Evaluation of Yoga for Preventing Adolescent Substance Use Risk Factors in a Middle School Setting: A Preliminary Group-Randomized Controlled Trial

Bethany Butzer[1], **Amanda LoRusso**[2], **Sunny H. Shin**[3], and **Sat Bir S. Khalsa**[2]

[1]Department of Psychology, University of New York in Prague, Londýnská 41, 120 00 Praha 2, Prague, Czech Republic

[2]Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

[3]School of Social Work and Department of Psychiatry, School of Medicine, Virginia Commonwealth University, Richmond, VA, USA

Abstract

Adolescence is a key developmental period for preventing substance use initiation, however prevention programs solely providing educational information about the dangers of substance use rarely change adolescent substance use behaviors. Recent research suggests that mind–body practices such as yoga may have beneficial effects on several substance use risk factors, and that these practices may serve as promising interventions for preventing adolescent substance use. The primary aim of the present study was to test the efficacy of yoga for reducing substance use risk factors during early adolescence. Seventh-grade students in a public school were randomly assigned by classroom to receive either a 32-session yoga intervention ($n = 117$) in place of their regular physical education classes or to continue with physical-education-as-usual ($n = 94$). Participants (63.2 % female; 53.6 % White) completed pre- and post-intervention questionnaires assessing emotional self-regulation, perceived stress, mood impairment, impulsivity, substance use willingness, and actual substance use. Participants also completed questionnaires at 6-months and 1-year post-intervention. Results revealed that participants in the control condition were significantly more willing to try smoking cigarettes immediately post-intervention than participants in the yoga condition. Immediate pre- to post-intervention differences did not emerge

for the remaining outcomes. However, long-term follow-up analyses revealed a pattern of delayed effects in which females in the yoga condition, and males in the control condition, demonstrated improvements in emotional self-control. The findings suggest that school-based yoga may have beneficial effects with regard to preventing males' and females' willingness to smoke cigarettes, as well as improving emotional self-control in females. However additional research is required, particularly with regard to the potential long-term effects of mind–body interventions in school settings. The present study contributes to the literature on adolescence by examining school-based yoga as a novel prevention program for substance use risk factors.

Keywords

Yoga; Substance use; Adolescence; Meditation; Mindfulness; School; Addiction

Introduction

The prevalence of substance use among adolescents remains high, despite slow decreases over the past decade (Whitesell et al. 2013). Indeed, according to the 2015 Monitoring the Future (MTF) project, which surveyed 44,892 students across the United States regarding their beliefs and practices relating to substance use, 9.7 % of 8th graders reported past-month use of alcohol, 3.6 % reported past-month use of cigarettes, and 8.1 % reported past-month use of illicit drugs (MTF 2015). In addition, a nationally representative survey of 4245 adolescents across the United States found that relatively large proportions of adolescents report early substance use, with 52.4 % reporting alcohol use before age 16, 43.6 % reporting marijuana use, and 29.3 % reporting cigarette use (Moss et al. 2014). Adolescent substance use has been linked to a variety of detrimental long-term outcomes such as increased risk of sexually transmitted infections, vehicular fatalities, juvenile delinquency, and DSM-IV substance use disorder diagnoses (Moss et al. 2014; Whitesell et al. 2013).

Several biological, physical, and social-contextual factors interact to make adolescence a particularly vulnerable time period for substance use initiation, such as the onset of puberty, increases in unsupervised time with peers, and a reorganization of family relationships (Schulenberg et al. 2014). For example, prefrontal neural circuitry, which is responsible for exerting effortful control over behavior in emotional contexts, is not yet fully developed in adolescence, which can result in an increased sensitivity to reward and decreased ability to inhibit responses, and may result in increased risk-seeking behaviors (Whitesell et al. 2013). A combination of these neurobiological changes with social-contextual risk factors such as low parental monitoring and/or deviant peer environments, as well as psychological risk factors such as high anxiety or mood impairment may result in increased substance use during adolescence (Schulenberg et al. 2014).

In an effort to address these concerns, school-based programs designed to prevent substance use have grown substantially in the past twenty years (O'Connell et al. 2009), taking advantage of the widespread, long-term nature of schooling during formative development (Greenberg 2010). The majority of school-based prevention programs employ behavioral

skills training in an effort to prevent or change problem behaviors (Pentz 2014). Behavioral skills training typically involves providing students with information about substance use, and may also include modeling of skills by the teacher or a guest speaker, student experiential practice of skills within the classroom, discussions about skill performance, and/or practice in settings outside of the classroom (i.e., homework). Behavioral skills training has generally achieved modest effects in preventing health risk behaviors among youth (Durlak et al. 2011), and prevention programs solely providing educational information about the dangers of substance use rarely change adolescent substance use behaviors (Skiba et al. 2004). Taken together, these findings suggest that more work is needed in developing and testing substance use prevention programs for adolescents (Glassman et al. 2007), which has motivated researchers and practitioners to examine alternative approaches to substance use prevention. One such approach that has received increasing attention involves mind–body practices, such as yoga and meditation. Research suggests that mind–body practices may serve as an effective complement to existing substance use prevention programs by, for example, preparing students for behavioral skills acquisition by creating calmer classrooms and addressing implicit, associative, and emotional cues for behavior (Pentz 2014). It has also been argued that mind–body practices may reduce risk factors for substance use by alleviating anxiety, improving mood, and enhancing self-regulation (Carim-Todd et al. 2013; Fishbein et al. 2015).

Self-Regulation as a Risk and Protective Factor for Adolescent Substance Use

Research suggests that individual self-regulation processes serve important functions as risk and protective factors for adolescent substance use. For example, high levels of reward-seeking, low levels of harm avoidance, and low inhibitory control are all associated with substance use during adolescence (Chassin 2015). Indeed, middle adolescents (ages 14–17) display heightened reward-seeking in combination with low impulse control and immature self-regulatory capabilities which serve as risk factors for substance use, particularly when adolescents are in the presence of their peers (Steinberg 2015). As described previously, immature self-regulatory capabilities interact with a variety of biological, physical, and social-contextual factors, as well as controlled psychological processes (i.e., conscious goals) and automatic approach/avoidance processes (i.e., automatically activated associations) to make adolescence a particularly vulnerable time period for substance use (Chassin 2015).

The associations between self-regulation and adolescent substance use are complex, and can be examined from a variety of perspectives. The current study focuses primarily on emotional self-regulation as a risk and protective factor for adolescent substance use. Emotional self-regulation refers to "the process by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross 1998, p. 275). Researchers have distinguished between emotional self-control (a promotive, positive self-regulation) and emotional dysregulation (an impulsive, problematic self-regulation), and found them to be distinct constructs with different antecedents and substance use consequences (Wills et al. 2015, 2006). Few studies have examined the effects of emotional self-regulation on substance use (Southam-Gerow 2013), however preliminary research has found that emotional dysregulation increases adolescents'

vulnerability to substance use whereas emotional self-control is related to resisting temptations for substance use (Kassel et al. 2000; Simons et al. 2004; Wills et al. 2006). In addition, negative internalizing processes such as low mood and high stress have been linked to substance use in adolescents (Chan et al. 2008; King et al. 2004) and adults (Grant et al. 2004).

Furthermore, an orientation toward present occurrences (e.g., seeking out activities that produce immediate satisfaction such as alcohol use) versus future occurrences (e.g., investing in activities that require more effort but have positive long-term consequences such as physical exercise) is also an important factor with regard to adolescent substance use. Indeed, prior research has found that future time perspective has preventive effects whereas present time perspective has harmful effects on adolescent substance use (Wills et al. 2001). In summary, prior research suggests that interventions that focus on enhancing emotional self-control and reducing emotional dysregulation may be effective at preventing adolescent substance use.

Research on Yoga for Children and Adults

Yoga is a comprehensive system of practices for physical and psychological health and well-being that typically incorporates four techniques: physical postures/exercises to promote strength and flexibility, breathing exercises to enhance respiratory functioning, relaxation strategies that focus on reducing tension and stress, and meditation/mindfulness practices to enhance mind–body awareness and improve attention and emotion regulation skills (Butzer et al. 2016). As a common component of yoga practices, mindfulness techniques typically involve cultivating a non-judgmental and non-reactive state of awareness by continually bringing one's attention to the present moment (Carim-Todd et al. 2013).

Research on yoga for adults has grown in recent years (Jeter et al. 2015; McCall 2014), with studies suggesting that yoga may have beneficial effects on psychological and physiological outcomes such as stress (Sharma 2014), mood (Cramer et al. 2013), and cardiovascular disease (Cramer et al. 2014). Systematic and general literature reviews also suggest that yoga may have beneficial effects on the physical and psychological well-being of children and adolescents, particularly with regard to improvements in mood and reductions in stress, anxiety, and negative emotional states (Birdee et al. 2009; Galantino et al. 2008; Hagen and Nayar 2014; Kaley-Isley et al. 2010). Similarly, recent meta-analyses suggest that mindfulness practices may have beneficial effects on adolescent mental health (Kallapiran et al. 2015) and psychological symptoms (Zoogman et al. 2015). Indeed, a nationally representative survey in the US found that 2.1 % of children under 18 practice yoga and 4.8 % of child/adolescent complementary and alternative medicine users were specifically targeting anxiety and stress (Barnes et al. 2008). However, it is important to note that existing research on yoga for children and adults tends to suffer from a number of methodological limitations, such as small sample sizes and a relatively low frequency of randomized controlled trials (Birdee et al. 2009; Jeter et al. 2015). These limitations have resulted in a call for increased methodological rigor in this field (Jeter et al. 2015).

Yoga for Substance Use

Several theoretical review papers have hypothesized that mind–body practices such as yoga and meditation/mindfulness may be beneficial for preventing and treating substance abuse and addictive behavior (e.g., Calajoe 1987; Dakwar and Levin 2009; Kissen and Kissen-Kohn 2009; Lohman 1999). Indeed, a recent increase in research on this topic has led to a number of systematic literature reviews summarizing the effects of mind–body practices on substance use (Carim-Todd et al. 2013; Chiesa and Serretti 2014; Katz and Toner 2013; Khanna and Greeson 2013; Zgierska et al. 2009). These systematic reviews and theoretical papers propose multiple overlapping mechanisms to explain how mind–body practices may prevent or reduce substance use, including: (1) Reduction of stress (and/or tension) and its overt behavioral and underlying neuroendocrine components (Khanna and Greeson 2013); (2) Improvement of impaired mood such as reduction of depression and anxiety and a resulting increase in psychological well-being (Carim-Todd et al. 2013); (3) Induction of a peak experience or higher state of consciousness, effectively replacing the attraction of a substance-induced high (Lohman 1999); (4) Improvement in self-awareness and self-regulation of psychological and psychophysiological states allowing for improved self-efficacy through the ability to intervene and prevent destructive or maladaptive behavior before its onset (Chiesa and Serretti 2014); and (5) The establishment of improved self-esteem and a better philosophical relationship and understanding between the individual and his/her internal and external (social) worlds (Kissen and Kissen-Kohn 2009).

In summary, prior research suggests that mind–body practices may have beneficial effects on several psychological risk factors for substance use including stress, mood impairment, and emotional dysregulation, and that an amelioration of these risk factors may prevent or reduce substance use itself (see Fig. 1). In other words, it is possible that by addressing risk factors for substance use, yoga may prevent actual substance use even in the absence of explicit instruction or behavioral skills training regarding illicit substances. This hypothesis is supported in part by research showing that changes in health behaviors as a result of yoga programs often occur spontaneously, in the absence of any explicit, external instruction to change these behaviors. For example, in a prospective randomized controlled trial, Bryan et al. (2012) found that a yoga intervention increased exercise adherence in adults, not just adherence to yoga practice, but for all forms of exercise and physical activity. Similarly, in a qualitative study of a school-based yoga intervention, Conboy et al. (2013) found that students often reported health behavior changes resulting from the intervention, despite the fact that the intervention did not provide specific recommendations regarding health behavior. It is possible that these behavioral changes occurred as a result of increased mind–body awareness, which may have caused participants to gravitate toward healthy behaviors and away from unhealthy behaviors, based on an increased awareness of how these behaviors make the individual feel (Butzer et al. 2016). Accordingly, a number of substance abuse treatment programs have incorporated yoga or meditation as contributing therapies, and there is some research demonstrating efficacy of such treatments for adults (Carim-Todd et al. 2013; Hallgren et al. 2014). In addition, a number of studies have evaluated the specific effects of yoga interventions on addictive behavior, substance use risk factors, and substance abuse itself and have found positive results for adults, such as improvements in quality of life in opioid-dependent users (Dhawan et al. 2015), reduced risk of alcohol and drug use in

women with posttraumatic stress disorder (Reddy et al. 2014), improved global functioning and well-being in substance-dependent inpatients (Sureka et al. 2014), and improved mood and quality of life in women undergoing heroin detoxification (Zhuang et al. 2013).

The vast majority of studies of yoga for substance use have been conducted on adults, however a recent qualitative review of complementary and alternative medicine for adolescent substance use disorders found that, while existing research is preliminary, mindfulness and yoga exhibit the strongest evidence base when compared with other complementary and alternative medicine modalities for treating substance use disorders in adolescents (Wittenauer et al. 2015). For example, Sussman et al. (2001) and Idrisov et al. (2013) found that a teen smoking cessation program that involved components of yoga had beneficial effects on quit rates, future smoking expectation, and motivation to quit. In addition, a qualitative analysis of mindfulness for incarcerated adolescents suggests that mindfulness may be effective for treating adolescent substance use (Himelstein et al. 2014). Indeed, Black et al. (2012a) found that higher levels of trait mindfulness were inversely associated with adolescent smoking via the positive influence of mindfulness on negative affect and perceived stress, while Black et al. (2012b) found that adolescents with high intentions to smoke were more likely to smoke if they were low in trait mindfulness rather than high in trait mindfulness.

Yoga for Youth in Schools

Yoga is being increasingly taught in school settings as a strategy to enhance student health, well-being, and performance (Butzer et al. 2015), with systematic analyses (Ferreira-Vorkapic et al. 2015; Serwacki and Cook-Cottone 2012) and narrative reviews (Butzer et al. 2016; Khalsa and Butzer 2016) revealing preliminary evidence for the benefits of yoga in schools. For example, Khalsa and Butzer (2016) conducted a bibliometric analysis of research on school-based yoga programs and identified 47 studies, most of which reported beneficial effects of school-based yoga on student outcomes such as psychological well-being, academic performance, and health-related measures. However, as is the case with yoga research in general, studies of yoga in schools tend to suffer from low methodological quality. Indeed, Khalsa and Butzer (2016) found that only 57 % of the studies in their review utilized randomized controlled designs and most had small sample sizes. In addition, very few of the studies included long-term follow-up analyses. Despite these limitations, preliminary research suggests that school-based mind–body interventions may have beneficial effects on several risk factors for adolescent substance use identified in Fig. 1, including improvements in self-regulation (Bergen-Cico et al. 2015; Daly et al. 2015; Razza et al. 2015), mood (Felver et al. 2015; Noggle et al. 2012), and anxiety (Frank et al. 2014; Parker et al. 2014).

For example, a recent pilot study found that high school students who participated in a 20-session school-based yoga program reported trends toward decreased alcohol use and improvements in teacher-rated social skills compared to a control group (Fishbein et al. 2015). In addition, Sale et al. (2012) examined the effects of an after-school substance abuse and violence prevention program that included components of yoga and found that fourth- and fifthgrade students who received an expanded version of the intervention showed

improvements in social skills. Finally, two qualitative studies of school-based yoga found that adolescents have relatively positive opinions regarding the potential effects of yoga on substance use (Conboy et al. 2013; LoRusso et al. 2015). However, in order to advance research on school-based mind–body interventions for substance use, additional studies are needed that employ randomized controlled group designs and include long-term follow-up analyses (Greenberg and Harris 2012; Khalsa and Butzer 2016).

The Present Study

Prior research suggests that mind–body practices such as yoga may have beneficial effects on risk factors for adolescent substance use including stress, mood impairment, and emotional dysregulation, and that an amelioration of these risk factors may prevent substance use itself during adolescence. However, previous studies of school-based yoga have suffered from a lack of methodological rigor and a relative absence of long-term follow-up analyses. The present study addresses these limitations by conducting a preliminary group-randomized controlled trial to evaluate the efficacy of a school-based yoga program for reducing substance use risk factors and substance use itself during early adolescence.

The primary aim of the present study is to evaluate whether school-based yoga reduces the emotional and behavioral risk factors for substance use outlined in Fig. 1, specifically, emotional dysregulation, mood impairment, perceived stress, impulsivity, and present time perspective, as well as whether yoga promotes protective factors for adolescent substance use, specifically, emotional self-control and future time perspective. Secondary, exploratory analyses involve an examination of whether yoga prevents substance use initiation and/or reduces substance use frequency, as well as an evaluation of the potential long-term effects of yoga on adolescent substance use by conducting 6-month and 1-year post-intervention assessments. To the best of our knowledge, the present study represents the first randomized controlled trial of yoga for substance use risk factors in a middle school setting, as well as one of the first few studies to include long-term follow-up evaluations. Based on prior research, we hypothesized that students in the yoga group would either maintain or improve with regard to substance use risk factors, whereas students in the control group would deteriorate on these outcomes. We also anticipated that the yoga intervention would reduce the rate of substance use initiation and frequency of substance use.

Method

Participants

The present study was conducted during the 2013–2014 school year at an urban public school in Boston, Massachusetts. The school serves grades 7 through 12 and requires students to place above a certain score on a standardized exam assessing math skills, reading comprehension, and vocabulary, in order to attend. The 2013–2014 graduation rate at this school was 98.9 %, and 34.5 % of students were considered low income (students eligible for free/reduced price lunch or food stamps, or receiving Transitional Aid to Families benefits) (MESE 2015). Students were eligible to participate in the present study if they were enrolled in seventh grade at the school in 2013–2014 and registered for physical

education within the school curriculum. The school randomly assigns seventh-grade students to physical education, thus students were not placed in class sections based on any pre-existing aptitude or ability. During the 2013–2014 school year, 407 seventh-grade students were enrolled in physical education at the school.

Of the 407 students who were eligible to participate in the study, 211 students ($n = 117$ yoga; $n = 94$ control) provided written parental consent and written child assent to complete the outcome measures, resulting in a 52 % enrollment rate. Two students who initially provided consent and assent were withdrawn from the study. One of these withdrawals occurred before the student completed any questionnaires, due to parental concern that study staff would be accessing their child's health records (despite the fact that this was not the case). The second withdrawal occurred because a student with a pre-existing seizure disorder experienced a seizure while completing the baseline questionnaires. Table 1 provides a summary of the demographics for the entire school, as well as separately for the yoga and control groups. The final sample (combined yoga and control groups) was composed of 77 males (36.8 %) and 132 females (63.2 %) with a mean age of 12.64 ($SD = 0.33$) at baseline, suggesting that the current sample had a greater proportion of females than the school as a whole. The demographics also suggest that the study sample was composed primarily of White and Asian students, which is consistent with the demographics of the school as a whole. Figure 2 provides a diagram outlining participation throughout the 4 waves of data collection. Specifically, 209 students provided baseline data ($n = 116$ yoga; $n = 93$ control); 205 students provided end-program data ($n = 114$ yoga; $n = 91$ control); 206 students provided data for follow-up #1 ($n = 113$ yoga; $n = 93$ control); and 201 students provided data for follow-up #2 ($n = 110$ yoga; $n = 91$ control).

Procedures

In order to complete the outcome measures associated with the study, written informed consent by a parent was required, as well as written child assent. Parental consent and child assent pertained only to the acquisition of the outcome measures, not the yoga intervention itself, due to the fact that the yoga program was integrated into the school's physical education curriculum by the school administration for the duration of the study. In other words, all students who were randomized to the yoga condition were obliged by the school to participate in the yoga intervention, however only those students who provided parental consent and child assent completed the outcome measures. Prior to administering any outcome measures, consent and assent forms were handed out to students during homeroom by study staff, who requested that the students present the forms to their parents and return the signed forms if they were interested in participating in the study. A brief explanation of the study was given by study staff during homeroom and at an orientation night for parents. Study staff returned to the homerooms approximately twice per week over a 2-week period in order to collect signed consent/assent forms and remind students to return these forms if they had not done so already (while emphasizing that participation was voluntary and that students were not under any obligation to return the forms).

Eligible participants were group randomized into the experimental condition (yoga) or active control group (physical-education-as-usual) by physical education class section, of which

there were 15 in total. Randomization was stratified by class period (for situations in which more than one seventh-grade physical education class section occurred at the same time of day) and by physical education teacher (so that each physical education teacher's class sections were equally allocated to the yoga and control groups). Of the 15 physical education class sections, 8 were randomly assigned to the yoga group ($n = 215$ students), while the remaining 7 were assigned to physical education-as-usual ($n = 192$ students). Students who provided written assent (and whose parents provided written consent) completed questionnaires at 4 equally-spaced time points: one-week pre-intervention (time 1; October 2013), one-week post-intervention (time 2; April 2014), 6 months post-intervention (time 3; October 2014), and 1 year post-intervention (time 4; April 2015). The study protocol was reviewed and approved by the Brigham and Women's Hospital Institutional Review Board (Partners Human Research Committee).

Outcome Measures

Unless otherwise indicated, participants responded to all of the questionnaires below at all four time points of the study. Questionnaires were administered by study staff during physical education class time using mini-laptop computers equipped with REDCap survey software (Harris et al. 2009). Each participant was provided with a separate mini-laptop computer for the duration of the testing session in order to privately complete the outcome measures. Participants were given the entire class period (approximately 45 min) to complete the questionnaires. Before beginning the questionnaires, study staff verbally reminded the students of the information provided in the consent and assent forms, including the fact that all responses would remain confidential. Students were encouraged to answer the questionnaires honestly, particularly the items related to substance use, and were reassured that their individual responses would not be shared with their teachers, parents, or friends.

Mood—The Brunel University Mood Scale (BRUMS) was designed to assess mood in adolescents (Terry et al. 1999; Terry and Lane 2002). It contains 24 adjectives that are rated on a four-point scale to give a total mood score and scores for six subscales: tension, depression, anger, vigor, fatigue, and confusion. In a validation sample of nearly 2000 British adolescents (12–18 years of age), multi-sample confirmatory factor analysis showed high factor validity. Criterion and construct validity were also acceptable. More recently, the BRUMS has been successfully used in a large sample of American adolescents (Gould et al. 2005). Students were asked to respond to how often they felt a series of mood-related adjectives within the last month (e.g., panicky, lively, confused, worn out, etc.) on a scale ranging from 0 ("not at all") to 4 ("extremely").

Stress—The 10-item Perceived Stress Scale (PSS; Cohen et al. 1983) is a widely used and validated measure of the degree to which situations in one's life are appraised as stressful. Items were designed to tap how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes a number of direct queries about current levels of experienced stress. The PSS was designed for use in community samples with at least a junior high school education. Participants were asked to respond to each item with regard to

how they had felt over the past month. Items were rated on a 5-point scale ranging from 0 ("never") to 4 ("very often"), with higher scores indicating greater levels of perceived stress.

Impulsivity—The UPPS-P Impulsive Behavior scale is a 59-item self-report scale designed to measure the multi-dimensional nature of impulsivity (Lynam et al. 2006). The UPPS-P includes five subscales: (lack of) Premeditation (11 items), Negative Urgency (11 items), Positive Urgency (14 items), Sensation Seeking (12 items), and (lack of) Perseverance (10 items) that show high internal consistency in adolescent samples (Tercek 2008). Items are scored based on a four-point Likert scale ranging from 1 ("agree strongly") to 4 ("disagree strongly"), with several items being reverse-scored so that higher scores indicate more impulsive behavior. Impulsivity was also measured via the constructs of Future Time Perspective (FTP) and Present Time Perspective (PTP). A 7-item scale measuring FTP was adapted from the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo and Boyd 1999). This scale measures one's orientation toward future occurrences (e.g., investing in activities that require more effort but have positive long-term consequences). A 7-item scale measuring PTP (i.e., one's orientation toward present occurrences, such as seeking out activities that produce immediate satisfaction) was also derived from the ZTPI (Zimbardo and Boyd 1999). Items on the FTP and PTP questionnaires are rated on a 5-point scale ranging from 1 ("not at all true") to 5 ("very true").

Emotional Self-Regulation—Emotional self-regulation was assessed using seven self-report scales based on validated adolescent measures of self-regulation that have been shown to be sensitive to change over time (Wills et al. 2006, 2010). These seven scales were grouped into measures of emotional self-control (three scales) and emotional dysregulation (four scales) based on prior literature suggesting that these measures can be reliably grouped into these constructs (Wills and Ainette 2010; Wills et al. 2007; Wills and Dishion 2004). Unless otherwise indicated, the self-regulation measures used a 5-point Likert scale with anchor points *Not at All True* and *Very True*. A total score for each facet of self-regulation was calculated by summing the item scores. Higher scores indicate greater emotional self-control or greater emotional dysregulation, respectively.

Emotional Self-Control: Emotional self-control was assessed via questionnaires measuring three constructs: soothability, anger control, and sadness control. The 5-item Soothability scale of the Kendall-Wilcox Self-Control Schedule (Kendall and Williams 1982) assesses adolescents' capabilities to reduce emotional tension and control calmness when distressed. Adolescents' anger management was assessed by the 4-item Anger Control subscale of the Children's Anger Management Scale (CAMS; Zeman et al. 2002). A 5-item Sadness Control subscale from the Children's Sadness Management Scale (CSMS) assessed what participants do when they are feeling sad or down (Zeman et al. 2001).

Emotional Dysregulation: Emotional dysregulation was assessed via questionnaires measuring four constructs: affective lability, anger coping, sadness rumination, and anger rumination. To measure affective lability, a 10-item scale was adapted from the 54-item Affective Lability Scale (Harvey et al. 1989), which measures adolescents' tendency to change mood frequently. The 7-item Anger Coping subscale of the Wills Coping Inventory

measures the tendency to respond with anger in everyday situations, and was rated on a 5-point scale ranging from 1 ("never") to 5 ("usually") (Wills 1986). The 3-item measure for Sadness Rumination was adapted from the CSMS and assesses adolescents' emotional capabilities in dealing with sadness (Zeman et al. 2001). The 3-item Anger Rumination subscale of the CAMS was used to measure the extent to which participants engaged in excessive self-focus on feelings of anger (Zeman et al. 2002).

Substance Use Willingness (SUW)—A total of 13 willingness questions based on the substance use categories from the Youth Risk Behavior Survey (YRBS-MS; CDC 2014) were used to determine participants' willingness to experiment with substances such as cigarettes (3 questions), alcohol (3 questions), marijuana (3 questions), and other drugs (4 questions) (Gibbons et al. 1998). For example, the cigarette items asked participants to imagine a risk-conducive situation in which "You were with a group of friends and there were some cigarettes you could have if you wanted." Participants were asked how willing they would be to: take one puff, smoke a whole cigarette, and take some cigarettes to try for later. Participants rated each item on a scale ranging from 1 ("not at all willing") to 4 ("very willing"), with higher scores indicating a greater willingness to try illicit substances.

Lifetime Substance Use and Frequency—The 2013 middle school version of the Youth Risk Behavior Survey (YRBS-MS; CDC 2014) was used to assess participants' actual substance use. The YRBS-MS is a nationally validated scale composed of 16 items that measure participants' use of tobacco (8 questions), alcohol (2 questions), marijuana (2 questions), and other drugs (4 questions). Each category contains an item asking participants to indicate whether they have ever used a substance, which served as a measure of substance use over the time course of the entire study. For example, the cigarette smoking item asks, "Have you ever tried cigarette smoking, even one or two puffs" to which participants respond "yes" or "no." Frequency of substance use was assessed by items that asked students to indicate the amount of time/days during which they used substances. For example, one of the cigarette smoking items asked participants to respond to the question "During the past 30 days, on how many days did you smoke cigarettes" on a rating scale ranging from "0 days" to "all 30 days."

Yoga Intervention Feasibility—To determine the success and acceptance of the yoga intervention as compared to regularly scheduled physical education, a 12-item Yoga Evaluation Questionnaire (YEQ) was created by author SBSK and was administered to the intervention group during the time 2 data collection period immediately after the yoga program had ended. Sample items include "How much do you like regular gym class (without yoga)" and "How much do you like yoga class." Author SBSK also created an 8-item Control Evaluation Questionnaire (CEQ) that was administered to the control group participants during time 2 data collection. The CEQ omitted questions concerning participants' enjoyment of the yoga program but did ask how much students enjoyed regular gym class. Students rated their enjoyment of yoga and gym class on a visual analog scale ranging from 0 ("not at all") to 100 ("very much so"). The YEQ and CEQ also included an item asking how often students practiced yoga outside of school on average, which asked

participants to select from a series of responses ranging from 1 ("never") to 6 ("4–7 days per week").

Intervention and Control Group Characteristics

Yoga Intervention—A 32-session version of the Kripalu Yoga in the Schools (KYIS) curriculum, developed for high school students by the Kripalu Center for Yoga & Health, was used as the yoga intervention in the present study (KYIS 2015). The original KYIS program consisted of a 24-session intervention, however this program was expanded to 32 sessions for the present study in an effort to ensure that all of the intervention content could be delivered with a younger age group, as well as a desire to provide a high enough "dosage" to produce effects. The 32-session intervention was created by adding one review session after every three yoga sessions. Each review session was taught as a reinforcement of the prior lessons. Given previous research suggesting that yoga is as beneficial as, and sometimes better than, standard physical exercise at improving a variety of health-related outcomes (Ross and Thomas 2010), as well as research showing that yoga may increase exercise adherence in adults (Bryan et al. 2012) and improve physical fitness in adolescents (Purohit et al. 2016), study staff and school administrators felt confident that the yoga intervention would provide the physical activity necessary to meet requirements for the seventh-grade physical education curriculum. Analyses on class attendance revealed that dosage requirements were met, with an average student attendance rate of 95.75 % (range across class sections = 93.87–97.24 %) and with instructors teaching an average of 30.75 yoga sessions per class section (range = 29–32) (occasionally yoga sessions were cancelled due to snow days, assemblies, etc.).

The KYIS program aims to cultivate social and emotional learning (SEL) skills through yoga and mindfulness. Its curriculum is entirely secular, focusing on stress management, emotion regulation, self-appreciation, confidence, and strong peer relationships. The program emphasizes Kripalu yoga techniques such as mindfulness (self-observation without judgment), self-regulation ("riding the wave of resistance") and compassion meditation (loving-kindness). The KYIS intervention was integrated into the school's physical education curriculum by the school administration and thus occurred during students' regularly scheduled physical education sessions. The 45-min physical education sessions occurred twice within a rotating 6-day cycle, which corresponded to approximately 1-2 yoga sessions per week over a period of approximately 6 months. Students were provided with several minutes before and after class to change into appropriate exercise attire, resulting in each yoga session being approximately 35 min long. A typical yoga session contained the following segments (with some variation from class to class): centering and breathing exercises (~5 min), warm-ups (~5 min), yoga poses (~15 min), didactic/experiential content (~5 min), and relaxation (~5 min). Commonly practiced poses included warrior I, warrior II, triangle, sun salutations, integrative twist, and legs up the wall. Each session built upon the previous sessions and introduced new postures as the curriculum progressed. Sample breathing techniques included ocean breath (i.e., breathing through the nose while slightly constricting the esophagus), alternate-nostril breathing (i.e., breathing in through one nostril and out the other), and 3-part breathing (i.e., deep diaphragmatic breathing moving from the abdomen to the solar plexus and upper chest). Didactic and experiential content often

encouraged social interaction (e.g., peer-to-peer listening, group discussion, students leading poses) or activities for self-discovery (e.g., holding a posture beyond initial resistance, journaling about ways to de-stress) (see Appendix A for a sample lesson).

The KYIS intervention was instructed by 2 lead teachers (one male; one female) and 5 female assistants who were not members of the school staff. In other words, the intervention instructors were hired externally by study staff in an effort to recruit individuals with advanced training in the KYIS intervention and familiarity with research best practices, thus promoting intervention fidelity and adherence to the IRB protocol. All teaching staff were certified as 200-h yoga teachers. Both lead teachers were additionally certified in the 60-h KYIS training program. Four of the five assistants completed the KYIS training program. The fifth assistant did not complete the KYIS training, although she did attend a 4-month volunteer term at the Kripalu Center for Yoga & Health and was well-versed in the Kripalu yoga style. All teachers and assistants also attended a research training session to be in compliance with study policies, including proper IRB practices and maintaining session logs/notes. Each yoga session was instructed by one lead teacher and one assistant. The teacher and assistant who taught each session varied based on scheduling and availability, which resulted in participants being exposed to all of the lead teachers and assistants in varying combinations. The female lead teacher taught the majority of the sessions (67.6 %), while the male lead teacher taught the remainder of the sessions (32.4 %).

Physical Education Control Group—Physical education sessions were organized around students achieving three core goals: (1) Demonstrating competency in motor skills and movement patterns needed to perform a variety of physical activities (e.g., throw a variety of objects while demonstrating proper footwork; dribbling an object continually with a partner); (2) Demonstrating an understanding of movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities (e.g., detecting, analyzing, and correcting errors in personal movement patterns; demonstrating and leading the class in stretching at least four major muscle groups); (3) Exhibiting responsible personal and social behavior that respects self and others in various physical activity settings (e.g., respecting peers' personal space and exhibiting good sportsmanship; making responsible decisions about using time and applying rules in the locker room and gymnasium). Identical to the yoga sessions, the physical education sessions were held twice in a 6-day rotating cycle and lasted approximately 35 min, resulting in 1–2 physical education sessions per week over the study period of approximately 6 months. The physical education sessions were taught by a faculty of three physical education teachers whose methods of assessment included observational recording, class participation, fitness testing, and self-evaluation. A typical session included a warm-up (light jog or aerobic movement; ~2 min), large muscle group exercises (~5 min), a sport or game to promote relaxation/ enjoyment through competition with friends (~25 min), and a cool down (~2–5 min). No yoga techniques were taught during physical education for the duration of the study. Group sports included soccer, basketball, floor hockey, kickball, wiffle ball, and volleyball. Other activities included ball-handling drills, relay races, jump rope drills, and aerobics.

Data Analysis

The current study consisted of a total of 20 outcome measures (including questionnaire sub-scales). All data was analyzed at the individual student level, following the analytical approaches adopted by several preliminary studies of yoga in schools that also consisted of exploratory outcome measures and relatively small sample sizes (e.g., Butzer et al. 2015; Khalsa et al. 2012; Noggle et al. 2012). Data analysis procedures fell into three main categories. *Preliminary analyses* consisted of a series of independent-samples *t*-tests comparing baseline values on all outcome measures between the two experimental conditions (yoga vs. control) and gender (male vs. female) in order to assess whether they were equivalent at baseline. A series of oneway ANOVAs were also conducted to examine whether there were any differences between all 15 physical education class sections (8 yoga; 7 control) on all outcome measures at baseline.

Primary analyses examined immediate pre- to post-intervention effects. Specifically, these analyses were conducted to examine our primary hypotheses, namely whether end-program scores on mood, stress, impulsivity, emotional self-regulation, and willingness to use illicit substances differed significantly between the yoga and control groups while controlling for time 1 scores. Following the recommendations of Locascio and Atri (2011) for analyzing data with a continuous dependent variable, a between-subjects predictor variable, and a continuous covariate, a series of analyses of covariance (ANCOVAs) with condition (yoga; control) as the between-subjects factor and baseline scores as a covariate were conducted to examine immediate pre- to post-intervention effects.

Secondary analyses involved an examination of the effects of the yoga intervention on actual substance use, as well as an evaluation of potential long-term effects of the intervention and an examination of the feasibility of the intervention. Chi square analyses were conducted to determine whether substance use differed between the two groups (yoga; control) at each time point. In addition, following the recommendations of Locascio and Atri (2011) for analyzing longitudinal data in which there are relatively few, evenly spaced time points for each participant, split-plot analyses of variance (ANOVAs) with condition (yoga; control) and gender (male; female) as the between-subjects factors, and time (baseline; end-program; follow-up #1; follow-up #2) as the within-subjects factor were conducted to examine whether the trajectory of change on all outcome measures differed significantly between the yoga and control groups and/or males and females across all four time points. While the present study did not initially hypothesize any gender differences, gender was included as a between-subjects factor in these secondary analyses in a post hoc manner, due to the unequal gender distribution of the current sample, as well as baseline differences that were detected between males and females on several outcome measures (see below). For cases in which interactions between condition, time, and/or gender were statistically significant, post hoc repeated-measures analyses of variance (RM-ANOVAs) with Fisher's LSD test were conducted separately for males and females in each group (yoga; control) in order to determine which time points differed significantly from each other for each gender. Finally, participants' general perceptions of the yoga program were evaluated by examining descriptive statistics on the YEQ and CEQ, as well as conducting independent samples *t*-

tests to evaluate potential differences between yoga and control group perceptions of and participation in yoga.

The alpha level used to determine significance was $p < .05$ for all analyses. Adjustments were not made for multiple comparisons (e.g., MANOVA or Bonferroni corrections to reduce Type I error) based on the relatively small sample size and exploratory nature of the current study (Fishbein et al. 2015; Sproull 2002; Warner 2008), as prior research has shown that these approaches can increase the likelihood of Type II error in studies with small sample sizes and/or small effect sizes (Smith et al. 2002; Strahan 1982).

Results

Preliminary Analyses

The baseline comparisons between conditions, gender, and class sections revealed a few gender differences at baseline. Specifically, males scored significantly higher than females at baseline on PTP (female $M = 14.18$, $SD = 4.06$) (male $M = 15.91$, $SD = 4.34$), $t(206) = -2.90$, $p < 0.01$; willingness to drink beer (female $M = 3.31$, $SD = 0.71$) (male $M = 3.62$, $SD = 1.18$), $t(205) = -2.33$, $p < 0.05$; negative urgency (female $M = 1.90$, $SD = 0.61$) (male $M = 2.13$, $SD = 0.53$), $t(206) = -2.76$, $p < 0.01$; sensation seeking (female $M = 2.61$, $SD = 0.61$) (male $M = 2.83$, $SD = 0.53$), $t(206) = -2.63$, $p < 0.01$; and positive urgency (female $M = 1.61$, $SD = 0.56$) (male $M = 1.88$, $SD = 0.60$), $t(206) = -3.32$, $p < 0.01$. In addition, the 15 physical education class sections (8 yoga; 7 control) were equivalent on all outcome measures at baseline with the exception of the PSS. Tukey post hoc analyses revealed that one class section from the control group reported higher levels of stress at baseline ($M = 21.64$, $SD = 6.17$) than one class section from the yoga group ($M = 12.88$, $SD = 6.66$), $F(14) = 2.10$, $p < 0.05$.

Primary Analyses

Table 2 provides a summary of the means and standard deviations for all outcome measures at all four data collection time points, and Table 3 provides summary statistics of the ANCOVAs on end-program scores (with baseline scores as a covariate). Participants in the control group reported a significantly greater willingness to smoke cigarettes at time 2 ($M = 3.44$, $SD = 1.06$) than participants in the yoga group ($M = 3.21$, $SD = 0.76$) (see Fig. 3). None of the other risk/protective factors were significantly different between groups at time 2, including mood, stress, impulsivity, emotional self-regulation, or willingness to use beer, marijuana, or other drugs (see Table 3).

Secondary Analyses

Substance Use Frequency—Table 4 summarizes lifetime substance use across all four data collection time points for the yoga and control groups. Lifetime substance use was extremely low for both groups across all four time points. Chi square analyses on the distribution of participants in each group who responded "yes" to having initiated the use of tobacco, alcohol, marijuana and other drugs at each time point did not reveal any statistically significant differences between groups at any time point.

Long-Term Effects—Split-plot ANOVAs examining the trajectory of change between groups and gender across all four time points revealed a number of significant findings, which are summarized below (see Table 5). The following outcome measures did not show any significant effects in these analyses: emotional dysregulation, BRUMS vigor, BRUMS anger, or UPPS-P lack of perseverance.

Emotional Self-Control: A significant main effect of time emerged for emotional self-control, however this effect was qualified by a significant 3-way interaction between time, condition, and gender (partial eta squared = 0.02). Post-hoc analyses conducted separately for males and females in each group (yoga; control) revealed that females in the yoga group reported statistically significant increases in emotional self-control between time 1 versus time 4, time 2 versus time 4, and time 3 versus time 4, whereas males in the yoga group did not report significant changes in emotional self-control over time. Conversely, males in the control group reported statistically significant increases in emotional self-control between time 1 versus time 4, time 2 versus time 4, and time 3 versus time 4, whereas females in the control group did not report significant changes in emotional self-control over time (see Fig. 4).

SUW Cigarettes: A significant main effect of time emerged for SUW Cigarettes. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant increases in willingness to smoke cigarettes between time 1 versus time 2, time 1 versus time 3, time 1 versus time 4, and time 2 versus time 4 (time 1 $M = 3.18$, $SD = 0.65$; time 2 $M = 3.31$, $SD = 0.92$; time 3 $M = 3.47$, $SD = 1.31$; time 4 $M = 3.52$, $SD = 1.37$).

SUW Beer: A significant main effect of time emerged for SUW Beer. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant increases in willingness to drink beer between time 1 versus time 2, time 1 versus time 3, time 1 versus time 4, time 2 versus time 3, and time 2 versus time 4 (time 1 $M = 3.42$, $SD = 0.94$; time 2 $M = 3.81$, $SD = 1.67$; time 3 $M = 4.15$, $SD = 2.05$; time 4 $M = 4.19$, $SD = 2.03$).

SUW Marijuana: A significant main effect of time emerged for SUW Marijuana. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant increases in willingness to smoke marijuana between time 1 versus time 2, time 1 versus time 3, time 1 versus time 4, time 2 versus time 3, and time 2 versus time 4 (time 1 $M = 3.12$, $SD = 0.62$; time 2 $M = 3.25$, $SD = 1.02$; time 3 $M = 3.50$, $SD = 1.56$; time 4 $M = 3.58$, $SD = 1.51$).

SUW Drugs: A significant main effect of time emerged for SUW Drugs. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant increases in willingness to try drugs between time 1 versus time 4, time 2 versus time 3, and time 2 versus time 4 (time 1 $M = 6.82$, $SD = 1.25$; time 2 $M = 6.73$, $SD = 1.25$; time3 $M = 7.02$, $SD = 1.45$; time 4 $M = 7.12$, $SD = 1.63$).

Perceived Stress: A significant 2-way interaction between time and gender emerged for perceived stress. Post-hoc analyses revealed that regardless of condition, females reported significant increases in perceived stress between time 1 versus time 2 and time 1 versus time

4 (time 1 $M = 17.13$, $SD = 7.24$; time 2 $M = 18.69$, $SD = 7.20$; time 3 $M = 18.13$, $SD = 7.32$; time 4 $M = 18.72$, $SD = 7.19$), whereas males did not report significant changes in perceived stress (time 1 $M = 17.40$, $SD = 7.02$; time 2 $M = 17.32$, $SD = 7.21$; time 3 $M = 15.75$, $SD = 6.13$; time 4 $M = 16.10$, $SD = 6.89$).

Confusion: A significant main effect of gender emerged for confusion suggesting that across both conditions and all time points, females reported significantly higher levels of confusion ($M = 5.81$, $SD = 2.99$) than males ($M = 4.69$, $SD = 2.35$), $t(207) = 2.84$, $p = 0.01$.

Depression: A significant main effect of time emerged for depression. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant increases in depression between time 1 versus time 2, time 1 versus time 4, and time 3 versus time 4 (time 1 $M = 3.54$, $SD = 3.55$; time 2 $M = 4.13$, $SD = 4.03$; time 3 $M = 3.66$, $SD = 3.55$; time 4 $M = 4.27$, $SD = 4.15$).

Fatigue: A significant 2-way interaction between time and gender emerged for fatigue. Post-hoc analyses revealed that regardless of condition, females did not report significant changes in fatigue (time 1 $M = 10.43$, $SD = 4.02$; time 2 $M = 10.93$, $SD = 3.91$; time 3 $M = 10.71$, $SD = 4.26$; time 4 $M = 11.23$, $SD = 4.17$), whereas males reported significant decreases in fatigue between time 1 versus time 3 (time1 $M = 9.58$, $SD = 4.00$; time 2 $M = 9.19$, $SD = 4.36$; time3 $M = 8.51$, $SD = 3.64$; time 4 $M = 8.77$, $SD = 4.39$).

Tension: A significant main effect of time emerged for tension. Post-hoc analyses revealed that regardless of condition or gender, the entire sample reported significant decreases in tension between time 1 versus time 3 and time 2 versus time 3, as well as significant increases in tension between time 3 versus time 4 (time 1 $M = 7.07$, $SD = 3.96$; time 2 $M = 7.41$, $SD = 3.98$; time 3 $M = 6.30$, $SD = 3.86$; time 4 $M = 6.87$, $SD = 4.03$). A significant main effect of gender also emerged for tension suggesting that across both conditions and all time points, females reported significantly higher levels of tension ($M = 7.41$, $SD = 3.24$) than males ($M = 6.20$, $SD = 2.82$), $t(207) = 2.73$, $p = 0.01$.

Negative Urgency: A significant main effect of gender emerged for negative urgency suggesting that across both conditions and all time points, males reported significantly higher levels of negative urgency ($M = 2.08$, $SD = 0.52$) than females ($M = 1.93$, $SD = 0.54$), $t(207) = -2.06$, $p = 0.04$.

Lack of Premeditation: A significant 3-way interaction between time, condition, and gender emerged for lack of premeditation (partial eta squared = 0.02). Post-hoc analyses revealed that females in the yoga group reported a statistically significant increase in lack of premeditation between time 1 versus time 2, then a significant decrease from time 2 versus time 3, whereas males in the yoga group did not report significant changes in lack of premeditation. Conversely, females in the control group reported a significant increase in lack of premeditation between time 2 versus time 4, whereas males in the control group did not report significant changes in lack of premeditation (see Fig. 5).

Sensation Seeking: A significant main effect of gender emerged for sensation seeking suggesting that across both conditions and all time points, males reported significantly higher levels of sensation seeking ($M = 2.83$, $SD = 0.49$) than females ($M = 2.62$, $SD = 0.56$), $t(207) = -2.80$, $p = 0.01$.

Positive Urgency: A significant main effect of gender emerged for positive urgency suggesting that across both conditions and all time points, males reported significantly higher levels of positive urgency ($M = 1.88$, $SD = 0.60$) than females ($M = 1.66$, $SD = 0.53$), $t(207) = -2.84$, $p = 0.01$.

Future Time Perspective: A significant main effect of time emerged for FTP, however this effect was qualified by a significant 3-way interaction between time, condition, and gender (partial eta squared = 0.02). Post-hoc analyses revealed that females in the yoga group did not report significant changes in FTP, whereas males in the yoga group reported significant decreases in FTP between time 1 versus time 4, time 1 versus time 3, time 2 versus time 3, and time 2 versus time 4. Conversely, males in the control group did not report significant changes in FTP, whereas females in the control group reported a significant decrease in FTP between time 1 versus time 4 (see Fig. 6).

Present Time Perspective: Significant 2-way interactions between time and condition, and between time and gender emerged for PTP, however these interactions were qualified by a significant 3-way interaction between time, condition, and gender (partial eta squared = 0.03). Post-hoc analyses revealed that neither males nor females who were in the yoga group reported significant changes in PTP. Conversely, males in the control group reported significant decreases in PTP between time 1 versus time 3, time 1 versus time 4, and time 2 versus time 3, whereas females in the control group did not report significant changes in PTP (see Fig. 7).

Yoga Intervention Feasibility—A paired-samples *t* test on the YEQ items evaluating how much the yoga participants liked yoga vs. regular physical education revealed that yoga participants reported liking physical education ($M = 71.63$, $SD = 27.72$) significantly more than they liked yoga ($M = 44.45$, $SD = 32.46$), $t(107) = 5.51$, $p = 0.00$. However, an examination of the histograms for these questions suggests that a group of approximately 20 students chose extreme values (i.e., values of "0" for liking yoga and values of "100" for liking physical education), which may have skewed the means (see Fig. 8). An independent-samples *t*-test comparing the yoga and control participants on the YEQ/CEQ item related to yoga participation outside of school revealed that although external yoga participation was relatively low for both groups, the yoga group reported practicing yoga outside of school significantly more often ($M = 2.22$, $SD = 1.35$) than the control group ($M = 1.35$, $SD = 0.74$), $t(193) = 5.43$, $p = 0.00$ (see Fig. 9). An independent-samples *t*-test comparing the yoga and control groups on the YEQ/CEQ item related to how much participants liked regular physical education did not reveal significant differences between groups (yoga $M = 71.63$, $SD = 27.72$; control $M = 74.67$, $SD = 22.57$), $t(193) = -1.09$, $p = 0.28$.

Discussion

Adolescence is a developmental period that involves a variety of biological, physical, and social-contextual changes that put adolescents at an increased risk for experimenting with cigarettes, alcohol, and other drugs (Schulenberg et al. 2014). In response to this issue, numerous school-based substance use prevention programs have been created (O'Connell et al. 2009). Unfortunately, existing prevention programs, which focus mainly on behavioral skills training, are only modestly effective at preventing health risk behaviors among youth (Durlak et al. 2011). As an intervention that focuses on integrating mind- and body-based skills for physical and psychological well-being, yoga may be particularly well suited to prevent substance use. Indeed, school-based yoga interventions have been found to alleviate a number of known substance use risk factors including emotional dysregulation (Daly et al. 2015), anxiety (Parker et al. 2014), and mood impairment (Felver et al. 2015). The primary aim of the present study was to test the efficacy of school-based yoga for reducing substance use risk factors, and possibly curbing substance use itself, during early adolescence. Our findings suggest that yoga may have beneficial effects with regard to preventing males' and females' willingness to smoke cigarettes, as well as improving emotional self-control in females. However, additional research is required with more demographically diverse samples that include equal numbers of males and females. The present study contributes to the literature by providing the first randomized controlled trial of a yoga intervention for preventing substance use risk factors and substance use itself with long-term follow-up evaluations in a middle school setting.

Immediate Pre- to Post-Intervention Effects

Participants in the control condition reported a significantly greater willingness to smoke cigarettes immediately post-intervention than participants in the yoga group. Thus, it appears that the yoga intervention may have prevented students from becoming willing to smoke cigarettes. This finding is similar to previous research that has found school-based yoga interventions to provide preventive effects by mitigating the worsening of negative outcomes. For example, in two preliminary randomized controlled trials of school-based yoga, Noggle et al. (2012) and Khalsa et al. (2012) found that participants in the control groups reported deteriorations in psychosocial well-being, whereas participants in the yoga groups maintained their baseline levels. Similarly, Butzer et al. (2015) found that students who participated in a school-based yoga intervention maintained their grade point average (GPA) during the intervention, whereas control group participants reported decreases in GPA over the same time period.

Contrary to our hypotheses, yoga and control participants did not report significant post-intervention differences on any other risk/protective factors for substance use including mood, stress, impulsivity, emotional self-regulation, or willingness to use beer, marijuana, or other drugs. Significant differences also did not emerge between the yoga and control groups with regard to actual substance use. These findings are consistent with some studies of school-based yoga that have found very few (Telles et al. 2013; White 2012) or no (Haden et al. 2014; Hagins et al. 2013) group differences in potential risk factors for substance use. For example, Fishbein et al. (2015) found that, although students in the yoga group showed

trends toward decreased alcohol use, the yoga and control groups did not report significant post-intervention differences in self-regulation, mood or mindfulness. Similarly, Parker et al. (2014) did not find significant differences between an intervention and control group with regard to intentions to use alcohol or tobacco following a school-based mindfulness program. However, the current findings are in contrast with a qualitative component of the present study, in which 16 students from the yoga intervention were randomly selected to participate in one-on-one interviews. This qualitative study revealed that students reported several beneficial effects of yoga on outcomes such as stress, relaxation, self-regulation, and substance use (LoRusso et al. 2015). Other studies of yoga and meditation have also reported mixed findings in which quantitative outcomes do not show significant change, whereas participants report improvements when they are interviewed qualitatively (Sibinga et al. 2014).

Several potential reasons exist for the relative absence of immediate pre- to post-intervention changes in the present study. First, adolescents may find it easier to express their experiences in a qualitative rather than quantitative manner, which may be why our project reported positive qualitative, but null quantitative, findings. In addition, as described below and in LoRusso et al. (2015), students in the present study reported mixed evaluations of the yoga intervention, and on average, participants indicated that they preferred regular physical education to yoga. Thus, it is possible that some students' negative evaluations of yoga may have influenced their responses on the self-report outcomes. It is also possible that factors such as self-regulation, mood, and stress may not be the mechanisms by which yoga exerts its effects on substance use, an idea that is supported by an existing study of yoga for adolescent substance use that failed to find effects on these outcomes (Fishbein et al. 2015). In addition, it is possible that the current sample created a "floor effect" due to the fact that the rates of substance use were extremely low across all four data collection time points. Despite the fact that the current sample was drawn from a relatively diverse, urban school, as well as research suggesting that substance use initiation often begins in middle school (Johnston et al. 2006), it is possible that the students may not have had a chance to be exposed to illicit substances during 7th or 8th grade at this school. It is also possible that students might have been worried about answering the substance use questions honestly, despite repeated reassurance from study staff that all responses would remain anonymous and confidential.

In addition, it is possible that school-based yoga may not be the most appropriate or effective intervention for preventing adolescent substance use, particularly in non-clinical samples. Indeed, while some studies of yoga for adolescent substance use have shown promise (Wittenauer et al. 2015), these studies were primarily conducted with clinical samples. Existing studies of school-based yoga and mindfulness for substance use in non-clinical samples have generally found limited results, with most findings emerging as trends (Fishbein et al. 2015; Parker et al. 2014). It is possible that in order to be effective at targeting substance use risk factors, school-based yoga interventions may need to include explicit didactic learning material that is focused on the ways in which yoga-based skills may prevent substance use. It is also possible that school-based yoga may be more effective for some students than others. For example, the results of the present study suggest that yoga may have had a more positive impact on females, whereas standard physical education may

have had a more positive impact on males. The present effects were also delayed, in that most changes did not emerge until the two follow-up time points. Given that the majority of studies of school-based yoga and mindfulness do not include long-term follow-up evaluations (Greenberg and Harris 2012), it is possible that prior research may have failed to capture these effects. In summary, the immediate pre- to post-intervention efficacy of school-based yoga for psychosocial well-being in general, and substance use risk in particular, is an emerging area of study with mixed results. Additional research is required to determine the efficacy of school-based yoga, as well as potential moderators and mediators of intervention effects.

Long-Term Effects

A number of significant group differences were found when examining the trajectory of change for males and females in each condition across all four data collection time points. Of particular interest with regard to our hypotheses were the three-way interactions that emerged between time, condition, and gender for emotional self-control, lack of premeditation, future time perspective, and present time perspective. With regard to emotional self-control, the findings revealed a pattern in which females in the yoga group reported improvements, whereas males in the control group reported improvements. In addition, for the positive outcome of future time perspective, females in the control condition and males in the yoga condition reported *decreases* in this outcome. With regard to the negative outcomes of present time perspective and lack of premeditation, females in the control condition reported increases in lack of premeditation, whereas males in the control condition reported decreases in present time perspective.

In summary, these findings suggest that females in the present study tended to experience greater long-term benefits from participating in yoga, whereas males tended to experience greater long-term benefits from participating in standard physical education. This finding is supported by prior research which has found that males tend to be resistant to participating in school-based yoga (Conboy et al. 2013), as well as national studies of yoga participation which have found that there is a strong tendency for adolescent females to participate in yoga more than adolescent males (Black et al. 2015). Thus it is possible that North American cultural preconceptions regarding the gender-appropriateness of yoga may influence the effects that yoga has on students, particularly during developmental periods such as middle school when gender differences are accentuated (Hill and Lynch 1983).

It is also of interest to note that the majority of significant changes that emerged in the aforementioned three-way interactions were not between time 1 and time 2. Instead, most of the significant changes were between earlier time points (time 1 and 2) and later time points (time 3 and 4). In other words, it appears as though both the yoga intervention and control condition may have had delayed effects in which changes did not appear until the two follow-up time points. This finding is rather remarkable given that the two follow-up periods occurred 6 months and 1 year after the yoga intervention was complete, and suggests that school-based yoga may have delayed effects that take time to integrate. These findings are preliminary and will need to be replicated in future research.

While not directly relevant to the primary hypotheses of the present study, it is also of interest to note several significant effects that emerged regardless of participants' experimental condition. For example, significant two-way interactions between time and gender emerged for perceived stress and fatigue. These interactions revealed a pattern in which females tended to either not change or worsen on these negative outcomes over time, whereas males tended to not change or improve. In addition, significant main effects of gender emerged for confusion, tension, negative urgency, sensation seeking, and positive urgency. These main effects revealed that across both conditions and all time points, females reported higher levels of tension and confusion than males, whereas males reported higher levels of negative urgency, sensation seeking, and positive urgency than females. These findings are consistent with prior research suggesting that females tend to report higher levels of internalizing disorders than males (Zahn-Waxler et al. 2008), whereas males tend to report higher levels of impulsivity than females (Cross et al. 2011). Several outcome measures also showed significant changes over time regardless of participants' gender or experimental condition. For example, the entire sample reported significant increases in depression and willingness to try cigarettes, beer, marijuana, and drugs. These findings are consistent with prior research suggesting that the cumulative prevalence of psychiatric disorders increases throughout childhood and adolescence (Copeland et al. 2011) as well as willingness to experiment with drugs and alcohol (Johnston et al. 2006).

Yoga Intervention Feasibility

Analyses on participant perceptions of the yoga program revealed that student opinions were mixed. When examining average ratings, students appeared to have relatively neutral opinions about the yoga program, with mean levels of enjoyment being toward the mid-point of the rating scale. However, there were groups of approximately 20 students who evaluated the yoga program very negatively by choosing the lowest point on the rating scale, which may have skewed the results. In addition, on average, participants in the yoga group reported preferring physical education over yoga. These findings are consistent with qualitative studies suggesting that some students, particularly athletic males, have negative opinions about yoga replacing physical education for an extended period of time, and that students prefer to have the option to choose between yoga and physical education (Conboy et al. 2013; LoRusso et al. 2015). Finally, students in the yoga group reported practicing yoga more often outside of school than students in the control group, a finding that is consistent with qualitative research suggesting that students often report using skills and techniques from school-based yoga in a variety of areas of their lives (LoRusso et al. 2015; Wang and Hagins 2016).

Students' mixed perceptions of the yoga program may have occurred for a variety of reasons. For example, the fact that the yoga program replaced standard physical education for a period of approximately 6 months may have made some students, particularly students who enjoy physical education, feel that the intervention was too long. It is also possible that the physical education teachers' perceptions of the yoga program may have influenced the students' perceptions. In particular, some of the physical education teachers were supportive of the yoga program, whereas others were not as enthusiastic. This is understandable given that the present study involved external yoga instructors who replaced the physical education

teachers for half of each teacher's class periods for the majority of the school year. Indeed, anecdotal reports from study staff and the yoga instructors suggested that some of the physical education teachers were expressing concerns to students such as yoga not providing enough of a workout for students to succeed on state-mandated fitness testing. Previous research suggests that support from teachers and administrative staff is essential to the success of school-based yoga (Mendelson et al. 2013; Miller et al. 2014), thus the relatively low levels of physical education teacher buy-in may have influenced the present results.

Limitations

The current study has a number of strengths, however some limitations need to be acknowledged. First, the consent/assent process may have resulted in some sampling bias. Parent consent was required for acquiring the outcome measures, and a significant percentage of parents did not return consent forms. It is possible that these parents may have been less involved in their children's day-to-day lives and/or general welfare, and thus these children may have been more likely to be experiencing risk factors for substance use. This could have created floor/ceiling effects in which the sample evaluated in the present study may have been less likely to show significant improvements. Also, students were given the consent and assent forms during homeroom and asked to bring the forms home to their parents. Study staff explained that consent and assent pertained only to the acquisition of the outcome measures, and that all students would be randomly allocated to the yoga or control condition regardless of whether they returned their signed forms. However, some students may have misunderstood this instruction and believed that if they did not return a consent/assent form then they would not have to participate in yoga. The fact that the final sample had a greater number of females (63.2 %) than males (36.8 %) is consistent with the hypothesis that males might have been less likely to return their consent forms because they did not want to participate in yoga.

In addition, despite the fact that the school had a relatively diverse student population, it is an exam school that requires students to obtain a particular score to be admitted. Also, the current sample was comprised of a relatively large proportion of Asian students (30.6 %). However, it is encouraging to note that despite the study's relatively low enrollment rate, the study sample exhibited similar demographics as the school as a whole, suggesting that the sample was generally representative of the school population. In addition, while students at this particular school may be considered "high performing," the students came from a variety of ethnic and socio-economic backgrounds, with 34.5 % of the student population considered low income. In addition, due to their high performing nature, it is possible that these students experience particularly high levels of academic stress, a hypothesis that was confirmed by anecdotal conversations with school staff. Thus, it is possible that participants in the present study are relatively similar to students from other urban schools, at least with regard to demographics and academic stress.

An additional limitation of the present study is that all of the outcome measures were self-report in nature, which may have led to bias and/or dishonesty in student responses. Also, the yoga intervention was taught by external instructors which, while necessary to ensure treatment fidelity, caused some concern among physical education teachers and may not be a

feasible model for the long-term implementation of yoga in schools. In addition, the constraints of the school environment required that participants be randomized by classroom, instead of individually. Group randomization is relatively more vulnerable to threats to internal validity such as history and maturation (Eldridge et al. 2008). It is also possible that a 32-session intervention might have been too long for students, and may have resulted in the relatively low yoga enjoyment ratings given by some students.

It is also important to note that the magnitude of the significant effects in the present study (i.e., effect sizes) were relatively small, as was the sample size. For example, after accounting for variance explained by baseline scores, the yoga intervention only accounted for 2 % of the variance in post-intervention willingness to smoke cigarettes. Thus it will be important for future research to examine whether school-based yoga interventions can produce larger effects in different settings and for different outcomes with larger sample sizes. Finally, the fact that the yoga participants transitioned to the control condition after the intervention was complete complicates the interpretation of the follow-up data. Many of these challenges are limitations that are common to researchers who study school-based interventions, based on the fact that these interventions are delivered and evaluated in real-world settings. Thus we are optimistic that, despite these limitations, the present study presents valuable information regarding the potential effects of school-based yoga on substance use risk factors.

Future Research

It will be important for future research to address these limitations by taking several factors into consideration. For example, future research should examine the effects of yoga on substance use risk factors in more diverse samples of students, particularly in samples exhibiting higher substance use risk, in order to avoid the floor effect that occurred for substance use in the present study. Future research should also consider using alternative assessment methods other than self-report. It will also be important for researchers to test for potential gender effects in studies of school-based yoga, as well as collect data over extended follow-up periods to examine potential delayed effects. A final suggestion is for researchers to compare the results of study designs in which students are permitted to self-select into yoga or physical education, versus studies in which students are randomly assigned to conditions. Given that many physical education programs allow students to self-select into sports and/or to use physical education as a study hall (Conboy et al. 2013), allowing students to self-select into yoga may provide a more valid and realistic assessment of the effects of yoga in school settings.

Conclusion

Taken together, the results of the present study suggest that yoga may have beneficial effects on willingness to smoke cigarettes (for males and females) and emotional self-control (for females). It is also possible that school-based yoga may show delayed effects in which immediate pre- to post-intervention differences do not emerge, but improvements are observed over an extended period of time. The present findings are preliminary, and thus additional research is required to examine these subtle and nuanced effects.

Appendix: Sample Yoga Intervention Curriculum Materials

Lesson 5: Sticking Through Stressful Experiences

Lesson Overview

Introduction

Lesson 5 explores the concept of noticing one's experience while sticking with stressful situations rather than giving up or checking out. When faced with a challenge, the instinctive response is often to give up and avoid the challenge entirely, or check out and stay in the challenging situation, but mentally disconnect from the experience. This lesson invites students to practice remaining both physically and mentally engaged with a challenging experience.

Learning Goals

Participants

- Explore the idea that they can choose how to respond to stress
- Identify their habitual responses to stress
- Practice observing and accepting stressful experiences as they are
- Practice breathing techniques to focus and quiet the mind.

Key Concepts

- Noticing stress and sticking with it
- Mindful breathing

Key Practices

Three-Part Breath

Ocean Breath

- Foundational yoga postures
- Introduction to longer holds with an emphasis on "sticking with stress"

Materials and Room Setup

- • Blocks (Low Lunge series and Triangle)

- • Visual aid

- • Ocean Breath poster

Lesson Plan: Session 5

Didactic Content

- • Options for responding to stress

- • Start by asking students what they think are good things to do when they're stressed out. Or start by asking them if they've heard people say "take a deep breath" or "count to 10 before you react," and then ask them if they think those things work.

- • Introduce the concept of "sticking with stress"

Benefits of Ocean Breath

- • Relieves insomnia and promotes sleep

- • Soothes the nervous system

- • Settles the mind

Experiential Activity

- • Yogi Twisters

- • Call out names of body parts, e.g., "just one foot," "two hands," "just your sitz bones." Students can only touch the floor with the body parts called out. Encourage creativity. If appropriate, have the students take turns being the caller.

Centering and Breathwork

- • Three Letting-Go Breaths

- • Silent check-in

- • Three supine belly breaths

- • Three supine breaths into the rib cage

- • Three supine breaths into the chest

- • Supine Three-Part Breath

- • Introduction to Ocean Breath

  - – Establish steady and even Three-Part Breath. Open the mouth, constrict the back of the throat, and whisper the syllable "eeeee" on the inhalation and "haaaaaa" on the exhalation, cultivating a steady, smooth

sound. Then close the mouth and continue whispering "eeee" and "haaaa" to create this soft, smooth sound from the back of the throat.

– How do you identify stress? Stress can feel different to different people —some breathe shallowly or hold their breath, some get headaches or stomach pain, some feel antsy or exhausted. Start by sharing your own experience of what stress feels like for you and ask students to share their experiences. Use this discussion of how to identify stress to lead into the discussion of how to respond to it. The sound produced by Ocean Breath settles the mind by giving it a sensory focal point. You could say this breath "tricks" the mind into focusing on the present moment, which allows space for relaxation, healing, and building energy. Making louder sounds than normal while breathing may feel strange, so acknowledge the possibility that students may feel uncomfortable at first. Creating the audible sounds of Ocean Breath increases awareness—as the mind processes the sounds of the breath, the mind and body link.

Warm-Up

- Low Lunge series with blocks

- Extended Low Lunge to Hamstring Stretch

- Extended Low Lunge

  – From Down Dog, step the right foot forward in between the hands and bring the back knee down to the mat. Keep both hips squaring off toward the front of the mat as you drop them forward and down. Raise the arms overhead, reaching fingertips toward the ceiling and lifting the sternum.

- Hamstring Stretch

  – Place both hands on the ground and straighten the front leg, bringing the hips back toward the back heel. Keep the hips lifted off the heel and extend the torso forward, bringing the chin toward the extended knee.

- Knee-Down Twist

  – With the right foot forward, bring the left hand down next to the right foot and lift the right fingertips toward the ceiling, twisting toward the right knee. Return the right hand to the ground outside the right foot and lift the left arm in the air, twisting toward the left side of the room.

- Lateral Stretch

  – With the right foot forward, bring the right hand down to the ground or a block beside the right hip and reach the left hand up and over to the right, keeping the pelvis pressing forward and down. Return to the starting position and laterally stretch the spine to the other side.

Yoga Poses

- Full Sun Salutation weaving in:

- Five-breath hold of Plank and Chair

- Fundamentals of Warrior I

- From Down Dog, step the right foot forward between the hands.

- Keeping the back heel lifted, inhale the arms overhead.

- Keep the front knee stacked over the ankle and press the back knee up toward the ceiling.

- Flying Warrior I

- From Warrior I, inhale to reach up through the fingertips.

- On the exhale, reach forward, down, and then back, bringing the hands by the hips with the palms facing down and lowering the torso to a 45-degree angle.

- Inhale to reach the arms up, lifting the torso and bringing the biceps up by the ears.

- Repeat for a few more rounds of breath.

- Exhale the arms down to the ground, step the right foot back, and repeat on the other side.

- Fundamentals of Warrior II

- Begin in a wide-legged stance facing the left side of the mat so that the right foot is near the front of the mat.

- Rotate the right toes to face the front of the mat and bend the right knee to bring it over the right ankle.

- Keep the hips squared off toward the side of your mat—if the hip bones were headlights they would be pointing straight ahead.

- Bring your arms up parallel to the mat and reach through the fingertips, looking over your right shoulder.

- Release and repeat on the opposite side.

- Triangle

- Child

- Supine Twist

If students are struggling with the longer holds, give them the option of dropping their knees in Plank or placing their hands on their thighs in Chair.

Relaxation and Integration

- Rest pose with lengthened exhales

- Guide students to inhale to a slow count of three, and exhale to a slow count of six. Count aloud for them during the first couple rounds of breath, then guide them to continue the count silently to themselves.

Closure

At the end of class, bring everyone up to seated and ask the students to take a minute for another silent check-in, guiding them to tune in and become mindful of where they are in the moment.

Bring closure to the lesson as a group. Options include, but are not limited to,

- Ring bell or singing bowl

- Bring hands to chest and feel heartbeat

- Collective breath (big breath in, sigh it out)

- Clasp hands behind back and fold forward over crossed legs

- Three Sun Breaths.

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Biographies

Bethany Butzer Ph.D. is an independent Research Consultant and Lecturer in the Department of Psychology at the University of New York in Prague, Czech Republic. She coordinated the study described in this article while she was a postdoctoral research fellow at Brigham and Women's Hospital, Harvard Medical School. Dr. Butzer's research interests span several areas of Positive Psychology, including the evaluation of school-based mind–body interventions for student psychological and physical health.

Amanda LoRusso B.Sc. is currently a massage therapy student at the Costa Rica School of Massage Therapy. She assisted with executing the study described in this article while she was a Research Assistant at Brigham and Women's Hospital. Her research interests include cognitive and contemplative neuroscience, acupuncture, yoga and other integrative health therapies.

Sunny H. Shin M.S.W., Ph.D. is an Associate Professor in the School of Social Work and Department of Psychiatry, School of Medicine at Virginia Commonwealth University, Richmond, VA. Dr. Shin's research interests include exposure to childhood traumatic events and later development of addictive behaviors.

Sat Bir S. Khalsa Ph.D. is an Assistant Professor of Medicine at Harvard Medical School, Brigham and Women's Hospital in Boston, MA. He is also director of research for the Kundalini Research Institute, research associate at the Benson Henry Institute for Mind Body Medicine, and research director for the Kripalu Center for Yoga & Health. Dr. Khalsa's research focuses on the efficacy of yoga practices as therapeutic and preventive medicine, with a particular emphasis on yoga within public school settings.

Yoga Practices
(postures, breathing, relaxation, meditation)

→

Substance Use Risk & Protective Factors
↓ Emotional Dysregulation
↓ Mood Impairment
↓ Perceived Stress
↓ Impulsivity
↓ Present Time Perspective
↑ Emotional Self-Control
↑ Future Time Perspective
↑ Mind-Body Awareness

→

Substance Use Willingness, Initiation & Frequency
↓ Willingness, initiation and use of alcohol, cigarettes, marijuana and other drugs

Fig. 1. Hypothesized associations between yoga practice, substance use risk and protective factors, and substance use willingness, initiation, and frequency

	407 Eligible	
	↓ → 196 did not return consent/assent forms	
117 Yoga	**211 Consented**	94 Control
1 withdrawal: health records ←	↓ → 1 withdrawal: seizure	
116 Yoga	**209 Completed Time 1 (Baseline)**	93 Control
1 student changed schools / 1 student missing data due to technical error ←	↓ → 2 students missing data due to technical error	
114 Yoga	**205 Completed Time 2 (End Program)**	91 Control
2 students changed schools ←	↓	
113 Yoga	**206 Completed Time 3 (6 Months)**	93 Control
2 students on extended absences / 1 student declined to take survey ←	↓ → 1 student changed schools / 1 student on extended absence	
110 Yoga	**201 Completed Time 4 (1 Year)**	91 Control

Fig. 2. Participant timeline throughout 4 waves of data collection
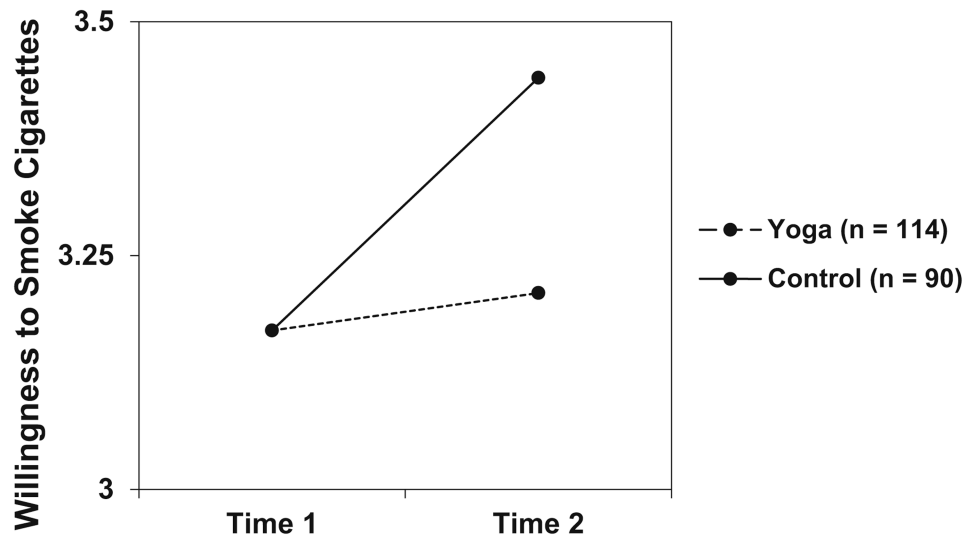
Fig. 3.
Yoga and control group participants' willingness to smoke cigarettes at baseline (time 1) and end-program (time 2). ANCOVA on end-program scores (with baseline scores as a covariate) significant at $p < 0.05$

YOGA GROUP

CONTROL GROUP

Fig. 4.
The interaction between condition, time, and gender predicting changes in emotional self-control. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

YOGA GROUP

CONTROL GROUP
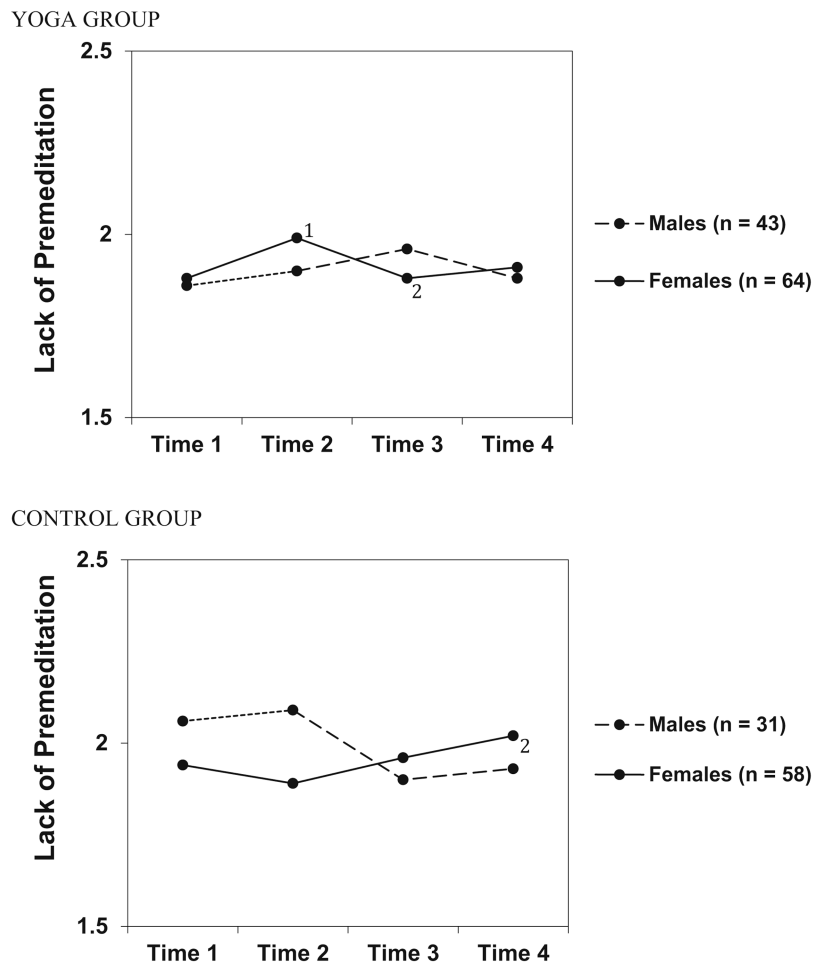
Fig. 5.
The interaction between condition, time, and gender predicting changes in lack of premeditation. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

YOGA GROUP

CONTROL GROUP
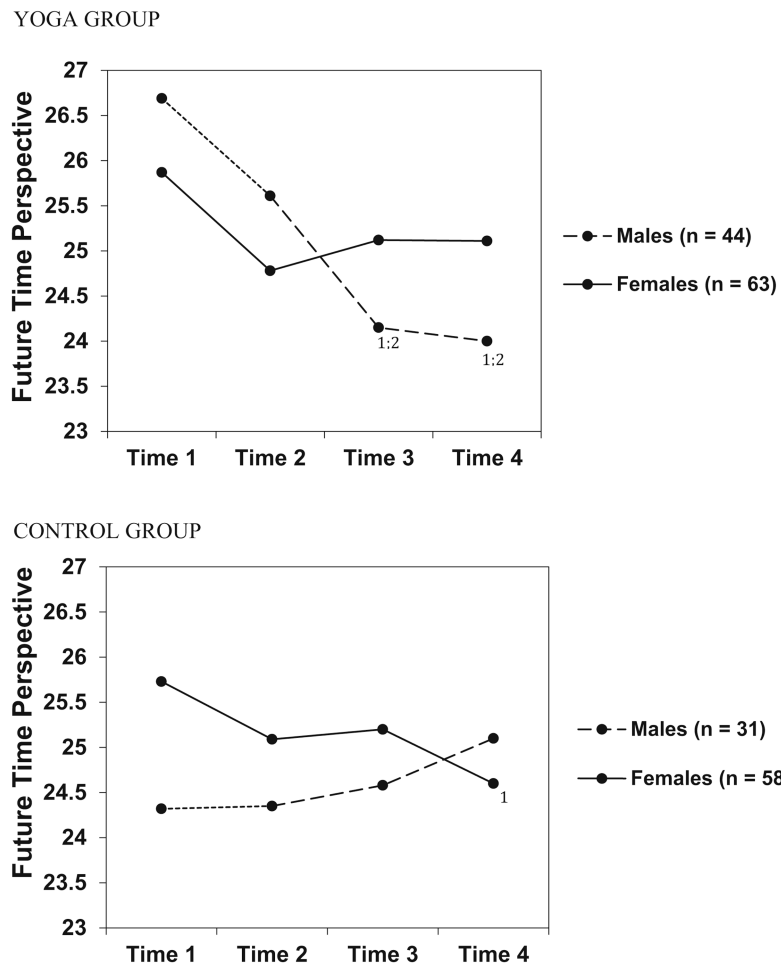
Fig. 6.
The interaction between condition, time, and gender predicting changes in future time perspective. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)
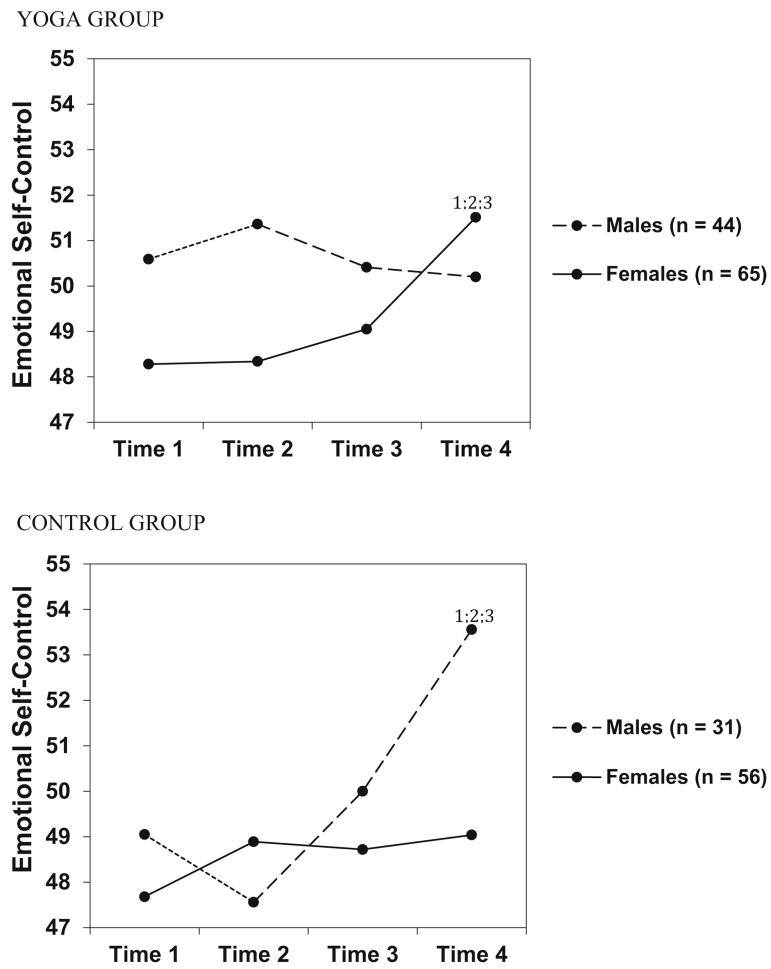
YOGA GROUP

CONTROL GROUP
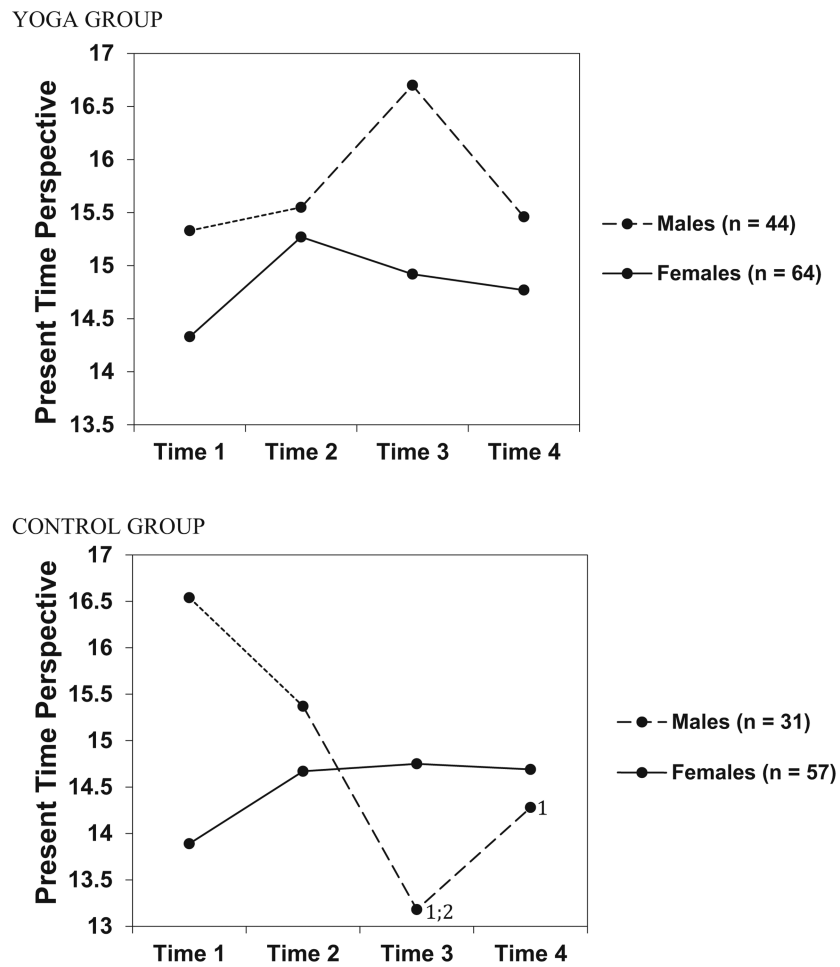
Fig. 7.
The interaction between condition, time, and gender predicting changes in present time perspective. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)
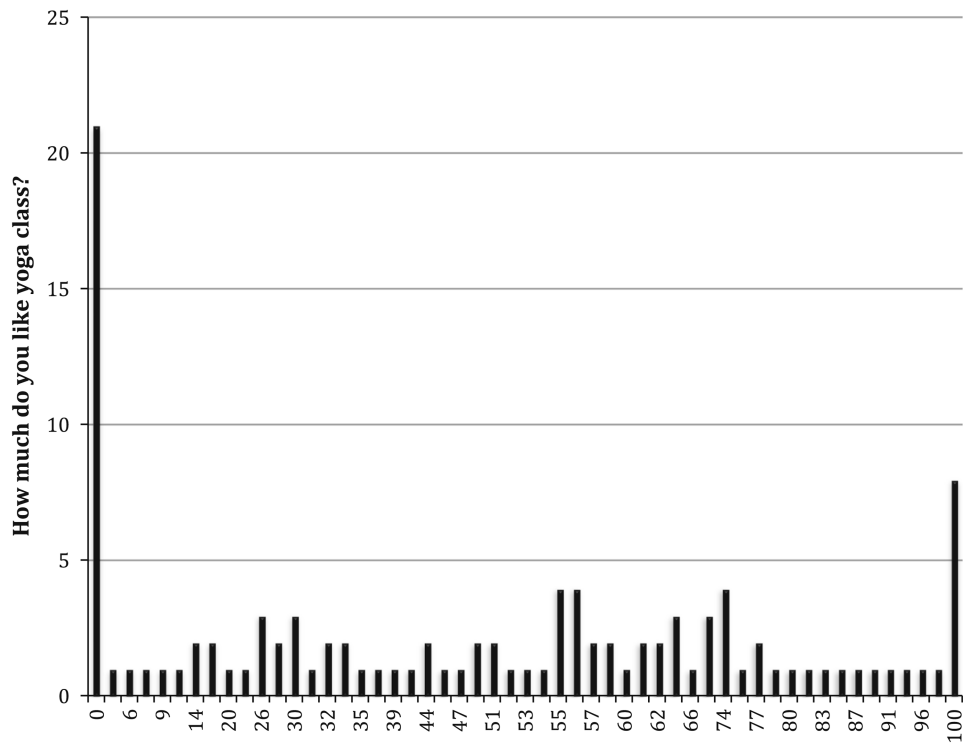
Fig. 8.
Frequency distribution of yoga participant responses to the question "How much do you like yoga class?" The question was rated on a 100-point visual analog scale ranging from 0 ("not at all") to 100 ("very much so") ($n = 110$)
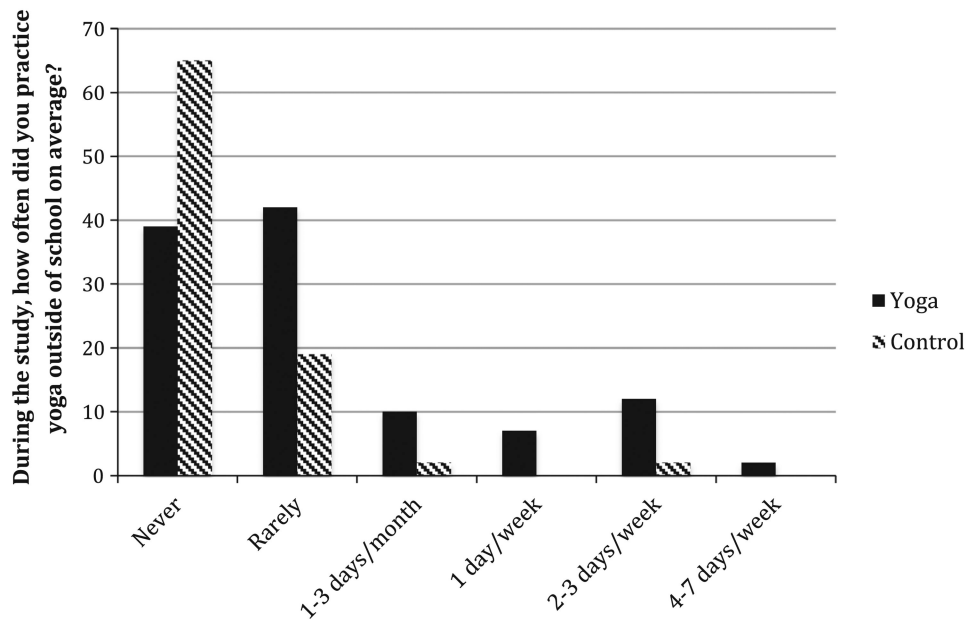
Fig. 9. Number of participants in the yoga (*n* = 112) and control (*n* = 88) groups who reported practicing yoga outside of school during the study

Table 1

Sample demographics

	Entire school ($n = 2205$) (%)	Yoga group ($n = 116$) (%)	Control group ($n = 93$) (%)
White	47.1	55.2	51.6
Asian	29.8	31.0	30.1
More than one race	3.1	6.0	10.8
African American	9.2	4.3	5.4
Native Hawaiian/Pacific Islander	0.1	1.7	0
Unknown	N/A	1.7	2.2
Hispanic	10.6	6.4	5.6
Male	45.2	38.8	34.4
Female	54.8	61.2	65.6

Values for the entire school were calculated based on enrollment during the 2013–2014 school year (MESE 2015)

Table 2

Mean scores for the yoga and control groups across all four data collection time points on emotional self-regulation, substance use willingness, perceived stress, mood, and impulsivity

Scale(s)	Construct	Yoga				Control			
		Pre	Post	Follow-up #1	Follow-up #2	Pre	Post	Follow-up #1	Follow-up #2
KWSCS; CAMS-AC; CSMS-SC	Emotional self-control	48.72 ± 10.21	49.07 ± 10.79	49.49 ± 9.56	50.80 ± 11.88	48.53 ± 9.08	48.36 ± 10.39	49.12 ± 9.61	50.75 ± 10.36
ALS; WCI; CSMS-SR; CAMS-AR	Emotional dysregulation	46.19 ± 13.35	47.09 ± 13.68	46.72 ± 14.74	44.37 ± 15.56	46.31 ± 11.65	47.07 ± 13.17	45.97 ± 12.44	46.35 ± 14.17
SUW	Cigarettes	3.17 ± 0.61	3.21 ± 0.76	3.51 ± 1.45	3.49 ± 1.26	3.17 ± 0.65	3.44 ± 1.06	3.41 ± 1.07	3.57 ± 1.48
	Beer	3.46 ± 0.97	3.75 ± 1.66	4.25 ± 2.22	4.16 ± 2.11	3.38 ± 0.85	3.87 ± 1.63	4.04 ± 1.76	4.31 ± 1.98
	Marijuana	3.10 ± 0.54	3.27 ± 1.19	3.58 ± 1.82	3.56 ± 1.48	3.12 ± 0.67	3.24 ± 0.72	3.42 ± 1.14	3.59 ± 1.53
	Drugs	6.75 ± 1.03	6.74 ± 1.30	7.10 ± 1.59	7.10 ± 1.48	6.82 ± 1.47	6.73 ± 1.16	6.90 ± 1.20	7.04 ± 1.78
PSS	Perceived stress	16.85 ± 7.73	17.46 ± 7.18	16.95 ± 7.33	16.81 ± 7.33	17.80 ± 6.33	18.95 ± 7.17	17.70 ± 6.47	18.72 ± 6.91
BRUMS	Anger	4.79 ± 3.62	5.38 ± 3.92	5.02 ± 3.52	5.04 ± 3.63	4.76 ± 3.18	5.34 ± 3.24	5.17 ± 3.43	5.59 ± 3.51
	Confusion	5.28 ± 3.40	5.24 ± 3.56	5.04 ± 3.29	5.00 ± 3.92	5.34 ± 2.96	6.00 ± 3.52	5.47 ± 3.17	5.71 ± 3.67
	Depression	3.49 ± 3.57	3.97 ± 4.27	3.58 ± 3.63	4.09 ± 4.32	3.59 ± 3.47	4.40 ± 3.60	3.88 ± 3.45	4.52 ± 3.93
	Fatigue	10.04 ± 4.12	10.06 ± 4.08	9.80 ± 3.98	10.10 ± 4.41	10.30 ± 3.87	10.36 ± 4.26	10.24 ± 4.35	10.52 ± 4.50
	Tension	6.93 ± 4.02	7.05 ± 4.00	6.00 ± 3.67	6.58 ± 4.00	7.23 ± 3.79	7.84 ± 3.87	6.90 ± 4.00	7.33 ± 4.07
	Vigor	9.02 ± 3.35	8.93 ± 3.42	8.56 ± 3.24	8.51 ± 3.47	9.36 ± 3.05	9.40 ± 3.24	9.31 ± 3.00	8.65 ± 3.29
UPPS-P	Negative urgency	1.99 ± 0.62	2.03 ± 0.63	1.95 ± 0.66	2.01 ± 0.76	1.98 ± 0.55	1.94 ± 0.58	1.96 ± 0.66	1.98 ± 0.64
	Lack of premeditation	1.89 ± 0.42	1.96 ± 0.45	1.93 ± 0.49	1.89 ± 0.50	2.00 ± 0.41	1.96 ± 0.49	1.95 ± 0.44	1.99 ± 0.46
	Lack of perseverance	1.91 ± 0.43	1.95 ± 0.47	1.99 ± 0.47	1.95 ± 0.50	1.92 ± 0.45	1.94 ± 0.47	1.92 ± 0.48	1.95 ± 0.48
	Sensation seeking	2.63 ± 0.60	2.67 ± 0.61	2.63 ± 0.62	2.69 ± 0.67	2.77 ± 0.58	2.71 ± 0.62	2.76 ± 0.66	2.79 ± 0.67
	Positive urgency	1.71 ± 0.62	1.81 ± 0.70	1.74 ± 0.68	1.80 ± 0.86	1.70 ± 0.55	1.67 ± 0.64	1.70 ± 0.72	1.74 ± 0.74
ZTPI	Future time perspective	25.85 ± 5.06	24.68 ± 5.46	24.49 ± 5.01	24.58 ± 5.76	25.15 ± 4.53	24.80 ± 5.15	24.85 ± 4.68	24.69 ± 4.96
	Present time perspective	14.72 ± 4.31	15.32 ± 4.79	15.63 ± 5.00	15.06 ± 4.58	14.94 ± 4.17	14.94 ± 4.32	14.36 ± 4.55	14.67 ± 4.55

KWSCS Kendall-Wilcox Self-Control Schedule, *CAMS-AC* Children's Anger Management Scale (Anger Management Scale (Anger Control Subscale), *CAMS-SC* Children's Anger Management Scale (Anger Rumination Subscale), *CSMS-SC* Children's Sadness Management Scale (Sadness Control Subscale), *CSMS-SR* Children's Sadness Management Scale (Sadness Rumination Subscale), *ALS* Affective Lability Scale, *WCI* Wills Coping Inventory, *SUW* Substance Use Willingness Scale, *PSS* Perceived Stress Scale, *BRUMS* Brunel University Mood Scale, *UPPS-P* The Urgency, Premeditation, Perseverance, and Sensation Seeking Plus Impulsive Behavior Scale, *ZTPI* Zimbardo Time Perspective Inventory

Table 3

Summary statistics for ANCOVAs comparing end-program (Time 2) scores between the yoga and control conditions on emotional self-regulation, substance use willingness, perceived stress, mood, and impulsivity

Scale(s)	Construct	Main effect of condition		
		F statistic	**p**	**Partial eta squared (η_p^2)**
KWSCS; CAMS-AC; CSMS-SC	Emotional self-control	0.05	0.83	0.00
ALS; WCI; CSMS-SR; CAMS-AR	Emotional dysregulation	0.08	0.78	0.00
SUW	Cigarettes	4.71	0.03 [*]	0.02
	Beer	1.31	0.25	0.01
	Marijuana	0.05	0.82	0.00
	Drugs	0.04	0.85	0.00
PSS	Perceived stress	0.93	0.34	0.01
BRUMS	Anger	0.09	0.77	0.00
	Confusion	2.11	0.15	0.01
	Depression	0.35	0.56	0.00
	Fatigue	0.04	0.84	0.00
	Tension	1.47	0.23	0.01
	Vigor	0.68	0.41	0.00
UPPS-P	Negative urgency	1.42	0.23	0.01
	Lack of premeditation	1.72	0.19	0.01
	Lack of perseverance	0.27	0.60	0.00
	Sensation seeking	0.25	0.62	0.00
	Positive urgency	1.95	0.16	0.01
ZTPI	Future time perspective	0.87	0.35	0.00
	Present time perspective	0.79	0.38	0.00

Baseline (Time 1) scores are included as a covariate in all analyses

KWSCS Kendall-Wilcox Self-Control Schedule, *CAMS-AC* Children's Anger Management Scale (Anger Control Subscale), *CAMS-AR* Children's Anger Management Scale (Anger Rumination Subscale), *CSMS-SC* Children's Sadness Management Scale (Sadness Control Subscale), *CSMS-SR* Children's Sadness Management Scale (Sadness Rumination Subscale), *ALS* Affective Lability Scale, *WCI* Wills Coping Inventory, *SUW* Substance Use Willingness Scale, *PSS* Perceived Stress Scale, *BRUMS* Brunel University Mood Scale, *UPPS-P* The Urgency, Premeditation, Perseverance, and Sensation Seeking Plus Impulsive Behavior Scale, *ZTPI* Zimbardo Time Perspective Inventory

[*] $p < 0.05$

Table 4

Lifetime substance use on the youth risk behavior survey—middle school version (YRBS-MS) for participants in the yoga and control groups

Question	Yoga				Control				Chi square statistic (p)			
	Pre	Post	Follow-Up #1	Follow-Up #2	Pre	Post	Follow-Up #1	Follow-Up #2	Pre	Post	Follow-Up #1	Follow-Up #2
Have you ever tried cigarette smoking, even one or two puffs?	1 (0.9 %)	3 (2.6 %)	2 (1.8 %)	2 (1.8 %)	0 (0 %)	1 (1.1 %)	1 (1.1 %)	3 (3.3 %)	0.79 (0.38)	0.62 (0.43)	0.16 (0.69)	0.45 (0.50)
Have you ever had a drink of alcohol, other than a few sips?	8 (7.0 %)	10 (8.8 %)	12 (10.8 %)	16 (14.8 %)	4 (4.3 %)	4 (4.3 %)	5 (5.5 %)	14 (15.4 %)	0.67 (0.41)	1.51 (0.22)	1.83 (0.18)	0.01 (0.91)
Have you ever used marijuana?	1 (0.9 %)	2 (1.8 %)	3 (2.7 %)	2 (1.9 %)	0 (0 %)	0 (0 %)	1 (1.1 %)	2 (2.2 %)	0.80 (0.37)	1.61 (0.20)	0.63 (0.43)	0.03 (0.85)
Have you ever used any form of cocaine, including powder, crack, or freebase?	0 (0 %)	1 (0.9 %)	2 (1.8 %)	2 (1.9 %)	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	n/a	0.81 (0.37)	1.60 (0.21)	1.70 (0.19)
Have you ever sniffed glue, breathed the contents of spray cans, or inhaled any paints or sprays to get high?	0 (0 %)	0 (0 %)	2 (1.8 %)	2 (1.9 %)	1 (1.1 %)	1 (1.1 %)	3 (3.4 %)	2 (2.2 %)	1.25 (0.26)	1.25 (0.26)	0.50 (0.48)	0.30 (0.86)
Have you ever taken steroid pills or shots without a doctors prescription?	0 (0 %)	0 (0 %)	2 (1.8 %)	2 (1.9 %)	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	n/a	n/a	1.62 (0.20)	1.70 (0.19)
Have you ever taken a prescription	0 (0 %)	0 (0 %)	1 (0.9 %)	1 (1.0 %)	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	n/a	n/a	0.78 (0.38)	0.86 (0.35)

Question	Yoga				Control				Chi square statistic (*p*)			
	Pre	Post	Follow-Up #1	Follow-Up #2	Pre	Post	Follow-Up #1	Follow-Up #2	Pre	Post	Follow-Up #1	Follow-Up #2
drug (such as OxyContin, Percocet, Vicodin, codeine, Adderall, Ritalin, or Xanax) without a doctors prescription?												

Values indicate the raw number and percent (in parentheses) of participants who responded "Yes" to each question

Chi square statistic compares the distribution of participants in the yoga versus control groups who responded "yes" to each question at each time point

Table 5

Summary statistics for split-plot ANOVAs Examining the trajectory of change across all four data collection time points on emotional self-regulation, substance use willingness, perceived stress, mood, and impulsivity

Scale(s)	Construct	Time		Condition		Gender		Time * Condition		Time * Gender		Condition * Gender		Time * Condition * Gender	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
KWSCS; CAMS-AC; CSMS-SC	Emotional self-control	4.13	0.01*	0.26	0.61	1.22	0.27	0.84	0.47	0.19	0.90	0.00	0.96	4.65	0.00**
ALS; WCl; CSMS-SR; CAMS-AR	Emotional dysregulation	1.17	0.32	0.02	0.88	0.30	0.59	0.66	0.58	0.72	0.54	0.36	0.55	1.05	0.37
SUW	Cigarettes	6.66	0.00**	0.02	0.88	0.22	0.64	1.48	0.22	0.68	0.56	1.86	0.18	2.32	0.07
	Beer	18.10	0.00**	0.22	0.64	2.45	0.12	1.26	0.29	0.16	0.93	2.42	0.12	1.34	0.26
	Marijuana	10.37	0.00**	0.46	0.50	1.73	0.19	0.89	0.45	0.72	0.54	2.46	0.12	1.05	0.37
	Drugs	3.52	0.02*	0.02	0.88	2.43	0.12	0.61	0.61	1.29	0.28	0.06	0.81	2.02	0.11
PSS	Perceived stress	2.00	0.11	2.72	0.10	2.96	0.09	0.79	0.50	4.19	0.01*	0.28	0.60	2.15	0.09
BRUMS	Anger	2.45	0.06	0.00	0.95	3.53	0.06	0.41	0.75	1.49	0.22	0.74	0.39	0.73	0.53
	Confusion	1.59	0.19	0.34	0.56	8.49	0.00**	0.64	0.59	0.41	0.75	2.91	0.09	1.85	0.14
	Depression	3.31	0.02*	0.74	0.39	1.28	0.26	0.07	0.97	1.02	0.38	0.40	0.53	0.69	0.56
	Fatigue	1.10	0.35	0.03	0.87	15.18	0.00**	0.05	0.98	2.96	0.03*	2.24	0.14	1.25	0.29
	Tension	6.16	0.00**	0.79	0.38	7.13	0.01*	0.29	0.83	2.70	0.05	1.38	0.24	0.78	0.51
	Vigor	2.66	0.05	0.29	0.59	0.47	0.50	0.87	0.45	0.33	0.80	0.01	0.92	1.07	0.36
UPPS-P	Negative urgency	0.24	0.87	0.17	0.68	5.15	0.02*	0.58	0.63	2.32	0.07	1.59	0.21	1.38	0.25
	Lack of premeditation	0.60	0.62	1.56	0.21	0.04	0.83	1.04	0.37	1.15	0.33	0.30	0.58	3.84	0.01*
	Lack of perseverance	0.73	0.54	0.03	0.86	0.37	0.54	1.20	0.31	1.28	0.28	0.07	0.79	2.37	0.07
	Sensation seeking	0.71	0.55	1.60	0.21	7.12	0.01*	0.14	0.93	2.29	0.08	0.17	0.69	0.96	0.41
	Positive urgency	0.35	0.79	0.82	0.37	7.49	0.01*	0.61	0.61	1.58	0.19	2.32	0.13	1.62	0.19
ZTPI	Future time perspective	3.08	0.03*	0.23	0.63	0.29	0.59	2.14	0.09	0.48	0.70	0.14	0.71	3.09	0.03*
	Present time perspective	0.57	0.63	1.33	0.25	1.42	0.24	3.83	0.01*	2.89	0.04*	0.31	0.58	5.16	0.00**

Split-plot analyses of variance (ANOVAs) were conducted with condition (yoga; control) and gender (male; female) as the between-subjects factors, and time (baseline; end-program; follow-up #1; follow-up #2) as the within-subjects factor

KWSCS Kendall-Wilcox Self-Control Schedule, *CAMS-AC* Children's Anger Management Scale (Anger Control Subscale), *CAMS-AR* Children's Anger Management Scale (Anger Rumination Subscale), *CSMS-SC* Children's Sadness Management Scale (Sadness Control Subscale), *CSMS-SR* Children's Sadness Management Scale (Sadness Rumination Subscale), *ALS* Affective Lability Scale, *WCI* Wills Coping Inventory, *SUW* Substance Use Willingness Scale, *PSS* Perceived Stress Scale, *BRUMS* Brunei University Mood Scale, *UPPS-P* The Urgency, Premeditation, Perseverance, and Sensation Seeking Plus Impulsive Behavior Scale, *ZTPI* Zimbardo Time Perspective Inventory

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$p < 0.05$

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$p < 0.01$