; data processing was conducted by TP, LR, MA, and JM; data analysis was conducted by TP; all authors interpreted the results; TP and JM drafted the manuscript, and all authors provided editorial input.

ORCID iD

James MacKillop  <https://orcid.org/0000-0002-8695-1071>

Supplemental Material

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