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School-based Yoga Programs in the United States: A Survey

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Abstract

Context—Substantial interest has begun to emerge around the implementation of yoga interventions in schools. Researchers have found that yoga practices may enhance skills such as self-regulation and prosocial behavior, and lead to improvements in students' performance. These researchers, therefore, have proposed that contemplative practices have the potential to play a crucial role in enhancing the quality of US public education.

Objective—The purpose of the present study was to provide a summary and comparison of school-based yoga programs in the United States.

Design—Online, listserv, and database searches were conducted to identify programs, and information was collected regarding each program's scope of work, curriculum characteristics, teacher-certification and training requirements, implementation models, modes of operation, and geographical regions.

Setting—The online, listserv, and database searches took place in Boston, MA, USA, and New Haven, CT, USA.

Results—Thirty-six programs were identified that offer yoga in more than 940 schools across the United States, and more than 5400 instructors have been trained by these programs to offer yoga in educational settings. Despite some variability in the exact mode of implementation, training requirements, locations served, and grades covered, the majority of the programs share a common goal of teaching 4 basic elements of yoga: (1) physical postures, (2) breathing exercises, (3) relaxation techniques, and (4) mindfulness and meditation practices. The programs also teach a variety of additional educational, social-emotional, and didactic techniques to enhance students' mental and physical health and behavior.

Conclusions—The fact that the present study was able to find a relatively large number of formal, school-based yoga programs currently being implemented in the United States suggests that the programs may be acceptable and feasible to implement. The results also suggest that the popularity of school-based yoga programs may continue to grow.

Some research has suggested that mind-body practices, such as yoga, may have beneficial effects on the mental and physical health of children and adolescents.¹⁻⁴ Indeed, substantial interest has begun to emerge in the United States regarding the development and application of meditation- and yoga-based interventions in schools to improve students' mental and physical health and performance.⁵⁻¹¹ In a review proposing the implementation of contemplative practices such as yoga and meditation in education, Davidson et al⁵ have suggested that these practices induce changes in brain structure and function, which can enhance skills, such as self-regulation and prosocial behavior, and lead to improvements in students' performance. These researchers, therefore, have proposed that contemplative practices have the potential to play a crucial role in enhancing the quality of US public education. Similarly, Hyde¹² points to recent governmental initiatives in the United States that have focused on educating *the whole child* and suggests that teaching yoga in schools is an important part of that movement. Yoga is increasingly being implemented in school settings,¹³ with several school-based yoga programs emerging across the United States.¹⁴

Research on School-based Yoga

The National Center for Complementary and Integrative Health (NCCIH) defines *yoga* as follows:

A mind-and-body practice with historical origins in ancient Indian philosophy. Like other meditative-movement practices used for health purposes, various styles of yoga typically combine physical postures, breathing techniques, and meditation or relaxation.¹⁵

Research on school-based yoga interventions is in its early stages; however, initial results are promising. For example, Serwacki and Cook-Cottone¹⁶ recently reviewed 12 published studies of school-based yoga interventions. Although most of the studies were of low-to-moderate methodological quality, the preliminary evidence suggested that the yoga interventions exerted positive effects on several factors, including emotional balance, attentional control, cognitive efficiency, anxiety, negative thought patterns, emotional and physical arousal, reactivity, and negative behavior. Additional research has also revealed positive effects for school-based yoga on such factors as concentration, self-regulation, attention, anxiety, stress, mood, resilience, emotional arousal, self-esteem, and coping frequency.^{9,17-32}

These preliminary findings suggest that providing yoga within the school curriculum may be an effective and feasible way to help youth develop skills in stress management and emotional regulation. The high prevalence of psychiatric disorders among youth,³³ coupled with the fact that most schools do not prioritize training in stress management and emotional regulation,³⁴ suggests that these types of interventions might be advantageous in school settings.

The growing interest in providing yoga in school settings has resulted in the development and implementation of numerous school-based yoga programs.¹⁴ It is important for educational policymakers and administrators; school health providers, such as nurses and counselors; and academics to be aware of the growing number of school-based yoga programs that are emerging across the United States, particularly in light of preliminary research suggesting potentially positive effects for these interventions.

However, school-based yoga programs have been created largely independently of one another, making it difficult for researchers, educators, and practitioners to compare features across programs and to assess whether a particular program suits their needs. The purpose of the current study was to provide a summary and comparison of school-based yoga programs across the United States. Although some preliminary research has been conducted on the efficacy of individual school-based yoga programs in isolation,¹⁶ to the research team's knowledge the current article represents the first attempt to summarize and compare interventions' characteristics *across* programs.

METHODS

Data collection for the current study took place between January 2013 and April 2014. *School-based yoga programs* were defined as yoga practices or curricula developed by organizations specifically for use in school settings.

School-based yoga programs were identified in 3 primary ways: (1) through the current research team's personal knowledge and communication with experts in the field; (2) through reviews of the research literature on yoga in schools; and (3) through online searches of 2 databases— the International Association for School Yoga & Mindfulness (IASYM) database, and the Garrison Institute's Contemplative Education Program database.

The Garrison Institute's database compiles information about US and Canadian programs that provide contemplative education for students from kindergarten through grade 12 (K-12). Similarly, the IASYM database was created as a resource to compile and disseminate information regarding school-based yoga programs around the world. After exhausting those primary sources, a final online search was performed using Google to identify any remaining programs. Terms for the Google search included words such as *school-based yoga*, *yoga in schools*, *yoga programs in schools*, and *contemplative education programs*.

Inclusion criteria required that an organization was currently providing yoga-based programming in schools within the United States. Mindfulness and/or meditation programs were included only if they explicitly incorporated a significant focus on yoga-based practices, such as physical postures and/or breathing exercises, in addition to meditation. Programs that focused exclusively on meditation (ie, solely on sitting meditation) and/or programs that were located outside of the United States were excluded. Meiklejohn et al,³⁵ Black et al,³⁶ Burke,³⁷ Sprengel and Fritts,³⁸ Zenger et al,³⁹ and Weare⁴⁰ provide reviews of research on mindfulness programs for youth.

The current research team queried the organizations that were found to provide school-based yoga programs by reaching out directly via e-mail or phone using a formal script. In particular, each organization was asked to provide answers to a series of questions regarding its program, including (1) the grade level(s) covered; (2) the type of program—in-academic-classroom instruction (eg, yoga at one’s chair or desk), full-yoga practice in an open space or gym, or both; (3) the primary geographical region(s); (4) the number of formally trained instructors; (5) the existence of a requirement for basic yoga-teacher certification prior to receipt of training in the program, including the number of hours required for certification; (6) the number of hours of training required by the school-based yoga program; (7) the number of schools currently implementing the program; and (8) the number of years that the program has been in service.

To gain additional breadth regarding the characteristics of each program, the current research team also compiled and reviewed online and print materials regarding each program’s scope of work, curriculum characteristics, teacher-certification and training requirements, implementation model, mode of operation, and primary geographical region.

RESULTS

Table 1 provides a detailed summary of the information gathered from each program. Thirty-six organizations were identified that are currently offering yoga programs in school settings in the United States. The number of years in service across all of the programs ranged from 2 to 21 years, with an average of 9 years.

The results suggested that more than 940 schools across the United States are currently implementing a yoga program, and more than 5400 instructors have been trained by those organizations to facilitate yoga in schools. The programs represent a mix of nonprofit and for-profit organizations.

Several of the organizations provide customized curricula and implementation plans (ie, manualized programs outlining a series of yoga-class lesson plans) for individual schools and whole school districts. However, some of the smaller organizations do not have manualized programs, and, thus, yoga teachers are encouraged to develop their own lesson plans based on the core principles and guidelines of the overarching program. Some programs focus exclusively on school programming, whereas other yoga programs are also run at mental health organizations, community youth programs, or community organizations for at-risk youth. In addition to children’s programming, many programs also include yoga instruction for parents, classroom teachers, and other school staff.

Grades Covered

A total of 75% of the programs surveyed (ie, 27 of 36) offer yoga programming that spans kindergarten, or even preschool, through grade 12, whereas the remaining programs focus specifically on elementary, middle-school, or high-school students. Some programs have developed separate manuals for each age group (eg, “Yoga Ed” and “YoKid”); however, most programs simply allow teachers to use existing manuals and modify their yoga instruction to be appropriate for the age level that they teach.

Setting and Components

The organizations were also asked about their primary modes of operation, distinguishing between instruction in the academic classroom (eg, yoga at one's chair or desk) and a full-yoga practice in an open space or gym. Programs that use in-classroom lessons insert short yoga breaks throughout the school day during regular class time to introduce a few simple exercises, instead of providing a typical, full, yoga class (30-45 min). Full-yoga implementation, on the other hand, places a greater emphasis on the elements of physical exercise in the yoga practice and often operates as a part of physical-education class, an after-school elective, or a between-class recess. This form of yoga program typically requires special equipment (eg, mats, blocks, blankets, or straps) as well as a space other than the regular classroom (eg, a gym).

Eight programs in the current study's sample indicated that they run a full-yoga program exclusively; 3 programs specialize in in-classroom yoga instruction; and the remaining 25 programs indicated that they offer both a full-yoga program and an in-classroom option, tailoring the program to each school's needs.

All of the programs outlined in Table 1 typically have incorporated the 4 basic elements of yoga practice into their curriculums, including physical postures, breathing exercises, relaxation techniques, and mindfulness and meditation practices. Most programs also include didactic elements, such as ethics, philosophy, or psychology lessons.

Each yoga class can include all 4 aspects of yoga or only a few elements. Many programs also allow the inclusion of nonyoga components, such as games, songs, arts and crafts, journaling, team-building, and community-enhancing exercises as well as activities that teach skills, such as social-emotional learning, bullying prevention, peer-counseling techniques, community action and outreach, leadership training, and character development. In most cases, these nonyoga elements are woven into the yoga lessons.

All 36 programs also stressed that their yoga lessons are secular (nonreligious) and teach universal values, often referred to as life skills. The inclusion of elements that are not traditionally part of a yoga class allows the yoga programming to be integrated with a school's values and existing school-wide, social-emotional learning programs. Although the majority of programs do not have a formal relationship with the Collaborative for Academic, Social, and Emotional Learning (CASEL), many of the programs have goals that are aligned with the core CASEL competencies (ie, enhancing students' self-awareness, self-management, social awareness, relationship skills, and responsible decision-making).⁴¹

Training and Implementation

A great deal of heterogeneity exists with regard to the training and implementation methods currently used by school-based yoga programs. In particular, the levels of training and certifications required as well as the nomenclature employed within a program's structure (eg, certified teacher, facilitator, apprentice, or licensed trainer) can vary extensively.

For example, some organizations offer training for independent yoga teachers who are interested in implementing yoga in schools as part of what might be considered a yoga

internship or residency, whereas other organizations train classroom teachers, physical education teachers, school counselors, school nurses, and/or paraprofessionals to implement a limited subset of practices from their programs. Depending on the model of implementation and the target audience, the organizations may offer 1-day, professional development workshops for school staff, design customized trainings for a particular school or school district based on needs and funding, or host multiday trainings for professional yoga teachers who want to expand their repertoire and become certified in a program to be applied in schools.

The prerequisite training requirements across the surveyed organizations were also quite variable. Some programs require their candidates to be classroom teachers with professional experience, with an additional background in yoga and mindfulness. Other programs do not set prerequisites for participation in their yoga-training programs and instead require extensive training for all.

A total of 42% (n = 15) of the organizations stated that a basic 200-hour, registered yoga teacher (RYT) certification by Yoga Alliance, the governing yoga-teacher training authority in the United States, is required prior to attending their specialized, school-based yoga training.

However, some variability and exceptions exist (Table 1). In summary, programs vary in terms of their instructors' training; however, many programs try to combine the 3 primary delivery methods into a coherent structure to ensure sustainability: (1) external yoga teachers who are not staff members of the school, (2) on-site staff members of the school who become certified yoga instructors, and (3) classroom teachers who are trained to apply a limited subset of yoga practices.

DISCUSSION

The current study makes a unique contribution to the literature by providing a preliminary indication of the scope of implementation of school-based yoga programs in the United States. Specifically, the results of the present study suggested that numerous formal programs exist that provide yoga within school settings as a strategy to enhance students' mental and physical health, behavior, and performance.

Indeed, the present survey identified a total of 36 programs that are currently offering school-based yoga programming, with nearly 5400 yoga instructors reaching students in more than 940 schools across the United States. In general, the programs showed a substantial degree of variability with regard to their training and implementation models. For example, a large range exists with regard to the total number of hours and other requirements that are necessary to complete each program's teacher training. Variability also exists with regard to who is trained, for how long, and with what intention.

At a curriculum level, most of the programs surveyed were more alike than different. For example, despite the variability in the exact mode of implementation— in-classroom versus full-yoga, level of training requirements, number of locations served, or the grades covered, the majority of programs share the common goal of combining the 4 basic elements of yoga

—physical postures, breathing exercises, relaxation techniques, and mindfulness/meditation practices—with a variety of additional techniques to promote positive outcomes for students. Indeed, the majority of programs state explicit goals around improving students' psychological and physical health, social-emotional skills, classroom behavior, and academic performance.

Although additional research is necessary to confirm whether school-based yoga does in fact deliver on those proposed benefits, preliminary studies in the area are promising.¹⁶ Table 1 provides the Web sites of the programs found in the current study, which outline how school-based yoga programs are being implemented at individual schools.

It is also of interest to note that many of the programs surveyed have come into existence in a relatively short period, with most being in their first 5 to 10 years of service. This fact suggests that the popularity of school-based yoga programs is increasing and that the smaller organizations may begin to create manuals for their curriculum materials in time. Taken together, despite some differences that may exist between programs, it can be seen that most programs share an overarching mission to provide yoga in school settings as a technique to promote a variety of positive outcomes for students.

Implications

Schools play an essential role in helping children develop social and academic skills that are required to be successful as adults. Indeed, several preliminary studies suggest that school-based yoga interventions may positively affect numerous aspects of students' health.^{9,17-32} Thus, implementing yoga within the curricula of US schools could have widespread implications, especially considering the fact that school attendance is legally mandated in the United States.

Given that the majority of psychiatric disorders have onsets during childhood or adolescence⁴² and that more than one-third of US children are considered overweight or obese,⁴³ school-based yoga programs have the potential to provide a large-scale preventive intervention that may target early risk factors for psychological and physical health problems in both childhood and adulthood.

It is important to note, however, that implementing yoga within school settings often comes with a unique set of challenges.⁴⁴ Traditional bureaucratic structures, combined with potential fears and misunderstandings about yoga, can cause some parents to be reluctant to endorse participation of their children in yoga-based programming. The yoga programs surveyed for the present study were very careful to emphasize the secular nature of their offerings; however, that reassurance is not always sufficient for some parents. A recent court case in Encinitas, California,⁴⁵ in which a group of parents attempted to sue a school district for implementing a yoga program, serves as an example of that type of resistance. In addition, bringing external teachers into a school to teach yoga can sometimes create logistical issues and cause concern among in-house school staff regarding their roles while the yoga is being taught as well as the stability of their employment. It will be important for future research to examine the most effective and feasible delivery methods for school-based yoga programming.

Limitations

Although every effort was made to contact and include as many school-based yoga programs as possible for the present study, it is possible that the Internet, database, and literature searches did not capture all of the programs that are currently in existence, especially those that are new or emerging. In addition, the current study focused primarily on organizations that have developed school-based yoga programs, not on individual schools that may be offering yoga internally. Thus, it is likely that school-based yoga is being taught more widely than is reflected by the information in Table 1. It is also possible that some of that information is under- or overestimated, due to the fact that many of the included organizations brought up a lack of recordkeeping during discussion with the research team, or mentioned that they were unable to accurately estimate the prevalence of their program due to the nature of their implementation model. In addition, some of the statistics in Table 1 may not be directly comparable across programs, largely due to the variability that exists in the program models and delivery methods as well as to the fact that the programs are not centrally regulated and do not interact with each other.

Future Directions

Based on the limitations described above, it is important to keep in mind that the results of the present study are tentative and preliminary. A more rigorous study of the prevalence of yoga in schools in the United States should consist of a systematic evaluation of the prevalence of the programs by recruiting a random selection of schools to determine what programs are offered as well as the programs' characteristics. Such a study might include a random selection of 100 schools from various geographic regions in which the researchers query senior school staff as to whether their school is currently implementing a yoga program and then complete an analysis of the programs. This approach would not only give a more systematic overview of existing school-based yoga programs, it would also provide an estimate of the prevalence of yoga in schools across the country.

In addition, it will be important for future research to rigorously evaluate the efficacy of school-based yoga programs. Although initial research on yoga in schools has shown promising results,¹⁶ the research is highly preliminary and is often of low methodological quality, with many researchers creating their own informal yoga interventions that are not evidence based. Peer-reviewed research has begun to emerge on some of the yoga programs described in the present study, such as the Holistic Life Foundation,^{20,46} Yoga Ed,^{9,47,48} Kripalu Yoga in Schools,^{9,21,23,31} YogaKids,^{27,49} Niroga Institute,^{26,28} Yoga 4 Classrooms,³² and Get Ready To Learn^{50,51}; however, additional research is needed to build the evidence base for teaching yoga in schools.

Further, the current paper has focused exclusively on an analysis of school-based yoga programs in the United States; thus, it would be worthwhile for future research to examine the extent to which school-based yoga programs exist in other parts of the world. Some evidence of such programs in other countries is available, including the programs YogaBugs, Yoga'd Up, Yoga at School, and the Yoga Factory in the United Kingdom as well as the New Leaf Yoga Foundation and Yoga in Schools in Canada.

However, it is possible that school-based yoga programs are viewed and implemented differently across cultures. For example, given that yoga originated in India, researchers might assume that introducing yoga in schools in India would be well received. However, yoga is viewed differently in the United States and India, largely due to cultural differences.

For example, in India, a child's exposure to yoga often begins at home, where certain breathing exercises are a part of daily prayers.⁵² Indeed, programs to introduce school-based yoga as a part of governmental policy in India are usually met with objections, because people of other faiths associate yoga with the Hindu religion.⁵³ With that background, yoga is being introduced in schools and in separate camps⁵⁴ based on individual interests and the response that a program receives. However, at the current time, attempts to introduce yoga systematically into all schools across the Indian subcontinent have not been successful. In summary, it will be beneficial for future researchers to conduct a cross-cultural comparison of school-based yoga programs around the world.

CONCLUSIONS

The fact that the present study was able to find a relatively large number of formal, school-based yoga programs currently being implemented in the United States suggests that the programs may be acceptable and feasible to implement. The present results also suggest that the popularity of school-based yoga programs may continue to grow. Indeed, it is likely that the need for the positive outcomes that yoga may provide for students is increasing, including improved social-emotional skills, classroom behavior, and performance.

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Table 1

Summary of Characteristics of School-based Yoga Programs

Program	Grades	In Classroom vs Full Yoga	Basic RYT 200 Yoga Teacher Certification Required?	No. of Trained Instructors	No. of Mandatory Training Hours	No. of Schools Currently Implementing Program	No. of Years Organization in Service	Primary Geographical Region	Web Site
Bent on Learning	K-12	Full yoga	Yes	50	100	16	12	New York, NY	bentonlearning.org
Calm Kids Yoga	PreK-12	Both	Yes	200	40	Unable to answer	11	USA, primarily Colorado	calmingkidsyoga.org
Circus Yoga	K-12	Both	No	300	100	Unable to answer	16	Nationwide, primarily Northeast	circusyoga.com
Core Yoga in Schools	K-12	Both	Yes	10	18	4	4	Boston, MA	coreyoga.com
Get Ready to Learn	PreK-12	Both	Yes	100	60	55	7	USA, international	getreadytolearn.net
Go Grounded	PreK-12	Both	No	350	22	20	6	Georgia, North Carolina, New York, New Jersey	gogrounded.com
Headstand	K-8	In classroom	No	3	200	3	6	San Francisco, CA; New York, NY	headstand.org
Holistic Life Foundation	PreK-12	Both	No	9	250	16	13	Baltimore, MD; Northeast/ Midatlantic region	hlifnc.org/home.htm
Integral Yoga Institute: Yoga at School	K-12	Both	Yes	10	36	Unable to answer	10	New York, NY	iyiny.org/about-us/yoga-at-school
Karma Kids Yoga	K-12	Both	No	36	30	18	12	New York, NY	karmakidsyoga.com/yoga_classroom.html
Kripalu Yoga in Schools	G7-12	Full yoga	Yes	75	60	24	6	USA, primarily northeast; international	kripalu.org/be_a_part_of_kripalu/812
Lineage Project	G6-12	Full yoga	No	18	20	13	16	New York, NY	lineageproject.org
Little Flower Yoga/School Yoga Project	PreK-12	Both	No	52	206	24	8	New York, NY	littlefloweryoga.com
Mindful Practices	PreK-12	Both	Yes	23	40	75	7	Midwest, primarily Chicago, IL	mindfulpracticesyoga.com
Next Generation Yoga	PreK-8	Both	No	30	24	12	17	USA, primarily New York, California	nextgenerationyoga.com/ngy_kids_schools.html

Program	Grades	In Classroom vs Full Yoga	Basic RYT 200 Yoga Teacher Certification Required?	No. of Trained Instructors	No. of Mandatory Training Hours	No. of Schools Currently Implementing Program	No. of Years Organization in Service	Primary Geographical Region	Web Site
Niroga Institute	K-12	Both	Yes for full yoga; No for in-classroom	250 full yoga; 1000 in-classroom	15 in full yoga; 6 in-class level 1; 12 in-class level 2; 12 in-class level 3	100	9	USA, primarily California; international	niroga.org
Om Schooled	K-5	Both	No	160	20	5	4	New York, NY	om-schooled.com
Resilient Kids	K-12	In classroom	No	13	30	9	3	Rhode Island	resilientkids.org
School, Inc	PreK-5	Both	No	17	95	9	12	Los Angeles, CA; Pasadena, CA	school-yoga.org
The Newark Yoga Movement	PreK-12	Both	Yes	30	20	14	5	Newark, NJ	newarkyogamovement.org
The Sean O'Shea Foundation	G3-12	Both	Yes	100	10	18	6	San Diego, CA; Los Angeles, CA	seanosheafoundation.org
The Sonima Foundation	K-12	Full yoga	No	32	100	18	3	California, Florida, New York	sonimafoundation.org
The Wellness Initiative	PreK-12	Full yoga	Yes	25	30	37	8	Denver, CO, metro area	wellnessinitiative.org
YOGA for Youth	G1-12	Both	No	300	40	9	21	Los Angeles, CA; New York, NY; North Carolina; Toronto, Canada; Mexico	yogafor youth.org/the-program
Yoga 4 Classrooms	K-12	In classroom	No	50 licensed, ^a 35 school site ^b	57 licensed, ^a 23 school site ^b	60	4	USA; Canada; Puerto Rico	yoga4classrooms.com
Yoga Calm	PreK-12	Both	No	150	100	130	14	USA, primarily northwest; Oregon; Washington State; California; Colorado; Minnesota; Kentucky	yogacalm.org
Yoga Child	PreK-12	Both	No	50	50	3	14	Philadelphia, PA	yogachild.net

Program	Grades	In Classroom vs Full Yoga	Basic RYT 200 Yoga Teacher Certification Required?	No. of Trained Instructors	No. of Mandatory Training Hours	No. of Schools Currently Implementing Program	No. of Years Organization in Service	Primary Geographical Region	Web Site
Yoga Ed	PreK-12	Both	No	1000	95	100	15	Throughout USA; international	yogaed.com
Yoga Enriching Schools	K-12	Full yoga	Yes	12	38	3	2	Los Angeles, CA; Pasadena, CA	yogainschool.org
Yoga Gangsters	K-12	Both	No	761	15	Unable to answer	10	USA	yogagangsters.org
Yoga in My School	PreK-12	Both	No	4	24	25	11	Alberta, Canada	yogainmyschool.com
Yoga in Schools	K-12	Both	Yes	4	40	58	5	Pittsburgh, PA	
YogaKids International: Tools for Schools	PreK-8	Both	Yes	120	87	Unable to answer	21	USA, Canada	yogakids.com
YoKid	PreK-12	Full yoga	No	60	20	51	8	Maryland; Virginia; Washington, DC	yokid.org
Youth Yoga School	PreK-12	Full yoga	No	5	95	8	4	Midwest, primarily Indiana	youthyogaschool.com
108 Monkeys	K-12	Both	Yes	9	14	4	2	New Haven, CT	108monkeys.org

Abbreviations: RYT, Yoga Alliance Registered Yoga Teacher certification.

^aLicensed denotes semester-long in-classroom residency, in which a licensed yoga teacher teaches the program at a school.

^bSchool site denotes a member of the school's staff teaches the program at the school, providing training and support for all educators, administrators, and counselors.



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Yoga in public school improves adolescent mood and affect

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Abstract

The purpose of the present study was to directly compare the acute effects of participating in a single yoga class versus a single standard physical education (PE) class on student mood. Forty-seven high school students completed self-report questionnaires assessing mood and affect immediately before and after participating in a single yoga class and a single PE class one week later. Data were analyzed using paired-samples t tests and Wilcoxon-signed ranks tests and by comparing effect sizes between the two conditions. Participants reported significantly greater decreases in anger, depression, and fatigue from before to after participating in yoga compared to PE. Significant reductions in negative affect occurred after yoga but not after PE; however, the changes were not significantly different between conditions. In addition, after participating in both yoga and PE, participants reported significant decreases in confusion and tension, with no significant difference between groups. Results suggest that school-based yoga may provide unique benefits for students above and beyond participation in PE. Future research should continue to elucidate the distinct psychological and physiological effects of participating in yoga compared to PE activities.

Keywords

yoga; mindfulness; students; schools; adolescence; youth; mood; affect; physical education; education context

Introduction

In recent years, contemplative practices have become increasingly common in school settings (White, 2009; Butzer et al., submitted), and there has been a corresponding increase in applied research exploring the benefits of mindfulness- and yoga-based interventions in education contexts (Davidson et al., 2012; Jennings, 2008; Khalsa et al., 2012; Noggle et al., 2012; Saltzman & Goldin, 2008; Serwacki & Cook-Cottone, 2012; Thompson & Gauntlett-Gilbert, 2008). Yoga can be defined as:

...a holistic system of mind-body practices for mental and physical health and typically incorporates four primary components: physical postures/exercises to promote strength and flexibility, breathing exercises to enhance respiratory functioning, deep relaxation techniques to cultivate the ability to physically and

mentally release tension and stress, and meditation/mindfulness practices to enhance mind-body awareness and improve attention and emotion regulation skills, (Butzer et al., submitted).

Emerging research suggests that yoga is generally effective at reducing stress and improving mood and well-being in adults (Chong, Tsunaka, Tsang, Chan, & Cheung, 2011; Kirkwood, Rampes, Tuffrey, Richardson, & Pilkington, 2005; Li & Goldsmith, 2012; Pilkington, Kirkwood, Rampes, & Richardson, 2005; Sharma, 2014), as well as improving physical and mental health in children and adolescents (Birdee et al., 2009; Galantino et al., 2008; Kaley-Isley et al., 2010), prompting calls for systematic exploration of the benefits of similar interventions in school contexts with youth (Greenberg & Harris, 2012; Felver et al., 2013; Davidson et al., 2012).

Research that has been done exploring the effects of yoga interventions on youth in educational settings has indicated potential benefits in several domains. In a recent literature review, 12 studies were evaluated that used yoga interventions for students in several school contexts, including interventions conducted as part of regular school programming, after school programming, and as an offering at a residential treatment school (Serwacki & Cook-Cottone, 2012). One third of these studies were conducted with students receiving special education services, and the remaining two thirds were conducted with typically developing or high-risk youth. This review concluded that although the yoga interventions surveyed appeared to be beneficial for students, significant methodological limitations existed in most studies, including quasi-experimental study designs, small sample sizes, and inconclusive quantitative results. Additional studies of school-based yoga interventions also suggest positive effects of these programs on several factors such as concentration, attention, anxiety, stress, mood, resilience, emotional arousal, self-esteem, and coping frequency (Bothe et al., 2014; Case-Smith et al., 2010; Conboy et al., 2013; Ehud et al., 2010; Khalsa et al., 2012; Klatt et al., 2013; Mendelson et al., 2010; Noggle et al., 2012; White, 2012; Sethi et al., 2013; Telles et al., 2013), however the majority of these studies also suffer from the methodological limitations described above.

An important research question in this area relates to whether yoga offers any unique benefits for student psychosocial well-being compared to standard school curricula such as physical education (PE) class. Studies in adult populations have suggested that yoga is superior to exercise in its ability to improve psychological outcomes (Ross & Thomas, 2010). The few studies that have directly compared the effects of participating in school-based yoga versus PE have generally found positive effects of yoga (e.g. Khalsa et al., 2012; Noggle et al., 2012). For example, a secular yoga curriculum developed specifically for students in public schools, Kripalu Yoga in the Schools (KYIS; Kripalu Institute for Extraordinary Living) was recently studied to evaluate the effects of yoga on psychosocial well-being in high school students (Noggle et al., 2012). This study randomly assigned students by class ($n = 3$), and compared the KYIS curriculum to a treatment-as-usual condition of PE class. Results suggest that the curriculum was acceptable and feasible in this population, and that yoga seemed to improve psychosocial well-being relative to the PE class, specifically in the domains of mood and affect. These results added to the burgeoning literature supporting the benefits of yoga practice for students in school settings, however

the authors noted that results should be interpreted with caution due to the fact that students were assigned by class, and thus their data may be confounded by clustering effects (i.e., students statistically nested within class group). It is also important to note that some studies have found very few (Telles et al., 2013) or no (Hagins et al., 2013) significant differences between groups when directly comparing yoga to PE.

Although the application of contemplative practices, such as yoga, in educational settings is an emerging field of scientific inquiry, there exist sound theoretical rationales for this integration. Davidson and colleagues (2012) recently reviewed the evidence supporting a framework whereby contemplative practice strengthen basic cognitive and emotional neural processes, which in turn result in improved psychological and behavioral functioning in the classroom. As described in this framework, a common shared characteristic among contemplative practices is that they include regular practice in maintaining attention on a particular sensory experience, such as the sensation of breathing or somatic experience such as during yoga. By maintaining this state of awareness, cognitive abilities to regulate attention and emotion are bolstered, as individuals develop the skills needed to disengage their attentional resources away from stimuli that elicit undesirable outcomes (e.g., negative affective states and patterns of behavior) while simultaneously cultivating desirable dispositions (e.g., positive affective states and increased activation of the parasympathetic nervous system). These Improvements in basic self-regulatory skills then lead to improvements in other aspects of functioning, such as student behavior and academics (Durlak et al., 2011; Tangney et al., 2004).

The rationale for this current study was to contribute to the existing literature by addressing methodological limitations noted in previous reviews, and by demonstrating the benefits of yoga practices to student mood and emotional well-being. To address methodological limitations, this study used an active control condition to evaluate the effects of yoga as compared to PE by contrasting student outcomes before and after a single class, examining within-group changes in students' psychosocial well-being relative to the class they were engaged in. We also chose to replicate and extend results found in a previous study (Noggle, et al., 2012) that explored the effects of a specific yoga intervention on a specific measurements of psychosocial well-being, thereby also addressing another methodological limitation noted in the literature. This work also aims to extend the literature supporting the benefits of contemplative practices to emotional wellbeing by empirically evaluating effects to mood and affect, in-line with theoretical conceptualizations of contemplative practices with youth in educational settings.

To our knowledge, this is the first study to examine the immediate effects of participating in a single yoga class versus a single PE class on student psychosocial well-being. Based on recent literature suggesting that school-based yoga and meditation programs may be particularly well-suited to improve psychosocial well-being in youth (Davidson et al., 2012), as well as the specific focus of the KYIS curriculum on enhancing students' ability to manage their stress and mood, we predict that students' mood and affective states will improve following yoga class, and that these improvements will be greater than what is observed in PE class.

Method

Research Design

To evaluate changes in mood and affect following a yoga class, student data was collected before and after a single yoga class that was taught during health class, a class that alternated weekly with PE class time. To compare these effects to an active control condition, data was also collected from the same students before and after a PE class approximately one week later.

Sampling

Students were eligible for participation if they were registered for their school's standard wellness programming during the spring of 2013, which alternated health and PE class weekly. No exclusion criteria were implemented. This programming included alternating weeks of PE with three weeks of the standardized KYIS curriculum included as part of the health curriculum. Passive consent procedures were used whereby parents were notified that their child would be participating in a yoga curriculum as part of their PE programming, and that they would be completing questionnaires before and after their PE class as part of a research project. Student assent was obtained during data collection. Students were not compensated for participation in the research. Data collection occurred during the second or third week of yoga class within the gymnasium or classroom in which the health class was typically held. This study's protocol was reviewed and approved by the Institutional Review Board of Brigham and Women's Hospital.

Participants

Participants included ninth- and tenth-grade students who came from one of three different wellness classes in a public high school in rural western Massachusetts. According to 2012–2013 data on this secondary school (Massachusetts Department of Elementary and Secondary Education, 2013), 337 students were enrolled grades 7 through 12, the graduation rate was 87.8%, 21.7% of students were identified as having a disability, 1.2% of students were English Language Learners, and 24.3% of students received free or reduced price lunch. The racial and ethnic composition of this school was 91.1% White, 3.6% Hispanic, 3% non-Hispanic Multi-Race, 1.2% Asian, 0.9% African-American, and 0.3% Native American Students.

Measures

To assess psychosocial wellbeing, we chose to measure the constructs of mood and affect, selecting two commonly used scales that have been utilized in previous research on yoga in schools (Noggle et al., 2012).

Brunel University Mood Scale (BRUMS; Lane & Lane, 2002)—The BRUMS is a brief measure of adolescent state mood derived from the Profile of Mood States (POMS) questionnaire (McNair, Lorr, & Droppleman, 1992). The BRUMS asks participants to indicate if they are currently experiencing a simple mood descriptor (e.g., “energetic” or “tired”) using a 5-point Likert-type scale ranging from “not at all” to “extremely.” The 24-items of the BRUMS yield 6 subscales of state mood each comprised of four descriptors:

Anger, Confusion, Depression, Fatigue, Tension, and Vigour. Internal consistency for the BRUMS subscales in this sample was acceptable, with Cronbach's alpha values ranging from 0.73 to 0.93.

Positive and Negative Affect Scale for Children (PANAS-C; Laurent et al., 1999)—The PANAS-C is a brief measure of child and adolescent affect based on a tripartite model of depression and anxiety (Clark & Wilson, 1991) that asserts the common superordinate dimensions of positive affect (PA) and negative affect (NA) inherent to internalizing disorders. Using the same instructions as the BRUMS, the PANAS-C asks participants to endorse their current experience of 27 simple mood descriptors (e.g., “interested” or “sad”), with 12 and 15 items combining to yield the PA and NA subscales respectively. Internal consistency for the PA and NA subscales was acceptable, with Cronbach's alpha values of 0.93 for PA and 0.89 for NA.

Experimental Conditions

The students' wellness programming included alternating weekly curricula of health class (i.e., three weeks of yoga, experimental condition) and PE class (i.e., active control condition). Wellness programming was offered daily Monday through Friday.

Yoga class – Kripalu Yoga in the Schools (KYIS) curriculum—The KYIS curriculum was developed by the Kripalu Center for Yoga and Health specifically for public schools and is completely secular in nature. The KYIS includes both traditional yoga training and elements that target social-emotional well-being. Traditional elements of yoga training include physical exercises to promote flexibility, muscular strength, balance, coordination, and somatic awareness, breathing exercises to improve respiratory function and reduce psychophysiological arousal, and mindfulness practices that focus on the ability to control attention and develop mind-body awareness. While the Kripalu Center does not have a formal relationship with the Collaborative for Academic, Social, and Emotional Learning (CASEL), the KYIS curriculum was developed to target the core CASEL social-emotional competencies of self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (CASEL, 2013). Thematic elements in KYIS related to social-emotional skills include developing somatic self-awareness, introducing basic physiological response of stress (i.e., the fight-or-flight response), and cultivating compassion for self and others.

To implement KYIS, instructors complete the Kripalu Center for Yoga and Health 1-week (55 hour) training program.

The experimental yoga class utilized the KYIS curriculum. KYIS is a 24-lesson secular curriculum that is designed to be taught during a high school class, typically as a unit of health or PE. In the present study, the KYIS intervention occurred for 15-lessons, with five lessons per week for three nonconsecutive weeks that alternated weekly with PE class. All of the 35-minute KYIS classes followed a similar format, including a brief warm-up (e.g., 5 minutes of mindful breathing) and experiential activity, 20 minutes of moving through various yoga postures, and a brief relaxation activity (e.g., 5 minutes spent lying on back and focusing on somatic sensations of non-activity) to end the class. Each class also incorporates

a theme that is integrated into the yoga postures and group discussion (e.g., dealing with stress, non-judgmental self-awareness). The yoga class was delivered by the fourth author who is an experienced yoga practitioner with 8 years of yoga teaching experience and a master's degree in education, and who is co-author of the KYIS curriculum.

PE class—The active control condition was a standard PE class that occurred 5 times per week for 35 minutes during alternating non-yoga class weeks. The PE class was taught by Massachusetts state certified PE and health teachers. A typical week of PE included learning the history and rules of a sport or activity as well as practicing the sport or activity. The practice of, or any information relating to yoga was not included in the standard PE curriculum at this school. The specific content of the PE class during the week of data collection involved students playing “capture-the-flag” as an outdoor activity.

Data analysis

Data were coded and analyzed using SPSS version 16.0 (SPSS, Chicago, IL). Data was double coded and verified to ensure accuracy. To compare the effects of yoga to PE, difference scores were calculated on all subscales by subtracting pre-class scores from post-class scores. Paired sample statistical analyses were used to compare yoga and PE. Normally distributed data were compared using paired-sample *t*-tests and non-normally distributed data were compared using the Wilcoxon signed rank tests, a non-parametric paired sample test commonly used when assumptions of normality are violated (e.g., data having significant skew or multiple outliers).

Results

Recruitment and Demographics

No eligible students or parents declined to participate. Overall, 58 students from three wellness classes participated (*n*'s = 21, 13, and 13 respectively). Of these students, three attended the yoga class but were absent from the standard-PE class, and 8 attended the standard-PE class but not the yoga, yielding 11 students total who were not available for analysis at both time points. Student participants (*N* = 47) had approximately equal gender distributions (48% male) and the average student age was 15 years and 9 months (*SD* = 9 months). Disability status and racial/ethnic identify data were not collected.

Baseline Data Characteristics

Descriptive characteristics of each dependent variable were analyzed individually to determine if assumptions of normality were met. For the change score dependent variables (i.e., pre-class score subtracted from post-class score), the BRUMS subscales of Anger, Confusion, Depression, and Tension, and PANAS-C subscale Negative Affect were not normally distributed (i.e., negative skew and outliers). For individual yoga- and PE classes, the BRUMS subscales of Anger, Confusion, Depression, Fatigue and Tension, and the PANAS-C subscale of Negative Affect were not normally distributed (i.e., negative skew and outliers).

Baseline scores on the BRUMS and PANAS-C were compared for the yoga and PE class time points to determine if there were any differences in subject's mood or affect before class (i.e., at pre-intervention times only). Normally distributed variables (i.e., BRUMS subscales Fatigue and Vigor) and PANAS-C subscale of Positive Affect, were compared using a paired-sample *t*-tests. The non-normally distributed variables were compared with Wilcoxon signed rank test. Pre-class data were significantly different for BRUMS subscales Anger, Depression, and Fatigue, and PANAS-C Negative Affect ($p < .05$), with students reporting higher scores before yoga class than before PE class (see Table 2 for details).

Analysis strategy

To compare the relative effects of yoga to PE class, two series of analyses were employed. In the first more stringent analysis, change scores between the two classes were compared using paired-sampling between group tests (i.e., paired-sample *t*-test for normally distributed data, or Wilcoxon signed rank test for non-normally distributed data). In the second analysis, change scores from pre- to post-class were examined for yoga and PE classes independently using paired-sample within group tests. Because of the small sample size and preliminary nature of this research, statistical significance level was not adjusted for multiple comparisons. We also calculated effect sizes for each analysis to add an additional dimension of data analysis independent of statistical significance.

Comparison of Pre-Post Change Scores between Yoga and PE Classes

To compare the relative effects of yoga and PE classes, change scores from before to after class were analyzed. Effect sizes were also calculated by dividing the differences between the class means by the average standard deviation. Results can be found in Table 1 and Figure 1. Students reported improved mood and affect after the yoga class relative to the PE class, however only the BRUMS Anger ($Z = 2.48, p = .013$), Depression ($Z = 2.20, p = .028$) and Fatigue ($T = 2.20, p = .034$) variables were statistically significant ($p < .05$). These three variables also had the three largest relative effect sizes. Using standard classifications set forth by Cohen (1992), students in the yoga class reported small effect sizes for BRUMS Anger ($d = .24$) and Depression ($d = .27$) mood variables, and a nearly medium effect size for BRUMS Fatigue mood variable ($d = .48$).

Within-Group Pre-Post Change Scores for Yoga and PE Classes

To further evaluate the relative effects of yoga and PE classes, the change scores from before to after class were analyzed separately for each class type. Effect sizes were calculated by dividing the differences between pre- and post-class measurement by the average standard deviation. Results can be found in Table 2 and Figure 2. Students reported improved mood and affect after both yoga and PE classes, however the magnitude of the difference was generally greater after participating in the yoga class. After participating in the yoga class, students had statistically significant ($p < .05$) improvements in five mood variables (i.e., BRUMS Anger, Confusion, Depression, Fatigue, and Tension) and one affect variable (PANAS-C Negative affect), whereas only two mood variables (i.e., BRUMS Confusion and Tension) showed significant improvement after participating in the PE class. Using standard classifications set forth by Cohen (1992), effect sizes were also consistently

larger for students in the yoga class, with small effect sizes for two mood variables (i.e., BRUMS Depression and Vigor) and one mood variable (i.e., PANAS-C Negative affect), and medium effect sizes for four mood variables (i.e., BRUMS Anger, Confusion, Fatigue, and Tension).

Discussion

This study was designed to extend and replicate previous research exploring the psychosocial benefits of yoga implemented as part of standard public education programming. We chose to extend the existing literature by using a paired-sample research design, whereby students' change following a yoga class was compared to their own change following a PE class, thus incorporating an active control condition. The results suggest that students had immediate improvements in their mood and affect following both types of wellness class, however the yoga class had a larger effect than the standard PE programming. Given that mood and affect in school-aged youth have been shown to predict later psychosocial functioning, such as psychopathology (Rothman et al., 2009), substance use (Weinstein & Mermelstein, 2013), and academic achievement (Gumora & Arsenio, 2002), interventions that may boost mood and affect, such as yoga, should be considered for use in school settings. These results contribute to the literature suggesting that school-based yoga interventions may improve youth psychosocial well-being above and beyond typical school programming, which may be important to promoting beneficial long-term outcomes for youth. However, more research is needed to empirically evaluate if the short-term benefits of yoga translate to improved long-term outcomes.

Comparing our results to the previous study implementing this particular yoga curriculum (KYIS), similarities and differences emerge in the results obtained. As in the previous study (Noggle et al., 2012), students reported improved aspects of mood and affect following yoga class compared to PE programming. These results suggest that yoga should be considered as a viable alternative curriculum for schools to utilize in PE, or at least as an addition to the PE curriculum, as yoga may have additional benefits for psychosocial well-being above standard PE. The pattern of benefits to student's mood and affect was in some ways different from results obtained by Noggle and colleagues (2012), as students reported improvements in different aspects of mood between the two studies, but did consistently endorse better Negative Affect. This discrepancy could be the result of methodological differences between the two studies, as our current study assessed immediate benefits following PE programming and used a paired-sample research design, whereas Noggle and colleagues (2012) used a longer time period (approximately 10 weeks) from pre- to post-assessment and used an independent-sample design. Future research should consider using similar study designs for replication, and the use of more stringent methodologies (e.g., randomized controlled trials) to better understand the more specific effects on mood and affect following school-based yoga interventions. Taken as a whole however, this research does suggest that yoga curricula in general, and the KYIS curriculum in particular, do benefit youth's psychosocial well-being.

To our knowledge, this is only the second study to document the effects of a yoga intervention to student emotional state among a group of typically developing students (the

other study being Noggle et al., 2013), however, there are documented intervention effects to student's emotional well-being in other studies of contemplative interventions. In a study exploring the effects of a school-based mindfulness intervention for students (Broderick & Metz, 2009), following 42 approximately thirty minute interventions sessions, high school students demonstrated significant reductions in negative affect as measured by the PANAS relative to a control group. Similarly, this research found significant reductions in negative affect on the PANAS immediately following a yoga intervention, suggesting that negative emotional states may be sensitive to intervention effects following contemplative interventions. Although not using the PANAS to measure student emotional states, other researchers have found similar effects following mindfulness-based interventions, including reductions in affective disturbance (Britton et al., 2014) and depression (Joyce et al., 2010). Taken as a whole, it seems that contemplative interventions, such as yoga and mindfulness-based interventions, appear to improve dimensions of negative mood and affect, and future research should consider including these variables as dependent outcomes as they appear to be sensitive to intervention effects.

Although the results from this study supported our hypothesis that a yoga curriculum would benefit student psychosocial well-being, this research does have several limitations. Some of our data were not normally distributed, which may have affected the statistical results. Although we implemented non-parametric analytic procedures to adjust for this, it could be that the results were influenced by data quality or other unaccounted variables. This study was limited by the sample size, which also may have affected the results as our data may be more susceptible to undue influences of statistical outliers. Some of the measured variables did have baseline differences in pre-class levels, which may have also influenced the findings. Given that we essentially collected data during two measurement periods, it could be that differences in the groups on these specific days could have influenced the results obtained. Data regarding more detailed student characteristics including disability status, psychiatric diagnoses, and family and peer relationships were not collected; this information may have been useful in providing richer contextual details to help interpret the results or may have provided an additional avenue for quantitative analysis. Future research exploring the benefits of yoga interventions in schools and the KYIS curriculum should seek to remediate these limitations.

Contemplative research among youth, particularly studies that utilize yoga interventions in school-based settings, is largely in its infancy. This research contributes to a burgeoning body of work suggesting that contemplative practices in youth may be beneficial for psychosocial well-being, although more research is needed. Specifically, future research that incorporates gold-standard research designs, long term measurement periods, and broader assessment of psychosocial and educational outcomes is needed. There is compelling evidence to continue this line of research, as yoga appears to be a viable practice for supporting the psychosocial needs of youth in today's classrooms.

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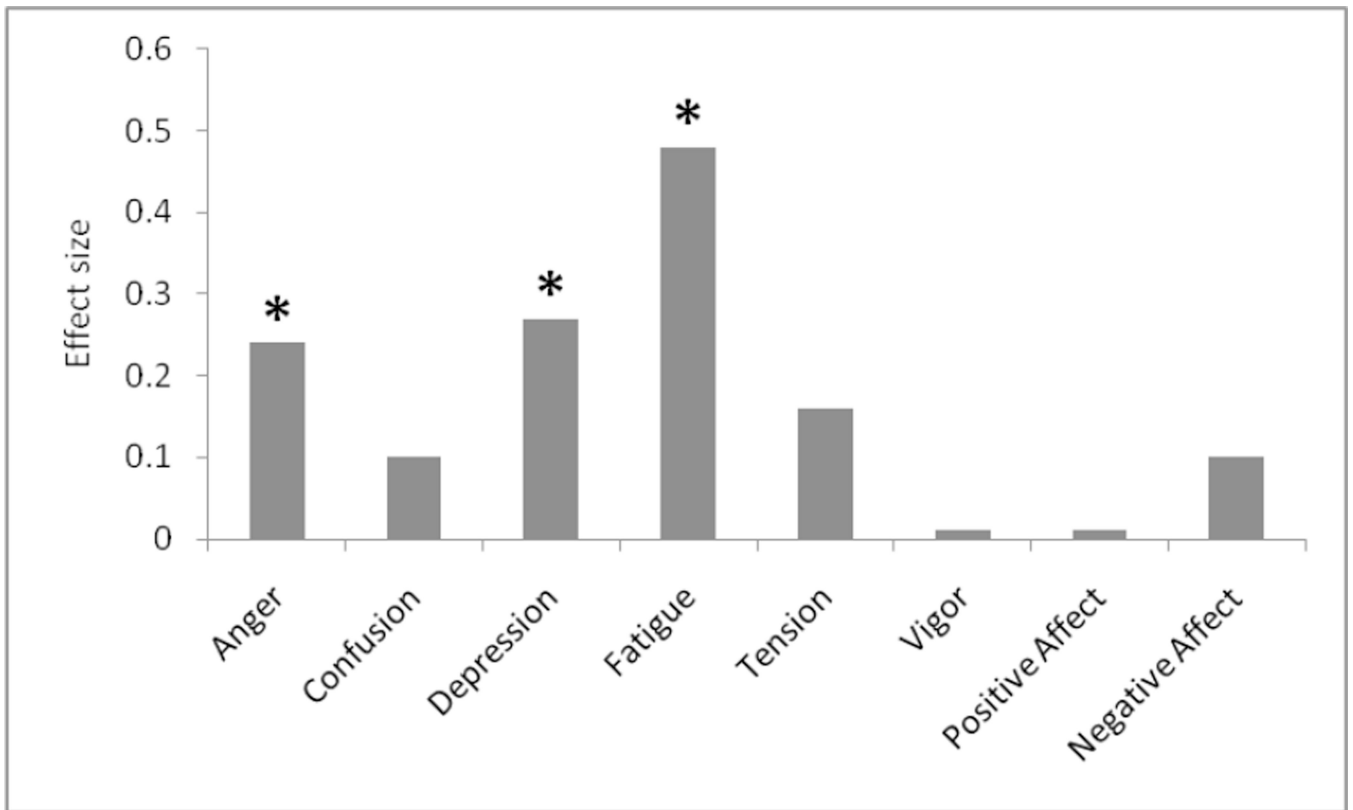


Figure 1.

Effect Sizes of Change Scores between Yoga and PE Classes

Note: PE, physical education; Anger, Confusion, Depression, Fatigue, Tension, and Vigor are mood variables from the BRUMS; Positive Affect and Negative Affect are affect variables from the PANAS-C. Effect sizes classified as .20 as small, .50 as medium, and .80 as large. Statistical significance ($p < .05$) denoted with an asterisk above.

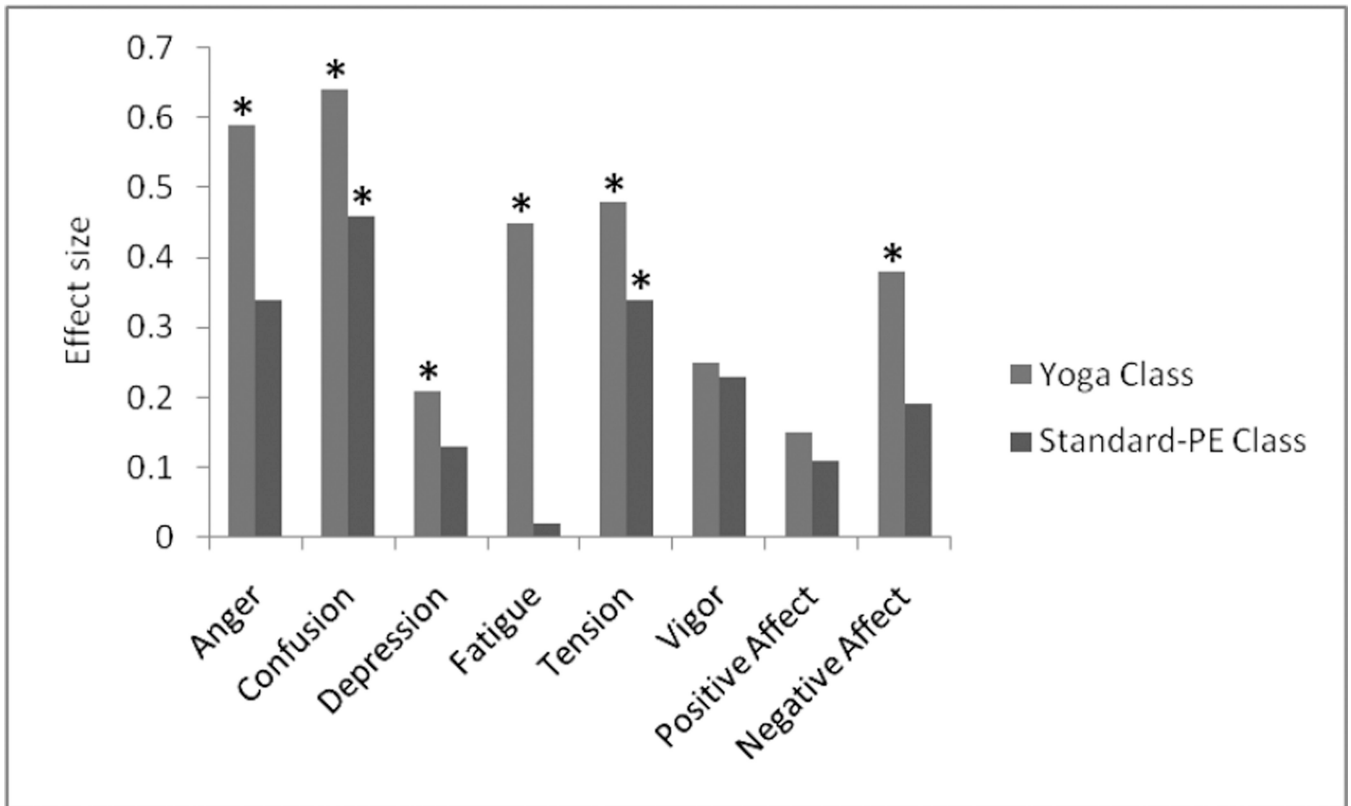


Figure 2.

Effect Sizes for Pre-class to Post-class Scores for Yoga and PE Classes

Note: PE, physical education; Anger, Confusion, Depression, Fatigue, Tension, and Vigor are mood variables from the BRUMS; Positive Affect and Negative Affect are affect variables from the PANAS-C. Effect sizes classified as .20 as small, .50 as medium, and .80 as large. Statistical significance ($p < .05$) denoted with an asterisk above.

Table 1

Comparison of Change Scores from Pre-class to Post-class between Yoga and PE Classes

Measure	Yoga		PE		T- or Z-Statistic	p	d
	Mean	SD	Mean	SD			
Mood – BRUMS							
Anger	-.87	1.75	-.45	1.80	2.48	.013	.24
Confusion	-.99	1.75	-.80	2.08	1.32	.188	.10
Depression	-.52	.97	-.19	1.44	2.20	.028	.27
Fatigue	-2.02	4.05	-.09	3.93	2.20	.034	.48
Tension	-.92	1.56	-.63	1.99	1.51	.132	.16
Vigor	.88	3.42	.92	3.83	.05	.957	.01
Affect – PANAS-C							
Positive affect	1.44	8.25	1.34	7.89	.08	.939	.01
Negative affect	-1.55	3.76	-1.03	6.50	1.17	.241	.10

Note: PE, physical education; BRUMS, Brunel University Mood Scale; Positive and Negative Affect Scale for Children, PANAS. Change scores calculated by subtracting pre-PE score from post-PE score. Test statistics for scores for Fatigue, Vigor, and Positive Affect computed with a two-tailed paired sample t-test; all other scores computed with Wilcoxon signed ranks test. Statistically significant when $p < .05$.

Table 2

Pre-class to Post-class Scores for Yoga and PE

Measure	Yoga			PE			T- or Z-Stat.	p	d
	Pre Mean (SD)	Post Mean (SD)	d	Pre Mean (SD)	Post Mean (SD)	d			
Mood - BRUMS									
Anger	1.35 (2.07)	0.40 (1.13)	.59	.80 (1.82)	.35 (0.81)	.59	1.89	.059	.34
Confusion	1.65 (2.11)	0.60 (1.17)	.64	1.15 (2.40)	0.35 (1.07)	.64	2.67	.008	.46
Depression	0.97 (2.30)	0.48 (2.26)	.21	.53 (1.76)	.35 (1.07)	.21	.57	.572	.13
Fatigue	6.35 (4.75)	4.30 (4.27)	.45	2.95 (3.90)	2.86 (3.43)	.45	.32	.746	.02
Tension	1.74 (2.13)	0.86 (1.54)	.48	1.35 (2.33)	.72 (1.33)	.48	2.21	.027	.34
Vigor	5.49 (3.18)	6.42 (4.36)	.25	5.90 (3.24)	6.79 (4.51)	.25	1.55	.128	.23
Affect - PANAS-C									
Positive affect	18.09 (8.57)	19.57 (11.54)	.15	16.72 (10.16)	17.95 (12.56)	.15	1.05	.300	.11
Negative affect	3.83 (4.52)	2.20 (4.02)	.38	3.32 (6.14)	2.31 (4.26)	.38	1.59	.112	.19

Note: PE, physical education; BRUMS, Brunel University Mood Scale; Positive and Negative Affect Scale for Children, PANAS. Test statistics for scores for Vigor and Positive Affect computed with a two-tailed paired sample t-test; all other scores computed with Wilcoxon signed ranks test. Statistically significant when $p < .05$.



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Effects of a Classroom-Based Yoga Intervention on Cortisol and Behavior in Second- and Third-Grade Students: A Pilot Study

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Abstract

This uncontrolled pilot study examined the effects of a classroom-based yoga intervention on cortisol concentrations and perceived behavior in children. A 10-week Yoga 4 Classrooms® intervention was implemented in one second- and one third-grade classroom. Students' salivary cortisol responses were assessed at three time points. Classroom teachers also documented their perceptions of the effects of the intervention on students' cognitive, social and emotional skills. Second, but not third, graders showed a significant decrease in baseline cortisol from before to after the intervention. Second and third graders both showed significant decreases in cortisol from before to after a cognitive task, but neither grade showed additional decreases from before to after

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AUTHOR CONTRIBUTION/ROLES

BB conducted the primary data analyses and wrote the majority of the final manuscript. AP, CR, SC, BD, and KW worked together on a preliminary version of this study as the thesis requirement for their Doctor of Physical Therapy degree at the University of Massachusetts Lowell. These authors also wrote and reviewed sections of the final manuscript. DD supervised AP, CR, SC, BD, and KW during their thesis work, and also wrote and reviewed sections of the final manuscript. DD, LF, ME, and SBSK worked together to conceptualize the study design, including methodology and outcome measures, and wrote/reviewed sections of the final manuscript.

ETHICAL APPROVAL

All study procedures and materials were approved by the University of Massachusetts Lowell Institutional Review Board (IRB). Letters approved by the University of Massachusetts Lowell IRB were sent to each student's parents explaining the Y4C program as well as the research study. Parents who did not wish their child to participate had the option to decline and their child was not entered into the study. Participants did not receive any type of compensation for participation, nor were any students/teachers given a penalty for opting not to participate.

DECLARATION OF CONFLICTING INTERESTS

LF is the founder of ChildLight Yoga and Yoga 4 Classrooms (Y4C). LF conceptualized the idea for the present study and developed the yoga intervention that was used in this research. However, LF was not involved in administering the intervention or in data collection/analysis. Her role was limited to providing logistical support during implementation of the intervention, as well as writing the intervention description for the current paper. ME received research consulting funds from Y4C while this study was being conducted, however she was not involved in the intervention administration or data analysis.

FINANCIAL DISCLOSURE/FUNDING

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a single yoga class. The second-grade teacher perceived significant improvements in several aspects his/her students' behavior. The third-grade teacher perceived some, but fewer, improvements in his/her students' behavior. Results suggest that school-based yoga may be advantageous for stress management and behavior.

Keywords

Yoga; school; cortisol; stress; behavior

INTRODUCTION

Yoga for Stress Management

Yoga is a holistic system of mind-body practices for mental and physical health involving multiple components such as physical postures and exercises to promote strength and flexibility, breathing exercises to enhance respiratory functioning, deep relaxation techniques to cultivate the ability to mentally and physiologically release tension and stress, and meditation/mindfulness practices to enhance mind-body awareness and improve attention and emotion regulation skills. Systematic research reviews suggest that yoga is effective at reducing stress and enhancing mood and well-being in adults.¹⁻⁵ Salivary cortisol, a potential biological marker of stress, tends to increase as part of the physiological stress response.⁶⁻⁸ While this stress response is generally considered adaptive, chronically heightened cortisol concentrations as a result of repeated stressors may have detrimental long-term effects on mental and physical health⁹, suggesting that interventions that reduce cortisol levels may be beneficial.

Evidence exists suggesting that participation in yoga may reduce cortisol concentrations in adults.¹⁰⁻¹³ However the literature in this area is inconsistent, with some studies failing to show associations between yoga and cortisol concentrations.^{14,15} In addition, one study of women with fibromyalgia showed that participation in yoga increased cortisol concentrations.¹⁶ Very little research exists on the effects of yoga on cortisol concentrations in children; however one study showed that hospitalized children who participated in a relaxation therapy class that included yoga showed decreases in cortisol.¹⁷

Yoga, which often includes practices that are specifically focused on calming the nervous system, may be ideally suited to prevent or alleviate the psychological and physiological stressors encountered by youth. A NIH/CDC Complementary and Alternative Medicine (CAM) therapy survey revealed that 2.1% of children under 18 practice yoga and that 4.8% of child/adolescent CAM users were specifically targeting anxiety and stress.¹⁸ Two systematic reviews and one clinical review paper on the therapeutic effects of yoga for youth indicated improvements in physical and mental health.¹⁹⁻²¹ In addition, research on children and adults suggest that yoga-based breathing exercises are beneficial for reducing physiological and psychological stress.²²⁻²⁶

Yoga in Schools

In a comprehensive review proposing the implementation of contemplative practices such as yoga and meditation in education, Davidson and colleagues²⁷ suggest that the benefits of yoga that have been observed in adults are also relevant for children and adolescents in school-based settings. Research on yoga interventions in schools is in its early stages, however initial results are promising. For example, Serwacki and Cook-Cottone²⁸ recently reviewed 12 preliminary studies of yoga in schools and concluded that the yoga interventions exerted positive effects on factors such as emotional balance, attentional control, cognitive efficiency, anxiety, negative thought patterns, emotional and physical arousal, reactivity, and negative behavior. Additional research also suggests positive effects of school-based yoga programs on several aspects of mental health such as concentration, attention, anxiety, stress, mood, resilience, emotional arousal, self-esteem, and coping frequency.^{23,28–36} It is important to note, however, that existing research on school-based yoga programs is highly preliminary, with most studies suffering from low methodological quality. In addition, prior research on yoga in schools has relied almost exclusively on student self-report, suggesting a need for more objective measures of the effects of these interventions.

Purpose of the Present Study

Preliminary research suggests that providing yoga within the school curriculum may be an effective and feasible way to help youth develop stress management skills. However, limited data exists on school-based yoga interventions, particularly with regard to objective measures of stress such as cortisol concentrations. The high prevalence of stress-related psychiatric disorders among youth³⁷ suggests that school-based yoga interventions may be advantageous in this regard.³⁸ The goal of this uncontrolled pilot study is to examine whether a 10-week school-based yoga program has beneficial effects on physiological markers related to stress and behavior in second and third grade students at an elementary school in Maine, USA. This is the first research study to use both subjective and objective data to examine the acute and longitudinal effects of a school-based yoga intervention in young children.

METHODS

Participants

Two classrooms (one second- and one third-grade) at an elementary school in Maine received the Yoga 4 Classrooms (Y4C) yoga intervention (described below). Letters approved by the university Institutional Review Board (IRB) were sent to each student's parents explaining the Y4C program as well as the research study. Parents who did not wish their child to participate had the option to decline and their child was not entered into the study. In total, 18 second-graders (11 male, 7 female) and 18 third-graders (9 male, 9 female) participated in the study. Participants did not receive any type of compensation for participation, nor were any students/teachers given a penalty for opting not to participate.

Procedure

The Y4C program includes an initial 6-hour professional development workshop provided to any interested teachers at the school to learn about the benefits of yoga and how to implement yoga practices in the classroom. This workshop was made available to all teachers at the school in the summer before the school year began. However, only the two participating classrooms received the 10-week yoga intervention, which began in January. These classroom teachers were instructed not to teach any Y4C techniques from September to December. The intervention involved a 30-minute weekly class, taught during regular class time, led by a licensed Y4C yoga instructor (10 yoga sessions total). The lead yoga instructor had completed a 200-hour yoga teacher training, the ChildLight Yoga (children's yoga) Instructor Certification Program, the Y4C Trainer program, and over 95 additional hours of training specifically focused on teaching yoga to children. The classroom teachers were present at each yoga session, and had both attended the 6-hour Y4C professional development workshop described above.

The Y4C program is completely secular and includes 4 key elements of classical yoga: breathing exercises, physical exercises and postures, meditation techniques, and relaxation. The program also incorporated a themed discussion at the start of each session with the intention of engaging the students in learning while promoting self-inquiry and a reflective environment. Finally, a focus on the Y4C approach to self-regulation, including the steps of noticing, mindful choice, regulation, reflection, and integration, was woven throughout the yoga program.

The 30-minute yoga sessions were structured as follows: a 2-minute centering, 5-minute themed discussion, 3-minute breathing exercise, 15 minutes of yoga postures/exercises (modified for a classroom setting), and a 5-minute relaxation and closing. Centering involved a short community-building chant/song and a timed focusing activity which was increased in length each week based on students' progress. Themed discussions focused on yoga-related topics such as: introduction to yoga and mindfulness, breathing for self-regulation, peace/non-violence, and self-care. Breathing exercises were primarily focused on calming and integrating breathing techniques, though energizing breathing techniques were also introduced. Students kept their shoes on and remained sitting at, or standing next to, their desks while practicing yoga posture variations appropriate for use in a typical classroom setting. All yoga activities were accessible and adaptable for all physical abilities, and emphasis was placed on listening to one's body and modifying as needed. Relaxation involved students progressively relaxing into 'Desk Rest Pose' (heads down on the desk) while listening to a themed visualization, followed by a closing song/chant and a few final deep breaths.

Data collected included results from the Attention Network Test (ANT-C) described below (the results of which are not the focus of the present study), saliva samples later analyzed for cortisol concentrations, and surveys completed by teachers assessing observed changes in student behaviors. Study staff collected data at the school on the first and last day of the 10-week intervention, for a total of two experimental days per classroom. The ANT-C was administered immediately before a single yoga class on each experimental day. Saliva samples were collected at three time points on each experimental day: immediately prior to

the ANT-C test (Cortisol 1), immediately after the ANT-C (Cortisol 2), and immediately after a single yoga class (Cortisol 3). Subjective surveys were given to teachers at the beginning and end of the 10-week intervention and were returned to study staff within approximately 1 week.

Outcome Measures

Attention Network Test (ANT-C)—The ANT-C is an attention test that involves responding to a target that is surrounded by flankers that point in either the same or opposite direction. All stimuli were displayed on a computer screen. Each trial began with a central fixation cross. The target array was a yellow colored line drawing of either a single yellow fish or a horizontal row of five yellow fish, presented above or below fixation, over a blue–green background. The participant was to respond based on whether the central fish was pointing to the left or right by pressing the corresponding single finger press (left click) or double finger press (right click) on the mouse. On congruent trials the flanking fish were pointing in the same direction, on incongruent trials the flankers point in the opposite direction from the central fish, and on neutral trials the central fish appeared alone.³⁹ Participants completed one round of 24 practice trials followed by three experimental blocks of 48 trials each, with the entire session taking between 18–25 minutes. Total reaction time and response accuracy were used as indicators of students' attention and ability to inhibit inappropriate responses. The results of the ANT-C are not the focus of the present paper, however this measure is described due to changes in cortisol concentrations that occurred from before to after the ANT-C (described below).

Salivary Cortisol—Collection of saliva involved asking the students to "drool" into a plastic conical tube until approximately 1 mL of saliva had been collected, excluding air bubbles. The vial was then capped and frozen to later be analyzed for free cortisol, with each subject's full set of samples run in the same batch. Salivary cortisol concentrations were measured using enzyme-linked immunosorbent assay (ELISA, Salimetrics, Inc., State College, PA). Absorbance was converted to cortisol concentration based on the standard curve using line of best fit (www.Myassays.com). Saliva samples were collected immediately prior to the ANT-C test (Cortisol 1), immediately after the ANT-C (Cortisol 2), and immediately after a single yoga class (Cortisol 3). Statistical comparisons on both the second and third grade classes were performed to determine if significant changes occurred between the following time points:

- Cortisol 1 (Week 1) vs. Cortisol 1 (Week 10) (longitudinal, baseline comparison)
- Cortisol 1 vs. Cortisol 2 (Weeks 1 and 10; pre vs. post-ANT-C)
- Cortisol 2 vs. Cortisol 3 (Weeks 1 and 10; post-ANT-C vs. post-yoga)

Perceived Behavior Change—The second and third grade teachers were asked to complete a behavioral observation survey (created by the present researchers) during Week 1 of the yoga intervention and at Week 10 following the intervention to record the perceived behavioral changes of each student over the 10-week period. The teachers rated each student on the following criteria using a 5-point scale (1 = Poor; 5 = Good): social interaction with classmates, respect for others, ability to be in control of their behavior, ability to manage

their anger, attention span, ability to concentrate on work, ability to stay on task, creativity, academic performance, ability to deal with stress and anxiety, confidence/self-esteem, and overall mood.

Data Analysis

Independent-samples *t*-tests were used to examine whether any differences existed between second and third graders at baseline. Data were then analyzed using a series of 2 x 2 split-plot ANOVAs, in which grade served as the between-subjects factor, and time served as the within-subjects factor, to examine whether cortisol concentrations and perceived behaviors changed significantly for second and third graders over time. The alpha level used to determine statistical significance was $p < .05$ for all analyses. Data are reported as mean \pm standard deviation.

RESULTS

Baseline Differences Between Grades

No statistically significant baseline differences were detected between the two grades for salivary cortisol, however second and third graders did show statistically significant baseline differences on 8 of the 12 items of the behavioral observation survey. In particular, at baseline, third graders were rated significantly higher than second graders on their social interaction with classmates, attention span, ability to concentrate on work, ability to stay on task, academic performance, ability to deal with stress/anxiety, confidence/self-esteem, and overall mood. Thus, data were analyzed separately for each grade by including grade as a between-subjects factor in the 2 x 2 ANOVAs described above.

Salivary Cortisol

Means and standard deviations for the salivary cortisol data are displayed in Table 1. The longitudinal, baseline comparison of Cortisol 1 at Week 1 vs. Cortisol 1 at Week 10 revealed a significant interaction between grade and time in which second, but not third, graders showed a significant decrease in baseline cortisol concentrations from before ($M = 0.18 \pm 0.09$ ug/dL) to after ($M = 0.12 \pm 0.06$ ug/dL) the 10-week intervention, $F(1,30) = 9.77$, $p < 0.01$ (see Figure 1).

In addition, a significant main effect of Time emerged for the Week 1 testing session in which, regardless of grade, participants showed a significant decrease in cortisol concentrations from before ($M = 0.14 \pm 0.06$ ug/dL) to after ($M = 0.09 \pm 0.04$ ug/dL) the ANT-C cognitive task, $F(1,27) = 48.25$, $p < 0.001$. However, neither grade showed additional decreases in cortisol concentrations from before to after a single yoga class during the Week 1 testing session, $F(1,27) = 1.06$, *ns*. A similar pattern of results emerged for the Week 10 testing session, in which, regardless of grade, participants showed a significant decrease in cortisol concentrations from before ($M = 0.13 \pm 0.06$ ug/dL) to after ($M = 0.11 \pm 0.07$ ug/dL) the ANT-C cognitive task, $F(1,34) = 16.12$, $p < 0.001$, however neither grade showed additional decreases in cortisol concentrations from before to after a single yoga class, $F(1,35) = 1.83$, *ns*.

Perceived Behavior Change

Means and standard deviations for the behavioral observation survey are displayed in Table 2. Analyses of the teacher ratings revealed a pattern of significant interactions between grade and time in which the second grade teacher perceived significant improvements on several cognitive, social and emotional skills from before to after the 10-week intervention, whereas the third grade teacher perceived little or no change. In particular, the second grade teacher perceived significant improvements in his/her students' social interaction with classmates (pre $M = 3.17 \pm 0.79$; post $M = 4.39 \pm 0.61$), attention span (pre $M = 2.94 \pm 1.00$; post $M = 4.08 \pm 0.69$), ability to concentrate on work (pre $M = 2.89 \pm 0.83$; post $M = 4.11 \pm 0.68$), ability to stay on task (pre $M = 2.67 \pm 0.91$; post $M = 4.06 \pm 0.73$), academic performance (pre $M = 3.11 \pm 0.92$; post $M = 4.11 \pm 0.68$), ability to deal with stress/anxiety (pre $M = 2.72 \pm 0.83$; post $M = 4.17 \pm 0.71$), confidence/self-esteem (pre $M = 2.67 \pm 1.19$; post $M = 4.31 \pm 0.71$), and overall mood (pre $M = 2.81 \pm 0.93$; post $M = 4.19 \pm 0.75$), however the third grade teacher perceived little or no change in his/her students on these variables (see Figure 2).

A significant main effect of time did, however, emerge for three of the items on the behavioral observation survey, suggesting that both the second and third grade teacher perceived significant improvements in their students' creativity (pre $M = 3.43 \pm 0.99$; post $M = 4.31 \pm 0.90$), ability to be in control of their behavior (pre $M = 3.71 \pm 1.20$; post $M = 4.15 \pm 1.02$), and ability to manage anger (pre $M = 3.54 \pm 1.18$; post $M = 4.40 \pm 0.98$) after the 10-week intervention. The remaining item on the behavioral observation survey (respect for others) was not significantly different between grades or over time.

DISCUSSION

Salivary Cortisol

The results revealed that second graders showed a longitudinal effect in which baseline cortisol concentrations significantly decreased from before to after the entire 10-week intervention, a finding that is consistent with prior studies of the longitudinal effects of yoga on cortisol in adults.¹⁰⁻¹² This result should be interpreted cautiously, however, due to the lack of a control group. For example, other variables could have contributed to changes in cortisol concentrations in the second graders over the 10-week period such as the children becoming more comfortable with the yoga instructor or with the classroom environment in general.

Interestingly, second- and third-graders both showed significant decreases in cortisol concentrations from before to after the ANT-C cognitive task at Weeks 1 and 10. The mechanisms underlying this effect are unclear, however it is possible that the presence of the researchers and the disruption of the typical school schedule could have caused the students to experience performance anxiety prior to the ANT-C, which may have resulted in increased cortisol concentrations that were relieved after the task was complete. Alternatively, prior research suggests that participating in cognitive tasks that are designed to train attention may improve executive functioning by training individuals to pay close attention to incongruent stimuli. It is thought that the improvements in attention that occur as

a result of this cognitive training may be similar to the attentional improvements that have been found following activities such as meditation.⁴⁰ Thus, it could be the case that having something finite to focus on during the ANT-C, similar to what occurs during meditation, could have had a calming effect on the children.

Cortisol secretion follows a diurnal pattern that peaks 20–30 minutes after awakening, decreases to approximately half by mid-afternoon, and is lowest by midnight.^{41,42} In their research on normative cortisol concentrations in children aged 4–10, McCarthy and colleagues⁴¹ found that cortisol concentrations decreased from 0.24 mcg/dl at 9am to 0.16 mcg/dl at 12pm and 0.12 mcg/dl at 3pm. This represents a decrease of 0.08 mcg/dl over 3 hours from 9am–12pm and a decrease of 0.04 mcg/dl over 3 hours from 12pm–3pm. Given that the average decrease in cortisol concentrations from before to after the ANT-C in the present study was 0.05 mcg/dl over a period of only 25 minutes, it is unlikely that diurnal reductions can account for these changes, although time of day may have had a minor contribution.

The present findings also suggest that there was no acute effect of a single yoga class on cortisol concentrations in second or third graders. Prior research on short-term changes in cortisol after yoga participation has been inconsistent, with some studies showing acute decreases in cortisol¹³ whereas other studies have not found acute effects.¹⁵ Prior research also suggests that participating in physical activity can actually increase cortisol concentrations over the short-term.^{13,43,44} Consistent with the present findings for second graders, some studies have found longitudinal decreases in cortisol concentrations when cortisol is measured before and after participation in longer-term yoga interventions (typically lasting several weeks).^{10–12} Thus, it could be the case that a relatively short (30 minute) yoga class may not have been a long enough time period to initiate and/or detect a decrease in cortisol concentrations. Additional research is needed that compares the acute vs. long-term effects of yoga practice on cortisol concentrations, particularly in children.

Perceived Behavior Change

The second grade teacher generally perceived more behavioral changes in his/her students than the third grade teacher. In particular, significant improvements were perceived in second graders', but not in third graders', social interaction with classmates, attention span, ability to concentrate on work, ability to stay on task, academic performance, ability to deal with stress/anxiety, confidence/self-esteem, and overall mood. However, students in both grades demonstrated perceived improvements in creativity, ability to be in control of behavior, and ability to manage anger. These improvements in social and emotional learning (SEL) skills underlie the core SEL competencies of self-management, social awareness and responsible decision-making⁴⁵, suggesting that yoga may have beneficial effects on the skills that are targeted by SEL goals.

In general, these results support prior research suggesting that yoga may increase mental health and well-being, positive behaviors, and SEL skills in children and adolescents.^{19–21,33,34,46,47} However it is unclear why second graders exhibited greater perceived positive behavior changes than third graders. Due to the lack of a control group, these results should be interpreted with caution, as the findings could be attributed to several

factors such as differences in teacher rating styles as well as other circumstances that may have changed over the course of the school year, including maturational improvements (children developing and changing rapidly over the course of the year) or class dynamics.

Comparison of Objective and Subjective Data

One of the strengths of the present study is that it involved the simultaneous collection of subjective data (teacher ratings of student behavior) and objective data (salivary cortisol). The results from these two forms of data were quite consistent with one another. In particular, second graders generally exhibited a greater number of improvements than third graders on both the subjective teacher ratings and their objective cortisol concentrations. The subjective findings for perceived behavior change, namely that second graders showed greater improvements on several social and emotional skills than third graders, was, in a sense, confirmed by the objective findings for salivary cortisol, in which second graders, but not third graders, showed significant decreases in baseline cortisol concentrations from before to after the 10-week intervention. In other words, it is possible that the behavioral changes that the second grade teacher observed in his/her students may have been valid and may not have simply been due to maturational differences between the grades or differences between the teacher rating styles, however this suggestion is highly preliminary and would need to be investigated in future research.

Limitations

The main limitation of this study is the lack of a control group. Without the use of a control group it is difficult to determine if the results were caused solely by the yoga intervention or by other factors. For example, the results could be attributed to the fact that the children were maturing naturally over time, that they had a new teacher (the yoga instructor) coming into their class, or differences in the behavioral rating styles between the two teachers. Thus, it cannot be determined with certainty that it was the yoga intervention alone that caused the results.

Another limitation of this study was the timing of the cortisol samples. Due to the age of the students involved in the study, the collection of cortisol samples was dependent on the school schedule. According to the recommended best practices for collecting saliva samples to determine cortisol concentrations, saliva samples shouldn't be taken within 60 minutes of eating.^{48,49} Alterations to the school schedule, such as the time of lunch, could not be made by the researchers. Attempts were made to address this issue by, for example, giving students a 20-minute reading exercise after lunch, however some saliva samples were collected within 60 minutes of lunch. School scheduling constraints also required the sample collection procedure to differ between the second and third graders. In particular, for third graders, all of the experimental procedures (including saliva samples) occurred *before* lunch, whereas for second graders all of experimental procedures occurred *after* lunch. These various scheduling differences could have affected the observed differences between the two grade levels' cortisol concentrations. In addition, there are other factors that can influence cortisol responses that were not controlled for in this study. For example, age/developmental stage, sex, weight, temperament, coping style, social competency, and pain sensitivity can also have an effect on cortisol concentrations.⁴¹

Finally, the subjective behavior ratings were performed by two teachers, whose individual biases for or against their students could have affected the results. For example, third-graders were rated significantly higher on several items of the behavioral observation survey at baseline than second-graders, such as attention span, ability to stay on task, and ability to concentrate on work. This finding may be due to actual age-related developmental and maturational differences between the students in each grade; however these results could also be due to differences in the behavioral rating styles between the two teachers.

Future Research

The limitations of the present study are not surprising given the pilot nature of this research; thus it will be important for future studies to confirm the findings by employing more rigorous designs that include larger sample sizes and random assignment to intervention and control groups. In addition, future research will benefit from the inclusion of developmentally appropriate tests of emotional skills, such as emotion understanding and awareness.⁵⁰ To supplement observational data, interviews or self-report questionnaires could also be used to assess students' social and emotional skills. It will also be important for future studies to further examine acute vs. long-term changes in cortisol concentrations as a result of yoga class participation, and to take into consideration the complexities involved in cortisol measurement, such as time of day and baseline levels of stress. Finally, future research should continue to collect data using both subjective and objective methods in order to enrich our knowledge above and beyond the information that can be gathered from self-report surveys alone.

Conclusions

Overall no statistically significant findings emerged regarding the acute effects of a single yoga class on elementary-aged children's cortisol concentrations, however there was an acute reduction in cortisol concentrations after taking a computer based attention network test (ANT-C). In contrast, a statistically significant longitudinal reduction in baseline salivary cortisol from before to after the 10-week yoga intervention did emerge in the second-grade students. More research is warranted to further investigate these results. The subjective information gained from the behavioral observation scale revealed significant perceived improvements, particularly for the second-grade students.

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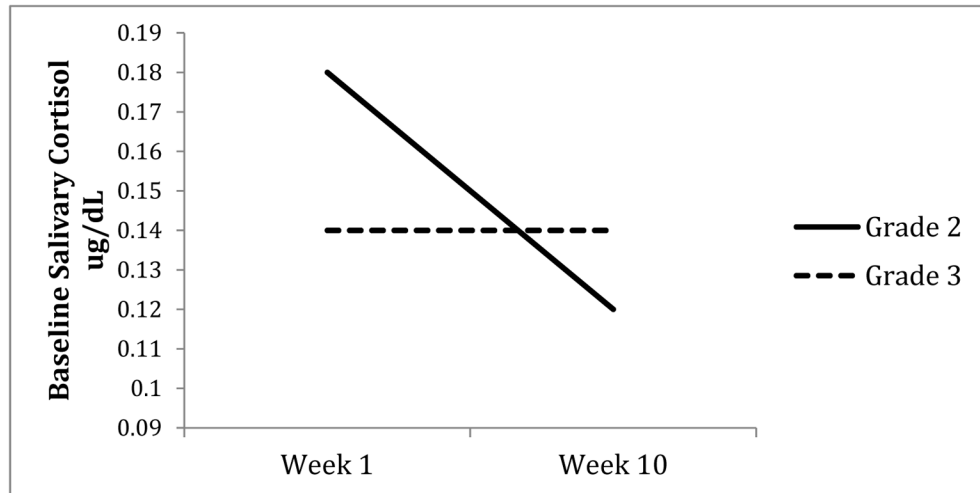


Figure 1. Interaction between grade and time for baseline cortisol at Week 1 and Week 10 of the yoga intervention ($p < 0.01$)

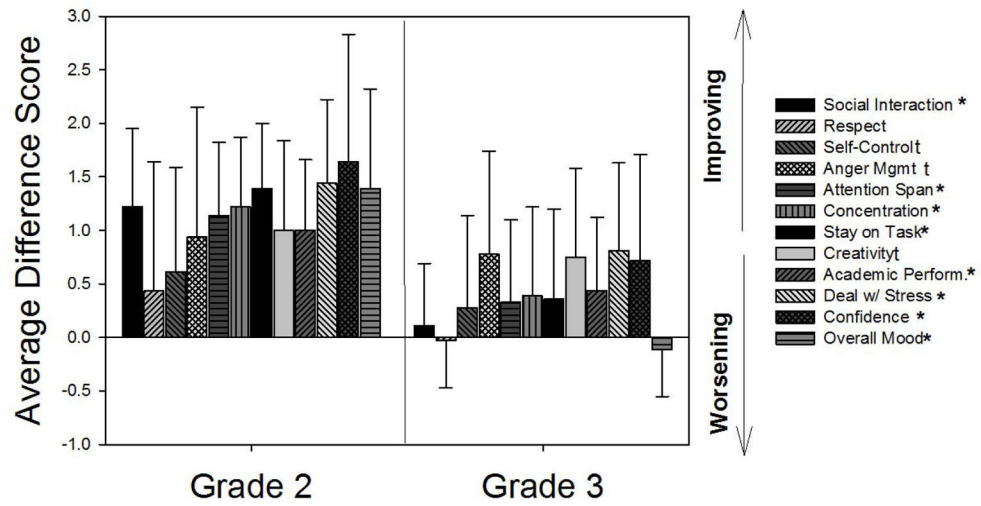


Figure 2. Differences in teacher-rated behaviors between 2nd and 3rd grade students. Crosses (*t*) indicate a statistically significant ($p < 0.05$) main effect of Time (Week 1 vs. Week 10). Asterisks (*) indicate a statistically significant interaction between Grade (2 vs. 3) and Time (Week 1 vs. Week 10).

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Table 1

Mean Salivary Cortisol Concentrations (ug/dL) Before and After the Yoga Program

Testing Session	Grade 2			Grade 3		
	<u>Cortisol 1</u>	<u>Cortisol 2</u>	<u>Cortisol 3</u>	<u>Cortisol 1</u>	<u>Cortisol 2</u>	<u>Cortisol 3</u>
Week 1	0.18±0.09	0.09±0.04	0.11±0.08	0.14±0.05	0.09±0.04	0.10±0.05
Week 10	0.12±0.06	0.10±0.07	0.09±0.07	0.14±0.07	0.12±0.06	0.10±0.06

Note: Data are reported as Mean ± Standard Deviation. "Cortisol 1" samples were gathered before any experimental procedures were performed, "Cortisol 2" samples occurred after the ANT-C cognitive task was administered, and "Cortisol 3" samples were taken after participation in a single yoga class.

Table 2
 Mean Scores on the Teacher-Rated Behavioral Observation Scale Before and After the Yoga Program

Construct	Grade 2		Grade 3		F-Statistic		
	Week 1	Week 10	Week 1	Week 10	Grade	Time	Interaction
Social Interaction	3.17±0.79	4.39±0.61	4.17±1.30	4.28±1.27	1.85	36.54***	25.37***
Respect	3.89±1.08	4.33±0.69	4.53±1.04	4.50±1.10	1.89	1.92	2.47
Self-Control	3.56±1.15	4.17±0.79	3.86±1.27	4.14±1.23	0.16	8.37**	1.18
Anger Management	3.56±1.04	4.50±0.62	3.53±1.33	4.31±1.26	0.12	22.38***	0.21
Attention Span	2.94±1.00	4.08±0.69	3.81±1.10	4.14±1.23	2.05	37.05***	11.09*
Concentration	2.89±0.83	4.11±0.68	3.81±1.06	4.19±1.18	2.90	42.05***	11.25*
Ability to Stay on Task	2.67±0.91	4.06±0.73	3.86±1.12	4.22±1.23	4.66*	51.55***	17.78***
Creativity	3.17±0.79	4.17±0.62	3.69±1.13	4.44±1.11	2.08	39.67***	0.81
Academic Performance	3.11±0.92	4.11±0.68	3.89±1.12	4.33±1.15	2.63	41.34***	6.12*
Ability to Deal w/ Stress/Anxiety	2.72±0.83	4.17±0.71	3.47±1.09	4.28±1.18	2.14	70.37***	5.67*
Confidence/Self-Esteem	2.67±1.19	4.31±0.71	3.67±1.18	4.39±1.05	3.29	42.11***	6.35*
Overall Mood	2.81±0.93	4.19±0.75	4.53±0.85	4.42±1.06	12.45**	27.67***	38.13***

Note: Data are reported as Mean ± Standard Deviation.

* = $p < 0.05$;

** = $p < 0.01$;

*** = $p < 0.001$



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

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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

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Authors' Contributions BB coordinated the study, conducted statistical analyses, and drafted the manuscript. AL assisted with the execution of the study and drafted portions of the manuscript. SHS and SBSK conceived of the study, supervised the coordination of the study, and drafted portions of the manuscript. All authors read and approved the final manuscript.

Conflict of interest The authors report no conflicts of interest.

Ethical Approval This study was reviewed and approved by the Brigham and Women's Hospital Institutional Review Board (Partners Human Research Committee). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Written parental consent and written child assent were obtained from all individual participants included in the standards.

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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 (Himmelstein 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 subscales). 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 $M = 6.73$, $SD = 1.25$; time 3 $M = 7.02$, $SD = 1.45$; 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 (time 1 $M = 9.58$, $SD = 4.00$; time 2 $M = 9.19$, $SD = 4.36$; time 3 $M = 8.51$, $SD = 3.64$; 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.

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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 "eeee" on the inhalation and "haaaaa" 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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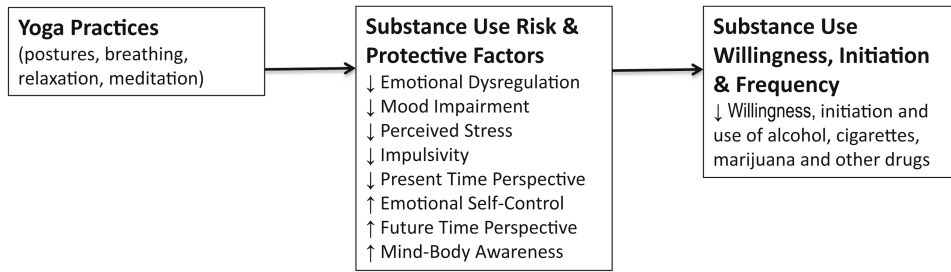


Fig. 1. Hypothesized associations between yoga practice, substance use risk and protective factors, and substance use willingness, initiation, and frequency

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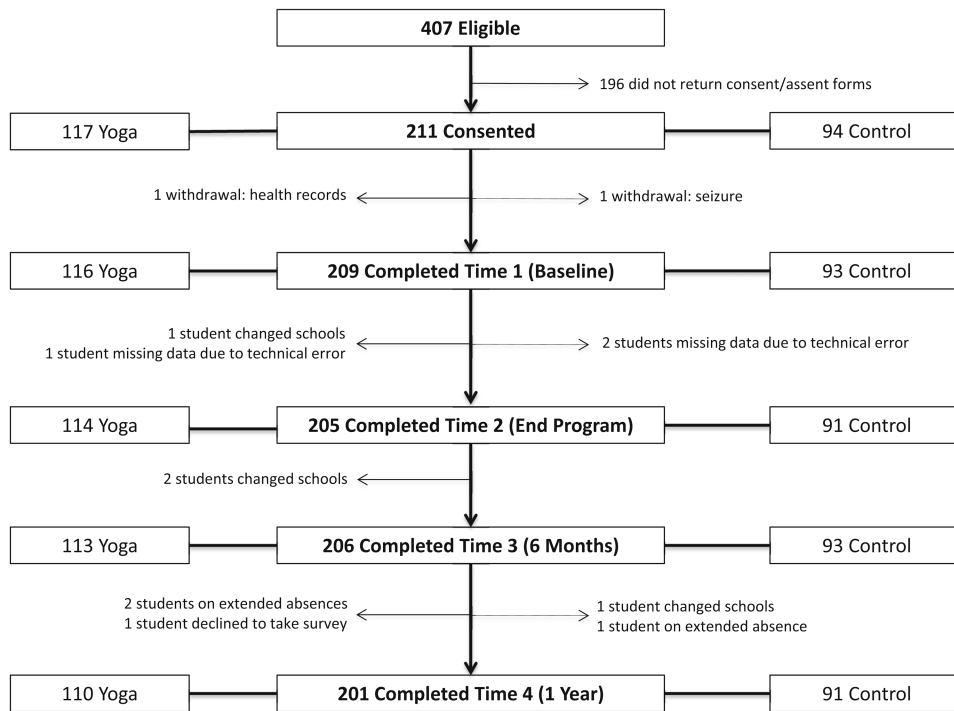


Fig. 2. Participant timeline throughout 4 waves of data collection

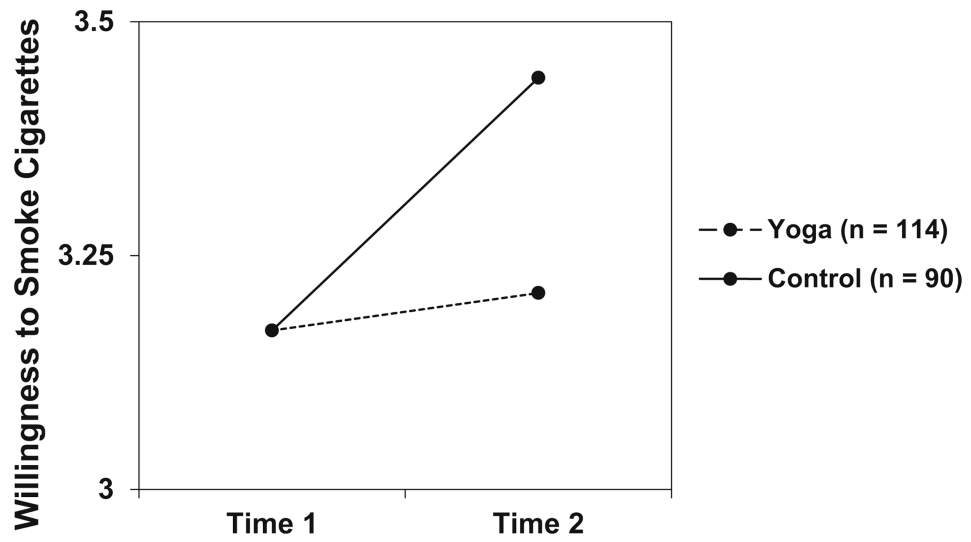


Fig. 3. Yoga and control group participants' willingness to smoke cigarettes at baseline (time 1) and end-program (time 2). ANCOVA on end-program scores (with baseline scores as a covariate) significant at $p < 0.05$

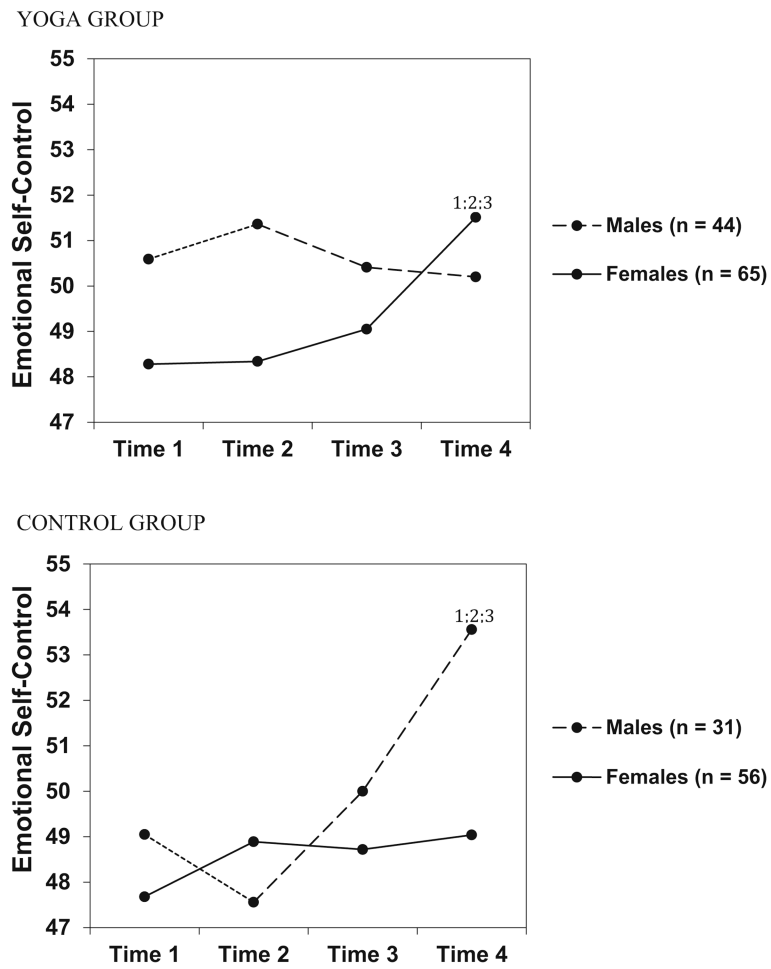


Fig. 4. The interaction between condition, time, and gender predicting changes in emotional self-control. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

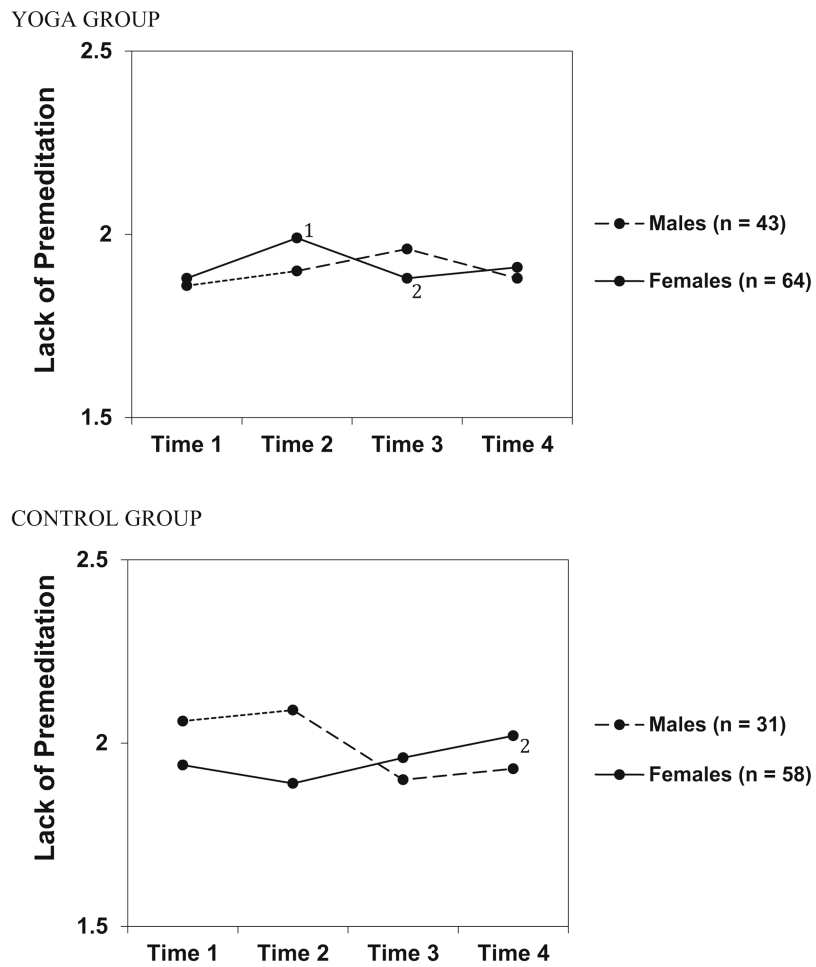


Fig. 5. The interaction between condition, time, and gender predicting changes in lack of premeditation. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

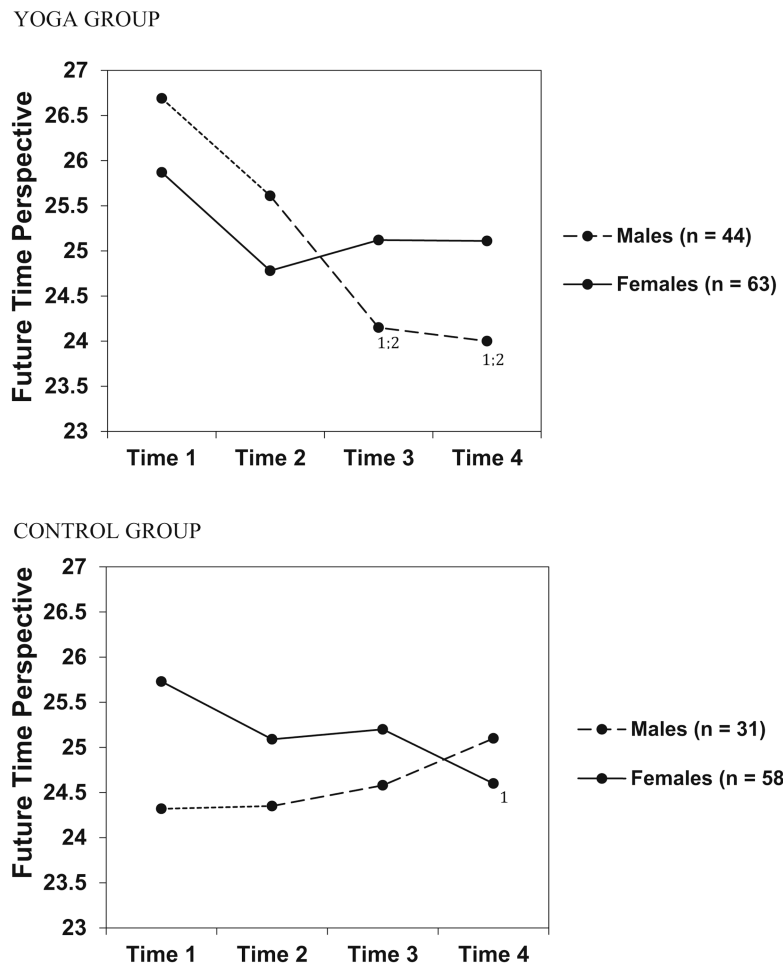


Fig. 6. The interaction between condition, time, and gender predicting changes in future time perspective. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

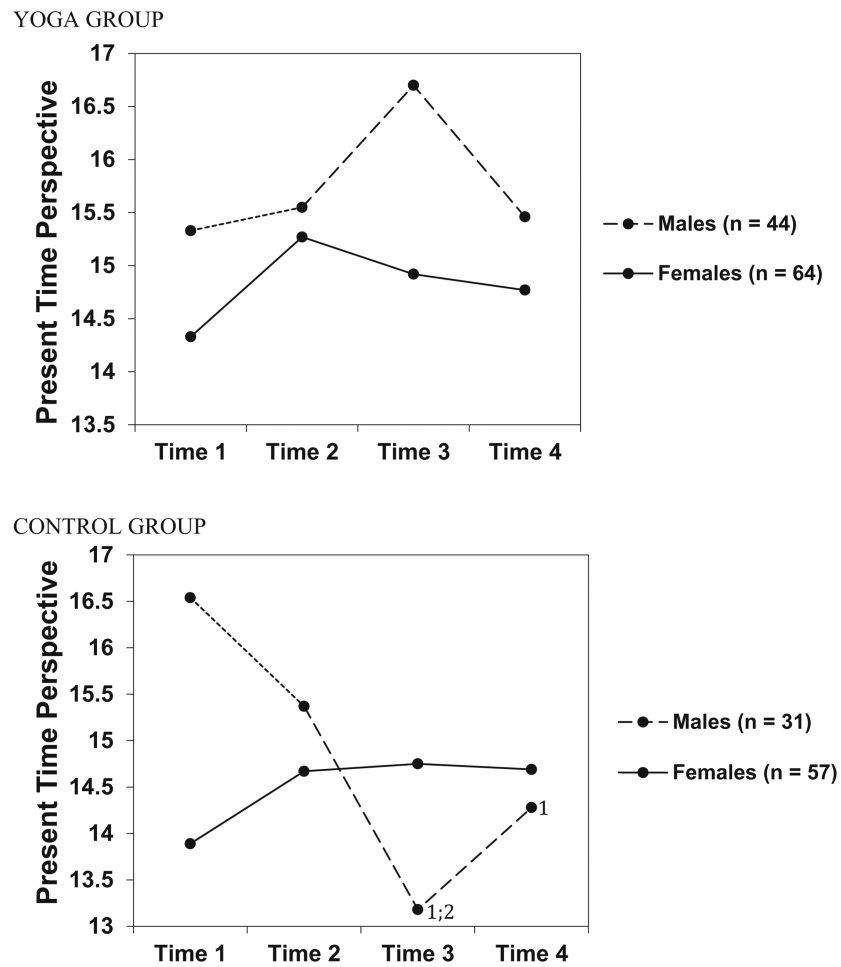


Fig. 7. The interaction between condition, time, and gender predicting changes in present time perspective. *Superscript numbers* indicate when a specific time point differs significantly from other time point(s) (1; 2; 3; 4)

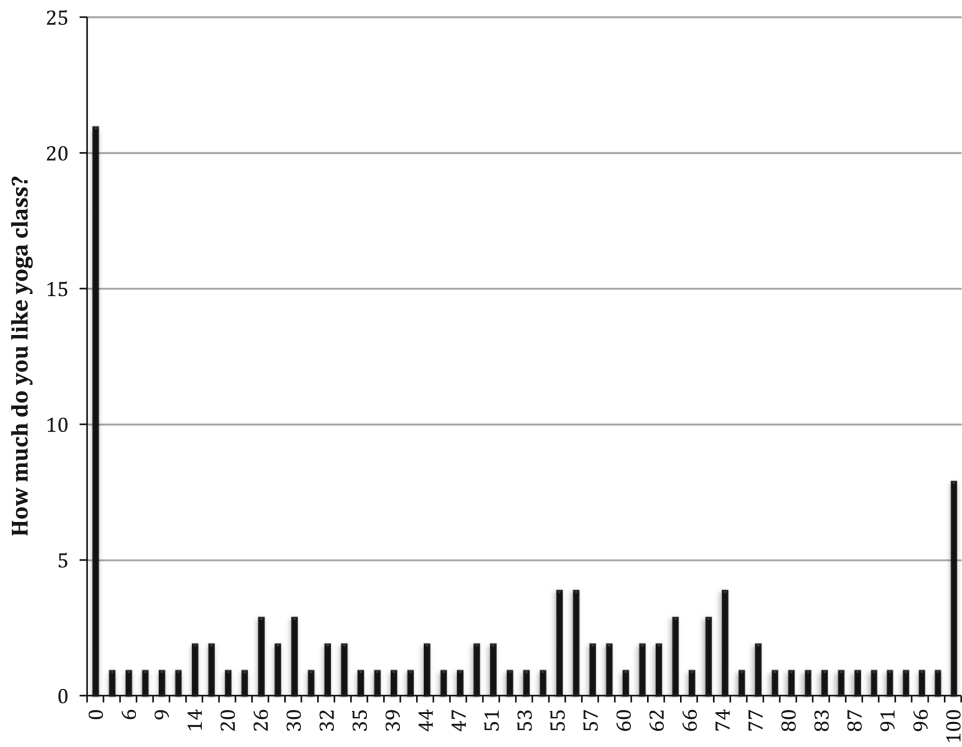


Fig. 8. Frequency distribution of yoga participant responses to the question “How much do you like yoga class?” The question was rated on a 100-point visual analog scale ranging from 0 (“not at all”) to 100 (“very much so”) ($n = 110$)

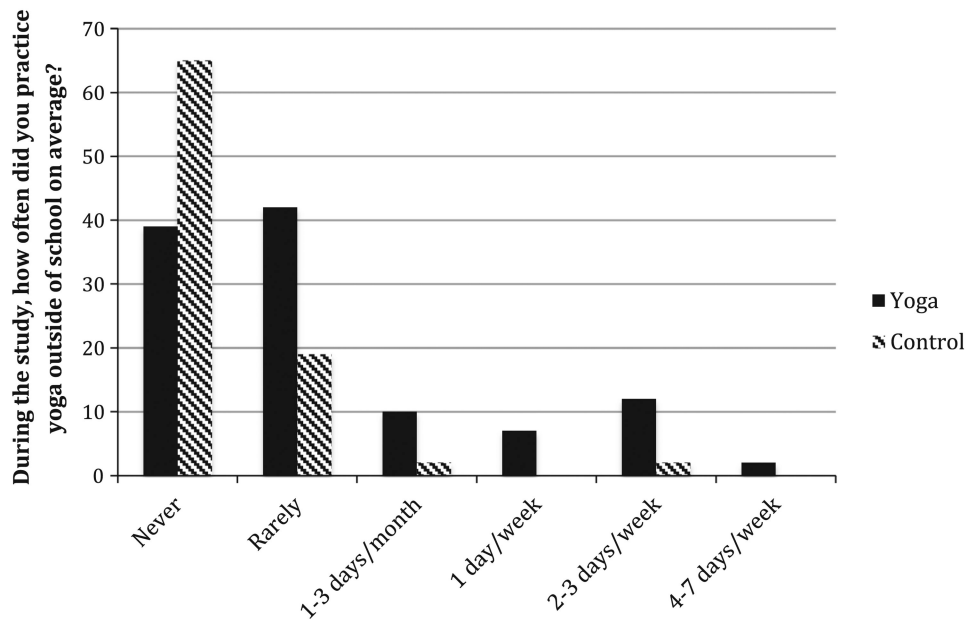


Fig. 9. Number of participants in the yoga ($n = 112$) and control ($n = 88$) groups who reported practicing yoga outside of school during the study

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Table 1
Sample demographics

	Entire school (<i>n</i> = 2205) (%)	Yoga group (<i>n</i> = 116) (%)	Control group (<i>n</i> = 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
	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
ALS; WCI; CSMS-SR; CAMS-AR	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
SUW	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
	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
BRUMS	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
UPPS-P	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
ZPTI	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
	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
UUPS-P	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
ZPTI	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
ZPTI	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 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 Liability Scale, *WCI* Willingness 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, *ZPTI* 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		
		<i>F</i> statistic	<i>p</i>	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
UPPS-P	Vigor	0.68	0.41	0.00
	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
ZTPI	Positive urgency	1.95	0.16	0.01
	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-Wilcoxon 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 Liability 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 (<i>p</i>)			
	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 doctor's 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 (<i>p</i>)					
	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 doctor's 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; WCI; CSMS-SR; CAMS-AR	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
PSS	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
BRUMS	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
	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
UPPS-P	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
ZTPI	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
UPPS-P	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
	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
ZTPI	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
ZTPI	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**

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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

KWS Kendall-Wilcoxon Self-Control Schedule, *CAMS-AC* Children's Anger Management Scale (Anger Control Subscale), *CAMS-AR* Children's Anger Management Scale (Anger Rumination Subscale), *CMS-SC* Children's Sadness Management Scale (Sadness Control Subscale), *CMS-SR* Children's Sadness Rumination Scale (Sadness Rumination Subscale), *ALSA* Affective Lability Scale, *WC7* Will's 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

* $p < 0.05$

** $p < 0.01$