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Behavioral and Psychophysiological Effects of a Yoga Intervention on High-Risk Adolescents: A Randomized Control Trial

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Abstract The purpose of this study was to conduct a pilot randomized control trial to test whether a mindful yoga intervention had a beneficial impact on substance use and its psychological and psychophysiological correlates in high-risk adolescents. Research on yoga has generated growing evidence for its positive effects on physical and emotional health. However, most studies are conducted with adults, with few controlled studies conducted with youth. We designed a 20-session mindful yoga intervention for adolescents attending a school for students at high-risk for dropping out. The 50-min classes were offered three times a week. The participants (mean age = 16.7 years) were randomly assigned to control and intervention groups. Multi-rater (student, teacher), multi-method (survey, cognitive, psychophysiological) data were collected before and after the yoga curriculum. At post-test, students in the yoga condition, as compared to control students, exhibited trends toward decreased alcohol use and improved teacher-rated social skills ($p < .10$); and showed a non-significant increase in arousal in response to relevant stimuli as measured in skin conductance. Significant effects were not found on hypothesized proximal measures of self-regulation, mood, mindfulness, or involuntary engagement coping. Future research is needed to replicate and expand upon our findings. Studies are also needed with larger samples to

further investigate potential mediators and moderators of yoga's effects.

Keywords Yoga · Mindfulness · Adolescents · Substance use · Stress reactivity

Introduction

Yoga is an ancient practice that combines breathing (prana), meditation, and movement (asana) to promote mindfulness and increase attention and awareness (Iyengar 1966; Lipton 2008). Yoga and mindfulness techniques are increasingly being used as tools to reduce stress and enhance wellness in various populations with different health concerns (Balasubramaniam et al. 2013; McCall et al. 2013; Serwacki and Cook-Cottone 2012). Studies document the effectiveness of yoga and mindfulness in reducing psychiatric symptoms (e.g., depression, anxiety) and improving attention and concentration (Matchim and Armer 2007; Teixeira 2008; Uebelacker et al. 2010). Moreover, research is emerging that explicates the underlying neural substrates influenced by mindfulness techniques (Kilpatrick et al. 2011; Singleton et al. 2014). Yet, despite this growing knowledge base, most studies are conducted with adult samples.

The Affective–Behavioral–Cognitive–Dynamic model of development (Greenberg et al. 1990; Greenberg and Kusche 1996) establishes the framework for studies aiming to identify effects of mindful yoga programs. As portrayed in Fig. 1, this model integrates emotional awareness, cognitive control over physiological stress responses, and contextual-cognitive processing. These processes form the basis for self-regulation—key protective processes against drug use (Griffin et al. 2006).

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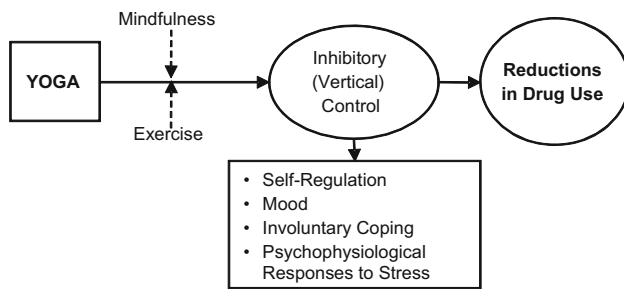


Fig. 1 Affective-behavioral-cognitive-dynamic model of development

Maturation of the prefrontal neural circuit subserves this developmental integration, thereby promoting the ability to exert effortful control over behavior in emotional contexts. These neurodevelopmental processes are particularly relevant to psychological and social adaptations during adolescence, when discrepancies in the pace of neurobiological development may lead to a disconnection between emotional regulation and behavioral restraint (Steinberg 2005). Adolescent risk behaviors such as drug use may be attenuated, delayed, or prevented by strengthening these underlying regulatory processes through mindful interventions, such as yoga.

A concept central to this model is vertical control, the process of higher-order cognitive processes inhibiting lower-level limbic impulses through the development of frontal cognitive control (Luria 1966). Poor vertical control is associated with impulsiveness, sensation seeking, and an inability to regulate emotional arousal under conditions of perceived threat, which predispose youth to externalizing behaviors such as substance abuse (McNamee et al. 2008). Yoga is theorized to enhance vertical control via practicing strategies for awareness and regulation of cognitions, emotions, and somatic sensations. Neuroimaging and electrophysiological studies suggest that the accentuated mindfulness promoted by yoga influences the underlying neurobiologic mechanisms that target regulatory and affective processes (Davidson et al. 2003; Davidson and McEwen 2012; Pagani et al. 2008). Therefore, by strengthening vertical control through mindful interventions such as yoga, it may be possible to attenuate, delay or prevent substance abuse.

A growing body of research attests to the effects of mindful interventions such as yoga on psychological states, although adult studies are more established and rigorous than studies conducted with children and adolescents (Serwacki and Cook-Cottone 2012). Studies with adults indicate that mindfulness is associated with greater emotional awareness, acceptance, and improved mood states (Brown et al. 2007; Feldman et al. 2007). Mindfulness and yoga also increase attention and positive affect, and

decreases negative affect and physical agitation (Salmon et al. 2008). Brain imaging studies further indicate that mindfulness is related to increased activation of brain regions responsible for modulating emotional responses via vertical control, as described above (Creswell et al. 2007). A recent review by Davidson and McEwen (2012) presents evidence for the effects of mindfulness-based practices on brain plasticity, concluding that there is potential to decrease stress reactivity through alterations in brain regions that regulate emotional responses.

The most heavily researched mindfulness intervention is the Mindfulness-Based Stress Reduction (MBSR) program, which includes a yoga component. MBSR has been shown to reduce a wide range of stress-based disorders among adults, including anxiety, mood, and panic disorders (Kabat-Zinn et al. 1992; Segal et al. 2002). In fact, of the MBSR elements, yoga is posited to be the most effective component in reducing psychological symptoms (Miller et al. 1995). Studies of yoga also show effects for reduced depression, anxiety, perceived stress, and negative affect (Cowen and Adams 2005; Shapiro et al. 2007; Woolery et al. 2004). Yoga and mindfulness interventions also reduce drug use and recidivism in adult prison populations (Bowen et al. 2006; Landau and Gross 2008).

Until recently, rigorous studies of the psychological effects of yoga with youth were sparse; however, more randomized control trials are beginning to emerge. Biegel et al. (2009) randomized adolescent psychiatric outpatients to either a control group or the MBSR program. Adolescents receiving the MBSR program reported reduced anxiety, depression, and hostility relative to controls. A number of recent studies of mindfulness interventions with youth show reductions in anxiety, negative coping (Leonard et al. 2013; Sibinga et al. 2013), rumination (Mendelson et al. 2010), depression (Raes et al. 2013), stress (Metz et al. 2013; Van de Weijer-Bergsma et al. 2012), and emotional arousal (Mendelson et al. 2010), and increased self-efficacy in emotional regulation (Metz et al. 2013). In addition, results from other school-based randomized control trial (RCT)s suggest that yoga may lead to reduced anger control and fatigue (Khalsa et al. 2011) and reduced mood disturbance and negative affect (Noggle et al. 2012).

Although studies with youth are beginning to examine psychological and behavioral outcomes, they have yet to concertedly examine the effects of yoga on adolescents' physiological responses to stress, with one exception. In a study of 6th graders, Hagins et al. (2013) did not find effects of yoga on stress responses, although different physiological indices were measured. The authors note that the lack of effects may have been due to either the inadequacy of the program or the measures. Thus, more needs to be learned about the extent to which physiological stress responses are a primary mechanism by which yoga

putatively exerts its positive effects on children and adolescents. Many studies with adults indicate that yoga improves psychophysiological responses to stress, as reflected in decreased salivary cortisol (West et al. 2004); low-frequency respiratory sinus arrhythmia (RSA) (Shapiro et al. 2007); skin conductance (SC) (Vempati and Telles 2002); and improved regulation of cardiovascular responses such as heart rate (Telles et al. 2004). RSA, SC, and heart rate are biological markers of individual-level traits reflective of self-regulation of behavior and emotion. These physiological responses operate to establish vertical control (Raine et al. 2000)—potentially explaining why aberrant physiological stress responses are consistently associated with the behavioral and psychological precursors of substance abuse (Iacono et al. 2000). Given that these physiological functions underlie the development of inhibitory control and emotional regulation—and that yoga has been shown to improve these functions in adults—we anticipate that yoga will improve psychophysiological stress responses in at-risk adolescents and, in turn, affect substance use behaviors. Adolescents may be particularly responsive to this approach given dramatic changes in brain maturation and plasticity in the context of social demands that enhance stress responsivity (Holder and Blaustein 2014; Leonard et al. 2013; Sibinga et al. 2014).

Our study extends the limited research on the effects of mindful yoga on adolescents and examines emotional, cognitive, and psychophysiological factors underlying risk for substance abuse. We hypothesized that students assigned to the yoga intervention condition would report reduced substance use (alcohol, marijuana, illicit drugs). We also hypothesized that students would report improvements in cognitive and affective processes that are hypothesized to underlie the effects of yoga on substance use, such as mindfulness, mood, and self-regulation. Finally, we hypothesized that yoga would lead to improved psychophysiological responses to stress reflected in indicators such as RSA, heart rate, SC.

Method

Participants

We implemented the study in a nontraditional, public school for grades 9–12 in a mid-sized city for students who had not succeeded in traditional schools and were at risk for dropping out. This “credit recovery” school used a self-paced, online curriculum that allows students to progress at their own pace. Many students entered the school behind 1–2 years in course credits, due to absenteeism, academic issues, or personal/family problems. The small environment also included personalized support (mentors and

counselors), and community-based learning (internships, job shadowing). Students were eligible for the study if they were age 14 or older.

Three cohorts of students were recruited: two from the high school program within the school and one from the middle school program. The intervention was conducted in fall 2010, spring 2011, and fall 2011. The baseline sample was 104, but 19 students dropped out of the school and/or the study following pre-testing. Thus, the final sample at post-test was 85 (40 control, 45 intervention). Sample sizes were similar across cohorts. Slightly more than half of the participants were female (54 %). The sample was ethnically diverse (59 % African-American; 17 % Hispanic; 9 % White; 14 % multi-racial), and students ranged in age from 14 to 20 (mean = 16.7 years). Within each cohort, students were randomly assigned to either the yoga intervention or care-as-usual (i.e., students went to their regularly scheduled classes) using the same procedures and proportions (half received the intervention in each cohort). Because of the nature of the school and its use of personalized instruction, there was no PE class that could serve as a control condition. The yoga intervention took place during a period that combined the students’ lunch and the second half of one of their classes (lunch was scheduled in the middle of a class period). The students ate lunch after yoga and control students had lunch during the second half of their class.

Procedures

To recruit participants, study team members made brief presentations in classrooms to describe the study. In addition, the yoga instructor demonstrated yoga poses to students and answered questions to further promote study recruitment. Students received a \$5 gift card for returning consent forms, regardless of participation status. Those who completed surveys were provided with \$20 gift cards pre and post yoga (\$40 total). Students who participated in the yoga condition received another \$20 gift card, and received an additional gift card of \$30 if they completed 80 % of the sessions. Students were recruited until each cohort reached approximately 33 participants.

The study received full Institutional Review Board approval as well as approval from the school district’s Department of Research. Due to requirements from the school district, parental consent was required for all students regardless of age; students also provided assent.

Yoga Intervention

The study team developed the 20-session mindful yoga curriculum (Miller et al. 2014). The team members brought extensive experience and knowledge in yoga practice,

developmental and clinical psychology, prevention of adolescent substance abuse and violence, curriculum development for preventive interventions, and mindfulness. We obtained additional input from (1) an expert panel of local practitioners with considerable implementation experience with youth similar to the school population; (2) a focus group with high-school seniors from the target school; and (3) the study's lead yoga instructor. Additionally, we consulted with another local yoga teacher who worked as a clinical social worker with high-risk adolescents in our community.

Based on feedback from students and experts regarding cultural and developmental sensitivity, we kept the mindfulness-based concepts were simple and repetitive, thus placing a strong emphasis on active learning and skill generalization. The curriculum utilized an acronym reflecting key mindfulness principles that were practiced and emphasized throughout the sessions *Be BOLD*—*B*reathe, *O*bserve, *L*et it go, and *D*o it again. This acronym provided a format for brief talking points regarding the benefits of a mindful yoga practice. Psychoeducational aspects focused on the use of mindfulness skills to manage stress. The curriculum reinforced skills generalization outside of session by covering how mindfulness could be applied in specific stressful situations (e.g., conflict with parent). Also covered were examples of how cognitions could influence behavior, and how students could simply observe their thoughts and let them pass (e.g. 'I can't do this homework right').

Sessions were provided three times a week at 50 min each over a 7 week timeframe. Each session followed a structured format that included goals and objectives; weekly mindfulness themes (e.g., focusing in the breath; stress; observing without judgment; awareness of thoughts and emotions; cultivating positive emotion; and skill integration). The sessions followed a consistent sequence that included an opening meditation/centering exercise (5 min); stretching and gentle movements (5 min); yoga postures (30 min) and their sequence; mindfulness prompts integrated into the yoga postures; and a closing meditation (10 min). The session concluded with an affirmation of respect to self and others. Sessions were completely secular and no Sanskrit language was used.

Across sessions, yoga postures were gradually added, including postures with increasing rigor. At the same time, the general sequence within sessions remained consistent as students learned new postures. The yoga style was hatha vinyasa flow, which involves sequencing basic yoga postures such that the students move from one posture to the next. The postures moved the body in different ways—bending forward, bending backwards, bending to the side, inverting (i.e., going upside down), twisting, and balancing. The postures were done standing, seated, and laying down.

Students were also taught meditation skills, and each session opened and closed with a brief meditation. The intervention was conducted in a dance studio in the school building during students' lunchtime. The studio was private and there were no distractions (e.g., other PE students) in the room. The room did include a mirror but students faced away from it. Students were provided a free lunch after the yoga session to compensate for missing lunch. The study provided yoga mats, props, and eye pillows, which were given to the students at the completion of the intervention. Students were encouraged, but not required, to dress in gym clothes.

The yoga sessions were taught by a lead instructor and an assistant instructor (both of whom were Registered Yoga Teachers through Yoga Alliance). The lead yoga instructor was an African American female who worked previously as a school social worker; the assistant yoga instructor was also a clinical social worker. Based on feedback from the Expert Panel, we hired a lead yoga teacher of similar race/ethnicity to the majority of the students.

Measures

Due to the physical nature of the yoga program, data were collected on health and fitness status to determine eligibility. Prior to study participation, the student and his or her parent each completed the Physical Activity Readiness Questionnaire (PARQ; American College of Sports Medicine 2000). This 7-item measure asks about health conditions that could potentially increase risk of injury or side effects from the yoga program (e.g., dizziness, breathlessness, high blood pressure, heart trouble). If the parent or student reported any of the conditions, the student was not permitted to participate.

Prior to full participation, we also assessed students' fitness level using a standard protocol adapted from the YMCA-approved protocol (Golding et al. 1989) to further confirm eligibility. Using a stationary bicycle, heart rate and blood pressure were monitored at rest and during each of the 3-min exercise segments to calculate submaximal intervals. Students were excluded from the study if their blood pressure exceeded 140/90 at rest or if their systolic blood pressure increased to ≥ 200 during exercise.

Multi-rater (student, teacher), multi-method (survey, cognitive, psychophysiological) data were collected before and after the 20-session yoga curriculum. Student surveys were completed via Audio Computer-Assisted Self-Interview (ACASI) using laptops with headphones to maximize comprehension, confidentiality, and accuracy. Questionnaires were completed during one class period (about 40 min) in a separate classroom under the guidance of a research assistant.

Abbreviated Dysregulation Inventory (ADI; Mezzich et al. 1997)

The 31-item ADI includes three subscales: emotional (arousability, weak emotional control, and irritability; $\alpha = 0.86$); behavioral (impulsivity, inattention, hyperactivity; $\alpha = 0.85$); and cognitive (poor problem solving and planning, inability to learn from experience, cognitive inflexibility; $\alpha = 0.85$). Students rated how true each statement was in the past month on a Likert-type scale from 1 (never true) to 4 (always true). This well-established instrument has been used with children, college students, and adults.

Response to Stress Questionnaire (RSQ; Connor-Smith et al. 2000)

The RSQ is a 57-item measure of coping that includes two major dimensions: voluntary coping (e.g., cognitive and behavioral adaptive strategies) and involuntary coping (disengagement, rumination, emotional numbing). We focused on the involuntary engagement coping scale, which encompasses rumination, intrusive thoughts, physiological and emotional arousal, and involuntary action. This subscale taps underlying mechanisms targeted by yoga and showed improvement in a study with children enrolled in a similar mindful yoga intervention (Gould et al. 2012; Mendelson et al. 2010). Students were asked to think about the types of coping strategies they had used in the past month to deal with stress related to friends or other kids. Alpha coefficients were as follows: Primary Control Subscale ($\alpha = 0.83$), Secondary Control Subscale ($\alpha = 0.84$), Disengagement Coping Subscale ($\alpha = 0.84$), Involuntary Engagement Coping Subscale ($\alpha = 0.91$), and Involuntary Disengagement Subscale ($\alpha = 0.87$). Potential coping responses were rated on a 4-point Likert-type scale from 1 (never true) to 4 (always true).

Five Facet Mindfulness Questionnaire (FFMQ; Baer et al. 2006)

The FFMQ is a 39-item measure that taps 5 dimensions of mindfulness: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience (e.g., “I notice feelings and emotions without having to react to them.” “I criticize myself for having irrational or inappropriate emotions.” “I was easily distracted.”). Respondents rated how true statements were in the past month on a 5-point scale from 1 (never or rarely true of me) to 5 (very often or always true of me). The Cronbach’s alpha for the total scale was 0.77.

Brunel Mood Scale (Terry et al. 2003)

This 24-item scale assessed negative mood states across six scales: anger ($\alpha = 0.82$), confusion ($\alpha = 0.83$), depression ($\alpha = 0.96$), fatigue ($\alpha = 0.88$), tension ($\alpha = 0.79$), and vigor ($\alpha = 0.79$). Items were rated on a scale from 1 (not felt this way at all in the past month) to 5 (felt this way extremely in the past month).

Drug Use Screening Inventory-Revised (DUSI-R; Tarter and Kirisci 2001)

The DUSI-R assessed the nature and extent of substance use, including alcohol, marijuana, other illicit drugs, and prescription drugs for nonmedical purposes. Students were asked how many times in the past month they used each drug or category of drugs; responses ranged from 0 (zero) to 4 (more than 20 times). Questions relating to alcohol and marijuana use also asked about quantity of use.

Behavior Assessment Scale for Children: Second Edition (BASC-2; Reynolds and Kamphaus 2004)

Teachers rated each student pre- and post-test on externalizing and social competency behaviors (46 items) on a 4-point scale ranging from 1 (never) to 4 (almost always). Approximately half of the teachers were willing to complete surveys for all participants. Each survey took approximately 10 min to complete, and teachers were paid \$10 for each student survey. Subscales and Cronbach alphas were conduct problems (0.92), social skill (0.92), attention Problems (0.92), and aggression (0.94). As students rotated class periods throughout the day, teachers had equivalent exposure to all study participants.

Stress Task and Physiological Assessment

The Stop-Change Task (SCT; Logan and Burkell 1986), a well-established measure of impulse control, was used as the stressful stimulus to evoke physiological arousal, allowing for an assessment of change in stress responses hypothesized to improve in response to the yoga intervention. The SCT requires intense concentration, impulse control, timing, and ability to shift responses to accommodate novel stimuli. Demanding and stressful continuous performance tasks (CPTs) such as these are known to elicit autonomic emotional and physiological stress responses, as measured in skin conductance (SC), heart rate (HR), and heart rate variability (HRV) (Blair 2003; Capuana et al. 2012; Fishbein et al. 2005). These measures were chosen to measure parasympathetic (HRV) and combined (parasympathetic and sympathetic) influences on the heart (HR). SC is a measure of sympathetic reactivity to environmental

stimuli modulated by the prefrontal cortex which regulates emotional responses (Nagai et al. 2004). A greater acute SC response to relevant stimuli (or threat) has been found to orient the individual to direct cognitive resources to obtaining more information or determining a course of action (Williams et al. 2006). Using these indicators, the autonomic cardiovascular response and recovery from stress can be described relatively completely (Sinha 2001).

Psychophysiological responses were monitored at five points: pre-stressor rest; paced breathing during the SCT; post-SCT relaxation; and post-SCT paced breathing. Paced breathing refers to 5 min of breathing 12 times per minute. People normally breathe at about 20 times per minute, so this paced breathing is significantly slower than normal breathing rate. J & J Engineering Biofeedback equipment (<http://www.jjengineering.com>) was used for these purposes. SC was measured by passing a very low current (that is not detectable to the participant) through surface electrodes attached to 2 fingers of the non-dominant hand. The same equipment measures HR, and HRV is derived from the differences among individual heart beats. Heart rate with the J & J device was measured with two surface electrodes taped to the lower chest. Earpieces were worn to confirm consistent findings between the earpiece and the J & J Engineering biofeedback system. The impulsivity-stress task lasted approximately 10 min.

Analysis

Prior to estimation of program effects, descriptive statistics examined item and composite distributions and missing data patterns. A small number of cases exhibited extreme scores on some outcomes. These cases were excluded from models estimating program effects when their outcome scores exceeded three standard deviations from the mean score. Additionally, we set a minimum dosage requirement of eight sessions for participation in the intervention. This cut-off was selected based on the length of MBSR (Kabat-Zinn et al. 1992) and mindfulness based cognitive therapy (Teasdale et al. 2000). These programs have been adapted for adolescents and shown to be efficacious (Biegel et al. 2009) and feasible (Sibinga et al. 2013) at this dosage. There is no agreement on dosage requirements for yoga interventions, although 8 sessions is the median duration (Cook-Cottone 2013) and change in underlying neural mechanisms for mindfulness have been identified with as few as 5 sessions (Tang et al. 2007). Thus, 15 of the 45 intervention students were excluded from the analyses, resulting in a total sample of 69 (39 control; 30 treatment). We compared students who attended at least eight sessions versus students who attended fewer than eight sessions and found no significant differences on indices of social skills, substance use, or emotional regulation.

A multilevel model equivalent to a two time-point longitudinal growth model was used to estimate the impact of the mindful yoga intervention on students (Singer and Willett 2003). Up to two observations were nested within each student, and the principal estimate of the intervention effect was the group (yoga vs. control) by time (pre to post) interaction. This parameter estimated differences in change over time by treatment condition. Models were estimated in SAS PROC MIXED or PROC GLIMMIX, depending on the distribution of the outcome (binary, continuous), and we included an intercept random effect. Age and gender were included as covariates in all models. The nominal Type I error rate was set at 0.10, owing to the small sample size and the exploratory nature of the pilot study (Sproull 2002; Warner 2008). The models controlled for age (which served as a proxy for cohort), and no significant differences were found across cohort.

Results

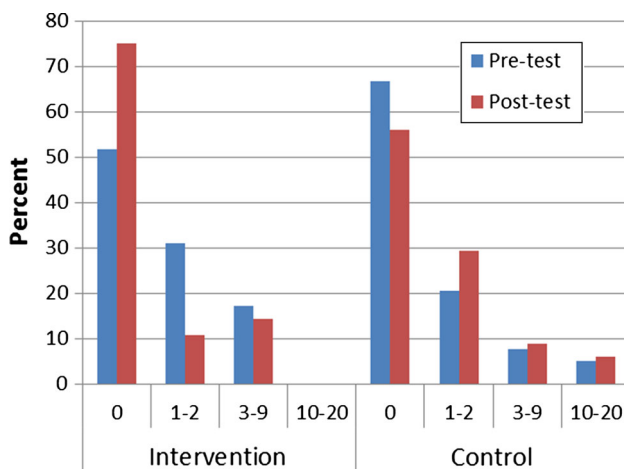
Table 1 shows the means for outcome scales at pre- and post-test. Marginally significant (at $p < .10$) differences in change over time were found for four outcomes: alcohol use, social skills, and two measures of stress reactivity as reflected in SC responses. The group by time interaction (interaction $\beta = -1.48$, $p < .10$), indicated a decrease in the frequency of alcohol use for the treatment group.

Figure 2 shows the past month level by time and group for each of the four alcohol response categories (i.e., none, 1–2 times, 3–9 times, or 10+ times in the past month). For the control group, the percentage of students reporting no alcohol use in the past month decreased, whereas the percentage of students reporting using alcohol once or twice or three or more times in the past month increased over time. In contrast—the percentage of students in the yoga condition who reported not drinking alcohol in the past month increased over time, while the percentage of students reporting drinking 1–2 times or 3–9 times decreased. Intervention differences were also found for teacher ratings of social skills (interaction $\beta = -1.48$, $p < .10$). The simple slope of the intervention group indicated a conventionally significant increase in social skills ($\beta = 1.77$, $p < .05$), whereas the comparison group decreased slightly ($\beta = -0.41$, ns).

Results also suggested positive effects for the yoga condition for SC. The average of 2 log-transformed conductance measures from two tasks showed group differences in change over time (interaction $\beta = 0.29$, $p < .10$). Average SC showed a decrease over time in the control students (at $p < .10$) while the intervention students showed a slight nonsignificant increase pre to post. This finding suggests increased arousal in response to the

Table 1 Observed means for questionnaire items

Measure	Pre (N = 99), mean (SD)	Post (N = 76), mean (SD)
ADI, total	2.01 (0.45)	2.02 (0.45)
ADI, emotional	2.04 (0.66)	1.98 (0.66)
ADI, behavioral	2.05 (0.58)	2.05 (0.65)
ADI, cognitive	1.92 (0.55)	2.05 (0.60)
RSQ, total	2.13 (0.56)	2.00 (0.59)
RSQ, involuntary engagement	1.88 (0.73)	1.72 (0.64)
FFMQ, total	2.69 (0.34)	2.66 (0.34)
Brunel, total	2.81 (0.86)	2.59 (0.83)
Brunel, anger	2.76 (1.17)	2.61 (1.14)
Brunel, confusion	2.39 (1.09)	2.08 (0.95)
Brunel, depression	2.33 (1.21)	2.08 (1.13)
Brunel, fatigue	3.21 (1.19)	3.00 (1.26)
Brunel, tension	2.52 (1.07)	2.35 (1.02)
Brunel, vigor	3.62 (1.00)	3.40 (1.11)
BASC-2 social skills	2.39 (0.66)	2.45 (0.58)
BASC-2 attention problems	2.24 (0.76)	2.33 (0.71)
BASC-2 aggression	1.48 (0.54)	1.51 (0.56)
DUSI-alcohol	0.41 (0.50)	0.35 (0.48)
DUSI-marijuana	0.38 (0.49)	0.31 (0.47)
DUSI-illicit	0.34 (0.48)	0.17 (0.38)

**Fig. 2** Yoga pre-post effects: past month alcohol use

stressful stimuli during the impulsivity task in the yoga students relative to the controls. Table 2 shows the model estimated means by group and time for these outcomes.

Table 2 Model estimated means

Outcome	Control		Intervention	
	Pre-test	Post-test	Pre-test	Post-test
BASC: social skills	19.61	19.20	18.85	20.62
Skin conductance, log transformed	1.53	1.33	1.48	1.56

N = 69. Estimates from models including group, time, sex, and age. Models exclude cases with outcomes outside ± 3 SD

There were no differences between the control and yoga conditions on self-reported levels of mindfulness, emotional regulation, or involuntary engagement coping.

Discussion

Findings from this pilot study add to the small but growing body of research on the potential benefits of yoga for youth (Khalsa et al. 2011; Lau and Hue 2011; Sibinga et al. 2011). The results are encouraging and show positive effects across a number of domains. Specifically, students who received the yoga intervention, as compared to students in the control condition, reported decreased alcohol use; were rated by their teachers as having improved social functioning; and exhibited a non-significant increase in sustained attention during a stressful task.

Our study's findings for alcohol use are promising and suggest the utility of yoga as a preventive intervention for high-risk adolescents. In particular, the findings are striking

in relation to students' lower levels of alcohol use. As depicted in Fig. 2, whereas 31 % of yoga students reported having 1–2 drinks in the past 30 days, this proportion decreased to 11 % at post-test (compared to a 9 % increase in the control group). In addition, the proportion of yoga students reporting no alcohol use increased from pre- to post-test by more than 20 % (whereas control students decreased by about 11 %). However, significant changes were not seen, either in the yoga or control conditions, for higher levels of alcohol use (3–9 drinks or 10–20 drinks in the past 30 days). Although purely speculative, it may be that yoga may have its greatest effect on youth who are experimenting with or using alcohol only occasionally, rather than youth with more established and higher levels of use. Our mindful yoga program was designed to exert preventive effects and would not be expected to be similarly effective in youth in need of more intensive alcohol intervention/treatment. Although studies have found effects of yoga and mindfulness on alcohol use in adults (Khanna and Greeson 2013), to our knowledge, this is the first study to find yoga effective in reducing alcohol use among adolescents. Further research is needed to replicate these findings. Future research would also benefit from examination of web-based interventions, for which there is a small, but growing body of literature (Gluck and Maercker 2011; Thompson et al. 2010). Such interventions may be a useful adjunct to school-based sessions to promote practice outside of sessions.

Our study's effects on teacher-reported social skills are important and show that yoga not only decreases problem outcomes, but also enhances positive outcomes, such as social skills. Students who participated in the yoga intervention showed increases in prosocial behaviors, such as complimenting others, offering encouragement to others, offering to help, and trying to bring out the best in people. This finding is intriguing because the intervention did not directly target instruction of social skills. We can speculate that yoga may have helped students feel calmer and less stressed, which could facilitate improved social skills. The mindfulness skills may also have encouraged prosocial behaviors by helping students identify uncomfortable emotions and letting them pass rather than reacting impulsively. Yoga may also have led to increased positive affect, which could further enhance social skills; however, the positive affect may have been too transitory to be captured in our measures. These findings support the need for future research to incorporate prosocial and resiliency measures.

One of the particular strengths of this study is the inclusion of psychophysiological measures to assess stress reactivity. To the best of our knowledge, this is only one of two yoga studies in adolescents to include monitoring of psychophysiological responses to stress known to be

associated with drug abuse and targeted by mindful interventions in general (Hagins et al. 2013). Hagins et al. (2013) did not find evidence for the effects of yoga on blood pressure or heart rate; SC, a more direct reflection of prefrontal functioning, was not included. Thus, although a number of other studies with youth find effects of yoga on attention (Van de Oord 2012), none have assessed SC during stress, which is indicative of a heightened state of arousal. Sustained SC activity is attributed to anxiety and heightened levels of stress. In contrast, higher SC occurring acutely during a demanding cognitive task is often considered a measure of an orienting response to allocate resources needed to process relevant incoming information. Children with attentional problems are more likely to have impaired inhibition (Plizka et al. 2006); thus, they have difficulty suppressing responses and evidence deficits in behavioral and emotional regulation (Walcott and Landau 2004). Strengthening ventral control over behavioral and emotional responses via yoga may translate to enhanced effortful prefrontal inhibitory control over emotional experiences (McNamee et al. 2008). In turn, this improved inhibitory control may enable suppression of inappropriate behavioral responses and increase attention to salient stimuli.

In essence, targeted training in inhibitory and attentional skills may exert higher-order changes that can be measured downstream through their effects on targeted functions. The result is, hypothetically, an attenuation of the behavioral and psychophysiological conditions that predispose to drug abuse. We posit that the mindfulness skills in our program relating to students observing their physiological arousal and breath may have helped students deal with stress regulation. Additional studies are needed with a larger sample size to replicate the findings, and determine the mediating effects of these putative mechanisms in yoga's effects on drug use.

On the other hand, effects did not surface in several other anticipated domains, such as emotional, behavioral, and cognitive regulation, mindfulness, involuntary engagement, coping, and mood. We can speculate a number of potential explanations for the lack of findings. These null findings are most likely a result of the small sample size and the relatively low dose of the intervention. Further, the mindfulness measure (FFMQ) was developed for adults, and its reading level and sophistication may have compromised its utility with adolescents. The Child and Adolescent Mindfulness measure (CAMM; Greco et al. 2011) was not available when this study began, and it is likely more developmentally appropriate for this sample. Although other studies have found an effect on involuntary engagement coping (Mendelson et al. 2010), ours did not. It may be that our intervention did not have enough focus or practice time on letting go of intrusive thoughts.

The lack of findings for self-regulation (ADI) and mood (Brunel) are puzzling, particularly given significant findings for alcohol use. It may be that yoga's effects are more subtle than what is captured by these measures. Instruments designed for clinical populations that are often more sensitive to change may prove useful. It is also plausible that a more intensive dosage is needed to affect complex regulatory processes. Our theoretical model represents an initial effort to hypothesize mechanisms that underlie the effects of yoga and is in need of additional theorizing and testing. Future research may benefit from examination of additional processes and continued refinement of our model. Given yoga's emphasis on somatic sensations, fruitful areas for exploration include interoceptive and proprioceptive awareness.

The study contains a number of limitations. First and foremost, as a pilot study, the sample size was small, which limited the statistical power to detect effects. The combination of the small sample, attrition and irregular attendance at the yoga intervention constrains our ability to conduct a full outcome assessment. A larger sample will provide the ability to confirm our findings and possibly identify additional effects on the hypothesized putative mediators. Students were also off-task some of the time, which may have decreased the potential effect of yoga. Further attention is needed regarding the implementation of yoga in school settings. As noted by Mendelson et al. (2013), implementation challenges in schools include minimizing burden on teachers and administrators and securing support for the study from school staff. Also, imposing structure and using behavior management strategies constitutes another challenge, particularly when working with high-risk youth, although the benefits if implemented effectively are expected to be measurable. In addition, we did capture some information that may have been useful in interpreting results, including the degree to which students dressed appropriately for yoga and their prior experience with yoga or similar types of body work.

Another limitation that may have impacted results is that students self-selected into the study and more than likely had some interest in yoga. In addition, although we randomized students, the control students may have been disappointed that they did not receive the program. Further, the control students did not receive an active treatment because this school did not offer regular PE classes; thus future designs should include control conditions with regular exercise. It is also possible that there was bias in teacher reports. School teachers were not blinded regarding what students were in the yoga condition. However, anecdotal data suggests that teachers were not aware of which students attended yoga, as sessions took place during the lunch hour and did not require that students miss class periods. In addition, the dosage of yoga students received

may have been a limitation. Although there are no accepted standards for therapeutic dosage in yoga research (Cook-Cottone 2013), it is possible that the average dosage that the students received was not sufficient to affect some regulatory processes. Movement accounted for 35 min of the class which, at 3 times a week, is less than the 150 recommended minutes of weekly exercise per the Department of Health and Human Services physical activity guidelines (2008). Finally, the internal consistency of the FFMQ was also comparatively low, and research is needed to develop measures that are developmentally relevant for children and adolescents.

This preliminary research provides further evidence that yoga has beneficial effects on psychological well-being in adolescents across multiple measurement types and domains (Birdee et al. 2009; Feldman et al. 2007; Greenberg and Harris 2012). High-risk youth are in particular need of innovative interventions to prevent and reduce drug use. School-based drug use prevention efforts tend to involve universal programs (e.g., Botvin and Griffin, 2007), rather than targeting those at highest risk. Also, interventions are often not tailored to the cultural needs of minority youths who face greater adversity. A report by the American Psychological Association's (APA) Task Force on Resilience and Strength in Black Children and Adolescents emphasizes the importance of culturally tailored approaches to teach self-regulation to protect against ecological stressors (e.g., racism and poverty) (APA 2008). This initial study suggests that providing yoga for this population is feasible and affirms the feasibility of providing yoga in a school-based setting. Further testing and refinement of our theoretical model and curriculum may be informative, particularly in light of the malleability of these maturational processes.

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References

- American College of Sports Medicine. (2000). *ACSM's guidelines for exercise testing and prescription* (6th ed.). Baltimore: Lippincott Williams & Wilkins.
- American Psychological Association, Task Force on Resilience and Strength in Black Children and Adolescents. (2008). *Resilience*

- in African American children and adolescents: A vision for optimal development. Washington, DC: Author. Retrieved from <http://www.apa.org/pi/cyf/resilience.html>
- Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45.
- Balasubramaniam, M., Telles, S., & Doraiswamy, P. M. (2013). Yoga on our minds: A systematic review of yoga for neuropsychiatric disorders. *Frontier Psychiatry*. doi:10.3389/fpsy.2012.00117
- Biegel, G. M., Brown, K. W., Shapiro, S. L., & Schubert, C. M. (2009). Mindfulness-based stress reduction for the treatment of adolescent psychiatric outpatients: A randomized clinical trial. *Journal of Consulting and Clinical Psychology, 77*(5), 855–866.
- Birdee, G. S., Yeh, G. Y., Wayne, P. M., Phillips, R. S., David, R. B., & Gardiner, P. (2009). Clinical applications of yoga for the pediatric population: A systematic review. *Academic Pediatrics, 9*(4), 212–220.
- Blair, C. (2003). Behavioral inhibition and behavioral activation in young children: relations with self-regulation and adaptation to preschool in children attending head start. *Developmental Psychobiology, 42*(3), 301–311.
- Botvin, G. J., & Griffin, K. W. (2007). School-based programs to prevent alcohol, tobacco, and other drug use. *International Review of Psychiatry, 19*(6), 607–615.
- Bowen, S. W., Witkiewitz, K., Dillworth, T. M., Chawla, N., Simpson, T., Ostafin, B. D., et al. (2006). Mindfulness meditation and substance use in an incarcerated population. *Psychology of Addictive Behaviors, 20*, 343–347.
- Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundation and evidence of its salutary effects. *Psychological Inquiry, 18*, 211–237.
- Capuana, L. J., Dywan, J., Tays, W. J., & Segalowitz, S. J. (2012). Cardiac workload and inhibitory control in younger and older adults. *Biological Psychology, 90*(1), 60–70.
- Connor-Smith, J. K., Compas, B. E., Wadsworth, M. E., Thomsen, A. H., & Saltzman, H. (2000). Responses to stress in adolescence: Measurement of coping and involuntary stress responses. *Journal of Consulting and Clinical Psychology, 68*, 976–992.
- Cook-Cottone, C. (2013). Dosage as a critical variable in yoga therapy research. *International Journal of Yoga Therapy Research, 23*(2), 11–12.
- Cowen, V. S., & Adams, T. B. (2005). Physical and perceptual benefits of yoga asana practice: Results of a pilot study. *Journal of Bodywork and Movement Therapies, 9*(13), 211–219.
- Creswell, J. D., Way, B. M., Eisenberger, N. I., & Lieberman, M. D. (2007). Neural correlates of dispositional mindfulness during affect labeling. *Psychosomatic Medicine, 69*(6), 560–565.
- Davidson, R. J., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S. F., et al. (2003). Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine, 65*, 564–570.
- Davidson, R. J., & McEwen, B. S. (2012). Social influences on neuroplasticity: Stress and interventions to promote well-being. *Nature Neuroscience, 15*(5), 689–695.
- Department of Health and Human Services. (2008). *2008 physical health guidelines for Americans*. Retrieved from <http://www.health.gov/paguidelines/guidelines/#pag>
- Feldman, G., Hayes, A., Kumar, S., Greeson, J., & Laurenceau, J.-P. (2007). Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-revised (CAMS-R). *Journal of Psychopathology and Behavioral Assessment, 29*, 177–190.
- Fishbein, D., Hyde, C., Eldreth, D., London, E. D., Matochik, J., Ernst, M., et al. (2005). Cognitive performance and autonomic reactivity in abstinent drug abusers and nonusers. *Experimental Clinical Psychopharmacology, 13*(1), 25–40.
- Gluck, T. M., & Maercker, A. (2011). A randomized controlled pilot study of a brief web-based mindfulness training. *BMC Psychiatry, 11*, 175.
- Golding, L., Myers, C., & Sinning, W. (Eds.). (1989). *The Y's way to physical fitness*. Champaign, IL: Human Kinetics.
- Gould, L. F., Dariotis, J. K., Mendelson, T., & Greenberg, M. T. (2012). A school-based mindfulness intervention for urban youth: Exploring moderators of intervention effects. *Journal of Community Psychology, 40*(8), 968–982.
- Greco, L. A., Baer, R. A., & Smith, G. T. (2011). Assessing mindfulness in children and adolescents: Development and validation of the child and adolescent mindfulness measure (CAMM). *Psychological Assessment, 23*(3), 606–614.
- Greenberg, M. T., & Harris, A. R. (2012). Nurturing mindfulness in children and youth: Current state of research. *Child Development Perspectives, 6*(2), 161–166.
- Greenberg, M. T., & Kusche, C. A. (1996). *The PATHS Project: preventive intervention for children*. Final report prepared for the National Institute of Mental Health (Grant Number R01MH42131). State College, PA: Pennsylvania State University, College of Health and Human Development, Prevention Research Center for the Promotion of Human Development.
- Greenberg, M. T., Kusche, C. A., & Speltz, M. (1990). Emotional regulation, self-control and psychopathology: The role of relationships in early childhood. In D. Cicchetti & S. Toth (Eds.), *Rochester symposium on developmental psychopathology* (Vol. 2). New York: Cambridge University Press.
- Griffin, K. W., Botvin, G. J., & Scheier, L. M. (2006). Racial/ethnic differences in the protective effects of self-management skills on adolescent substance use. *Substance Abuse, 27*(1–2), 47–52.
- Hagins, M., Haden, S. C., & Daly, L. A. (2013). A randomized controlled trial on the effects of yoga on stress reactivity in 6th grade students. *Evidence-Based Complementary and Alternative Medicine: eCAM, 2013*, 607134.
- Holder, M. K., & Blaustein, J. D. (2014). Puberty and adolescence as a time of vulnerability to stressors that alter neurobehavioral processes. *Frontiers in Neuroendocrinology, 35*(1), 89–110.
- Iacono, W. G., Carlson, S. R., & Malone, S. M. (2000). Identifying a multivariate endophenotype for substance use disorders using psychophysiological measures. *International Journal of Psychophysiology, 38*(1), 81–96.
- Iyengar, B. K. S. (1966). *Light on yoga*. New York: Schocken Books.
- Kabat-Zinn, J., Massion, A. O., Kristeller, J., Peterson, L. G., Fletcher, K., Pbert, L., et al. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *American Journal of Psychiatry, 149*, 936–943.
- Khalsa, S. B., Hickey-Schultz, L., Cohen, D., Steiner, N., & Cope, S. (2011). Evaluation of the mental health benefits of yoga in a secondary school: A preliminary randomized controlled trial. *Journal of Behavioral Health Services and Research, 39*, 80–90.
- Khanna, S., & Greeson, J. M. (2013). A narrative review of yoga and mindfulness as complementary therapies for addiction. *Complementary and Therapeutic Medicine, 21*, 244–252.
- Kilpatrick, L. A., Suyenobu, B. Y., Smith, S. R., Bueller, J. A., Goodman, T., Creswell, J. D., et al. (2011). Impact of mindfulness-based stress reduction training on intrinsic brain connectivity. *Neuroimage, 56*(1), 290–298.
- Landau, P. S., & Gross, J. B. J. (2008). Low reincarceration rate associated with Ananda Marga yoga and meditation. *International Journal of Yoga Therapy, 18*(1), 43–48.
- Lau, N., & Hue, M. (2011). Preliminary outcomes of a mindfulness-based programme for Hong Kong adolescents in schools: Well-being, stress and depressive symptoms. *International Journal of Children's Spirituality, 16*, 315–330.
- Leonard, N. R., Jha, A. P., Casarjian, B., Goolsarran, M., Garcia, C., Cleland, C. M., et al. (2013). Mindfulness training improves

- attentional task performance in incarcerated youth: A group randomized controlled intervention trial. *Frontiers in Psychology*, 4, 792.
- Lipton, L. (2008). Using yoga to treat disease: An evidence-based review. *Journal of the American Association of Physician Assistants*, 21(2), 34–41.
- Logan, G. D., & Burkell, J. (1986). Dependence and independence in responding to double stimulation: A comparison of stop, change and dual-task paradigms. *Journal of Experimental Psychology: Human Perception and Performance*, 12, 549–563.
- Luria, A. R. (1966). *Human brain and psychological processes*. New York: Harper & Row.
- Matchim, Y., & Armer, J. M. (2007). Measuring the psychological impact of mindfulness meditation on health among patients with cancer: A literature review. *Oncology Nursing Forum*, 34(5), 1059–1066.
- McCall, M. C., Ward, A., Roberts, N. W., & Heheghan, C. (2013). Overview of systematic reviews: Yoga as a therapeutic intervention for adults with acute and chronic health conditions. *Evidence-Based Complementary and Alternative Medicine*. doi:10.1155/2013/945895
- McNamee, R. L., Dunfee, K. L., Luna, B., Clark, D. B., Eddy, W. F., & Tarter, R. E. (2008). Brain activation, response inhibition, and increased risk for substance use disorder. *Alcohol Clinical and Experimental Research*, 32(3), 405–413.
- Mendelson, T., et al. (2013). Implementing mindfulness and yoga in urban schools: A community-academic partnership. *Journal of Children's Services*, 8(4), 276–291.
- Mendelson, T., Greenberg, M. T., Dariotis, J. K., Gould, L. F., Rhodes, B. L., & Leaf, P. J. (2010). Feasibility and preliminary outcomes of a school-based mindfulness intervention for urban youth. *Journal of Abnormal Child Psychology*, 8(7), 985–994.
- Metz, S. M., Frank, J. L., Reibel, D., Cantrell, T., Sanders, R., & Broderick, P. C. (2013). The effectiveness of the learning to BREATHE program on adolescent emotion regulation. *Research in Human Development*, 10(3), 252–272. doi:10.1080/15427609.2013.818488
- Mezzich, A. C., Tarter, R. E., Giancola, P. R., Lu, S., Kirisci, L., & Parks, S. (1997). Substance use and risky sexual behavior in female adolescents. *Drug and Alcohol Dependence*, 44, 157–166.
- Miller, J. J., Fletcher, K., & Kabat-Zinn, J. (1995). Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. *General Hospital Psychiatry*, 17, 192–200.
- Miller, S., Stahl, M. H., Fishbein, D. H., Lavery, B., Johnson, M. D., & Markovits, L. I. (2014). Use of formative research to develop a yoga curriculum for high-risk youth: Implementation considerations. *Advances in School Mental Health Promotion*, 7(3), 171–183.
- Nagai, Y., Critchley, H. D., Featherstone, E., Trimble, M. R., & Dolan, R. J. (2004). Activity in ventromedial prefrontal cortex covaries with sympathetic skin conductance level: A physiological account of a “default mode” of brain function. *Neuroimage*, 22(1), 243–251.
- Nogge, J. J., Steiner, N. J., Minami, T., & Khalsa, S. (2012). Benefits of yoga for psychosocial well-being in a U.S. high school curriculum: A preliminary randomized controlled trial. *Journal of Developmental and Behavioral Pediatrics*, 33(3), 193–201.
- Pagani, G., Cekic, M., & Guo, Y. (2008). “Thinking about not thinking:” Neural correlates of conceptual processing during Zen meditation. *PLoS ONE*, 3(9), e3083.
- Plizka et al. (2006). Neuroimaging of inhibitory control areas in children with attention deficit hyperactivity disorder. *American Journal of Psychiatry*, 163(6), 1052–1060.
- Raes, F., Griffith, J. W., Van der Gucht, K. J., & Williams, G. (2013). School-based prevention and reduction of depression in adolescents: A cluster-randomized controlled trial of a mindfulness group program. *Mindfulness*. doi:10.1007/s12671-013-0202-1
- Raine, A., Lencz, T., Bihrl, S., LaCasse, L., & Colletti, P. (2000). Reduced prefrontal gray matter volume and reduced autonomic activity in antisocial personality disorder. *Archives of General Psychiatry*, 57(2), 119–127.
- Reynolds, C. R., & Kamphaus, R. W. (2004). *BASC-2: Behavior assessment system for children, second edition manual*. Circle Pines, MN: American Guidance Service.
- Salmon, P., Lush, E., Jablonski, M., & Sephton, S. E. (2008). Yoga and mindfulness: Clinical aspects of an ancient mind/body practice. *Cognitive and Behavioral Practice*, 16(1), 59–72. doi:10.1016/j.cbpra.2008.07.002
- Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. New York: Guilford.
- Serwacki, M. L., & Cook-Cottone, C. (2012). Yoga in the schools: A systematic review of the literature. *International Journal of Yoga Therapy*, 22(1), 101–110.
- Shapiro, D., Cook, I. A., Davydov, D. M., Ottaviani, C., Leuchter, A. F., & Abrams, M. (2007). Yoga as a complementary treatment for depression: Effects of traits and moods on treatment outcomes. *Evidence-Based Complementary and Alternative Medicine*, 4(4), 492–502. doi:10.1093/ecam/nel114
- Sibinga, E., Kerrigan, D., Stewart, M., Johnson, K., Magyari, T., & Ellen, J. (2011). Mindfulness instruction for urban youth. *Journal of Alternative and Complementary Medicine*, 17, 1–6.
- Sibinga, E. M., Perry-Parrish, C., Chung, S. E., Johnson, S. B., Smith, M., & Ellen, J. M. (2013). School-based mindfulness instruction for urban male youth: A small randomized controlled trial. *Preventive Medicine*, 57(6), 799–801. doi:10.1016/j.ypmed.2013.08.027
- Sibinga, E. M., Perry-Parrish, C., Thorpe, K., Mika, M., & Ellen, J. M. (2014). A small mixed-method RCT of mindfulness instruction for urban youth. *Explore (NY)*, 10(3), 180–186.
- Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Methods for studying change and event occurrence*. New York: Oxford University Press.
- Singleton, O., Holzel, B. K., Vangel, M., Brach, N., Carmody, J., & Lazar, S. W. (2014). Change in brainstem gray matter concentration following mindfulness-based intervention is correlated with improvement in psychological well-being. *Human Neuroscience*, 18, 33.
- Sinha, R. (2001). How does stress increase risk of drug abuse and relapse? *Psychopharmacology (Berl)*, 158(4), 343–359.
- Sproull, N. L. (2002). *Handbook of research methods: A guide for practitioners and students in the social sciences*. Lanham, MA: Scarecrow Press.
- Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Science*, 9(2), 69–74.
- Tang, Y. Y., et al. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings from the National Academy of Science*, 104(43), 1712–17154.
- Tarter, R. E., & Kirisci, L. (2001). Validity of the Drug Use Screening Inventory for predicting DSM-III-R substance use disorder. *Journal of Child and Adolescent Substance Abuse*, 10(4), 45–53.
- Teasdale, J. D., Segal, Z. V., Williams, J. M., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence of major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology*, 68, 615–623.
- Teixeira, M. E. (2008). Meditation as an intervention for chronic pain: An integrative review. *Holistic Nursing Practice*, 2, 225–234.

- Telles, S., Joshi, M., Dash, M., Raghuraj, P., Naveen, K. V., & Nagendra, H. R. (2004). An evaluation of the ability to voluntarily reduce the heart rate after a month of yoga practice. *Integrated Physiology and Behavioral Science*, *39*, 119–125.
- Terry, P. C., Lane, A. M., & Fogarty, G. J. (2003). Construct validity of the POMS-A for use with adults. *Psychology of Sport and Exercise*, *4*, 125–139.
- Thompson, N. J., Walker, E. R., Obolensky, N., Winning, A., Barmon, C., Diiorio, C., et al. (2010). Distance delivery of mindfulness-based cognitive therapy for depression: Project UPLIFT. *Epilepsy Behavior*, *19*(3), 247–250.
- Uebelacker, L. A., Epstein-Lubow, G., Battle, C. L., Gaudino, B. A., Tremont, L., Battle, C., & Miller, I. W. (2010). Hatha yoga for depression: Critical review of the evidence for efficacy, plausible mechanisms of action, and directions for future research. *Journal of Psychiatric Practice*, *16*(1), 22–33.
- Van de Oord, S. (2012). The effectiveness of mindfulness training on behavioral problems and attentional functioning in adolescents with ADHD. *Journal of Child and Family Studies*, *21*(5), 775–787.
- Van de Weijer-Bergsma, E., Langenberg, G., Brandsma, R., Oort, F. J., & Bögels, S. M. (2012). The effectiveness of a school-based mindfulness training as a program to prevent stress in elementary school children. *Mindfulness*. doi:[10.1007/s12671-012-0171](https://doi.org/10.1007/s12671-012-0171)
- Vempati, R. P., & Telles, S. (2002). Yoga-based guided relaxation reduces sympathetic activity judged from baseline levels. *Psychological Reports*, *90*(2), 487–494.
- Walcott, C. M., & Landau, S. (2004). The relation between disinhibition and emotion regulation in boys with attention deficit hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology*, *33*(4), 772–782.
- Warner, R. M. (2008). *Applied statistics: From bivariate through multivariate techniques*. Beverly Hills, CA: Sage.
- West, J., Otte, C., Geher, K., Johnson, J., & Mohr, D. C. (2004). Effects of hatha yoga and African dance on perceived stress, affect, and salivary cortisol. *Annals of Behavioral Medicine*, *28*(2), 114–118.
- Williams L. M., Liddell B. J., Kemp A. H., Bryant R.A., Meares R. A., Peduto A. S., et al. (2006). Amygdala-prefrontal dissociation of subliminal and supraliminal fear. *Hum Brain Mapping*, *27*(8), 652–661.
- Woolery, A., Myers, H., Stemlieb, B., & Zeltzer, L. (2004). A yoga intervention for young adults with elevated symptoms of depression. *Alternative Therapies in Health and Medicine*, *10*, 60–63.