

Benefits of Yoga for Psychosocial Well-Being in a US High School Curriculum: A Preliminary Randomized Controlled Trial

Jessica J. Noggle, PhD,* Naomi J. Steiner, MD,† Takuya Minami, PhD,‡ Sat Bir S. Khalsa, PhD*

ABSTRACT: *Objective:* To test feasibility of yoga within a high school curriculum and evaluate preventive efficacy for psychosocial well-being. *Methods:* Grade 11 or 12 students (N = 51) who registered for physical education (PE) were cluster-randomized by class 2:1 yoga:PE-as-usual. A Kripalu-based yoga program of physical postures, breathing exercises, relaxation, and meditation was taught 2 to 3 times a week for 10 weeks. Self-report questionnaires were administered to students 1 week before and after. Primary outcome measures of psychosocial well-being were Profile of Mood States—Short Form and Positive and Negative Affect Schedule for Children. Additional measures of psychosocial well-being included Perceived Stress Scale and Inventory of Positive Psychological Attitudes. Secondary measures of self-regulatory skills included Resilience Scale, State Trait Anger Expression Inventory-2™, and Child Acceptance Mindfulness Measure. To assess feasibility, yoga students completed a program evaluation. Analyses of covariance were conducted between groups with baseline as the covariate. *Results:* Although PE-as-usual students showed decreases in primary outcomes, yoga students maintained or improved. Total mood disturbance improved in yoga students and worsened in controls ($p = .015$), as did Profile of Mood States-Short Form (POMS-SF) Tension-Anxiety subscale ($p = .002$). Although positive affect remained unchanged in both, negative affect significantly worsened in controls while improving in yoga students ($p = .006$). Secondary outcomes were not significant. Students rated yoga fairly high, despite moderate attendance. *Conclusions:* Implementation was feasible and students generally found it beneficial. Although not causal due to small, uneven sample size, this preliminary study suggests preventive benefits in psychosocial well-being from Kripalu yoga during high school PE. These results are consistent with previously published studies of yoga in school settings.

(*J Dev Behav Pediatr* 33:000–000, 2012) **Index terms:** yoga, psychosocial well-being, self-regulation, adolescence, school.

The age of onset of most mental health disorders in adults occurs in childhood and adolescence, with around 7.5% of adolescents meeting DSM-IV-TR criteria for 1 or more mental health condition.^{1,2} Furthermore, stress was identified as a strong indicator across the spectrum of mental health disorders. The transactional view of psychosocial stress centers upon an individual's cognitive appraisal of internal and external events as stressful, from which coping responses may follow.³

From the *Division of Sleep Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA; †Division of Developmental-Behavioral Pediatrics, Center for Children with Special Needs, The Floating Hospital for Children, Tufts Medical Center, Boston, MA; ‡Department of Counseling Psychology, School of Education, University of Wisconsin-Madison, Madison, WI.

Received August 2011; accepted January 2012.

This study was supported by funding from private donors to the Institute of Extraordinary Living at the Kripalu Center for Yoga and Health.

Disclosure: S.B.S. Khalsa and J.Noggle have received consultant fees from the Kripalu Center for Yoga and Health. The other authors declare no conflict of interest.

Address for reprints: Jessica Noggle, PhD, Sleep Disorders Research Program, Brigham and Women's Hospital, 221 Longwood Avenue BLI 035, Boston, MA 02115; e-mail: jnoggle@rics.bwh.harvard.edu.

Copyright © 2012 Lippincott Williams & Wilkins

Self-regulatory coping skills and resilience are believed to be effective countermeasures for stress, which may lessen the development of mood and affect-related problems.

Accordingly, there has been some development and evaluation of a variety of school-based stress management and wellness programs in the hope of providing adequate coping strategies, enhanced resilience, and self-efficacy.⁴ Elements of these programs have included cognitive restructuring, social skills, and school-related problem-solving training; emotional self-control techniques; problem-solving, modeling, role play, and relaxation skills training.

The usage of complementary and alternative medicine has increased over the past decade in adults and has been evaluated recently in the children. Mind-body therapies that have been practiced include biofeedback, meditation, progressive relaxation, self-hypnosis, deep breathing, and movement-based approaches such as Tai Chi, Qi Gong, and yoga. Of all the mind-body therapies in children, deep breathing and yoga were the most commonly used (2.2% and 2.1%, respectively) followed by meditation (1.0%).⁵

Yoga is a holistic system of mind-body practices for mental and physical health and incorporates multiple

techniques including physical postures and exercises that develop strength and flexibility, breathing exercises, deep relaxation, and meditation/mindfulness techniques to train attention. Yoga and meditation techniques have been shown to reduce perceived stress and improve mood.^{6,7} Research documenting the therapeutic benefits of yoga has grown steadily for the past 3 decades and now includes controlled clinical trials on psychiatric conditions such as depression and anxiety, breathing disorders such as asthma, cardiovascular disorders such as hypertension, endocrine disorders such as diabetes, and a variety of musculoskeletal and neurological conditions.⁸ There is also a growing body of research literature documenting the benefits of yoga in children and adolescents.^{9,10} For example, yoga intervention studies have reported improvements in attention-deficit hyperactivity disorder in boys; in weight loss, self-esteem, and anxiety in mostly Hispanic children and adolescents; and eating disorders in adolescents.¹¹⁻¹³

The multiple techniques of yoga likely work synergistically together to yield stress reduction and improved well-being. There are a few pilot studies that have examined the psychological effects of yoga in children outside of the school curriculum. For example, an inner city after school program with a weekly 12-week yoga protocol showed fewer stress-related negative behaviors in comparison with a control group.¹⁴

There are even fewer studies that have evaluated yoga within the school curriculum. A study incorporating yoga within the school curriculum evaluated a relaxation program incorporating yoga for fifth grade students in Germany.¹⁵ Students experienced significant reductions in aggression, helplessness in school, physical complaints, and improvements in static balance and stress-coping abilities. More recently, a randomized controlled trial of a 12-week, in-school yoga program in fourth and fifth graders reported a positive impact on problematic responses to stress including rumination, intrusive thoughts, and emotional arousal.¹⁶ In a single group pre/post design, teacher-reported improvements in attention have also been shown for elementary-aged children practicing yoga, who were recently exposed to war-related traumatic stress.¹⁷

Although yoga and meditation techniques seem ideally suited to prevent or alleviate the psychological issues encountered by adolescents in high school, we are unaware of reports of any randomized controlled studies within the school setting in this population. The overall purpose of this research program is to evaluate the psychological benefits of a yoga program conducted within the school curriculum for adolescents. This program has begun as a series of pilot studies aimed to develop the yoga intervention, test feasibility, and establish initial efficacy. Our initial pilot study was the first group-randomized controlled trial of yoga for adolescent mental health.¹⁸ Upper division students were randomly assigned to either regular physical education (PE) or an 11-week Yoga Ed program over 1 semester. Self-report

surveys administered pre/post indicated that yoga participants showed statistically significant differences over time relative to controls on measures of anger control and fatigue/inertia. There was a pattern of worsening in the control group, whereas changes in the yoga group were either minimal or slightly improved. Although promising, for this second pilot study we were interested in focusing on scales developed for normative adolescent populations, and basing the intervention on a different yoga style. Our initial study focused on clinically relevant measures of psychological health using the Behavior Assessment Scale for Children-Second Edition (BASC-2) Questionnaire, whereas this study has focused more appropriately on psychological constructs relevant to normative adolescent populations. In addition, this study evaluated a yoga intervention based on Kripalu yoga, whereas our previous study evaluated an intervention based on the Yoga Ed program.

We predicted that yoga would improve overall well-being by both decreasing negative aspects and increasing positive aspects. Although we predicted direct effects of yoga on psychosocial well-being, we also predicted that yoga may have beneficial effects on the development of self-regulatory skills (which may in turn have indirect effects on psychosocial well-being; however, these relationships could not be evaluated given the limited size of the current trial).

METHODS

Study Participants

This study took a similar design approach as the previous study, maintaining the group-randomized controlled trial in a physical education (PE) setting. Eligible students for this study were registered for upper division (Grades 11 and 12) PE class at a public high school in rural western Massachusetts for the spring 2009 semester. Upper division students were required to take PE for at least 1 semester. In the 2008/2009 school year, this high school had 625 students in Grades 9 to 12.¹⁹ The graduation rate was 81.8%, and 16.4% of students were considered low income (students eligible for free/reduced price lunch or food stamps, or receiving Transitional Aid to Families benefits). Race and ethnicity composition was 92.2% white, 3.5% Hispanic, 2.1% African-American, 1.4% multirace, and 0.8% Asian. Nearly all students spoke English (0.5% limited English proficiency).

Inclusion criteria were registration for upper division PE and the ability to participate in group yoga classes without the need for excessive individual instruction. The only exclusion criterion was participation in the yoga study conducted the previous semester (which excluded 4 class periods of students). Students were enrolled through a passive consent, opt-out procedure. Prior to the study, the research protocol was described verbally to students, and a study information sheet was sent home to parents with the option to opt-out. Participants in 3 PE class periods were unequally randomized by class period to the PE-as-usual group (active control;

1 class period) or the yoga group (active treatment; 2 class periods). Group allocation to yoga versus controls was conducted by blindly and randomly drawing paper slips. This study protocol was reviewed and approved by the Institutional Review Board of Brigham and Women's Hospital.

Yoga Intervention

Participants in the class periods assigned to the yoga intervention attended 2 to 3 yoga sessions a week (alternating weekly due to the school schedule) over 10 weeks (28 yoga sessions total). For the sake of clarity, a single yoga instruction period is referred to as a yoga "session," whereas class "period" is used to mean the grouping of students into separate PE classes. Individual yoga session attendance was recorded by the teaching assistants.

The 2 lead yoga instructors who created and implemented the program were teaching faculty at the Kripalu Center for Yoga and Health. They both completed 500-hour advanced yoga teacher training programs and the Yoga Ed training program which provides skills in teaching yoga to adolescents in a manner which enhances engagement and compliance while minimizing risk. A yoga teaching assistant was present at each yoga session (5 assistants in total), each of whom had taken a basic 200-hour yoga teacher training program from a yoga school and also participated in the Yoga Ed training program. Their role was to assist students individually, provide gentle adjustments upon permission, and keep notes in the teaching log. The school PE instructor was usually present as well, mainly to support classroom behavior.

The yoga intervention developed for this study represents the beginning of the development of a standardized Kripalu-based program for use in research evaluation of benefits of yoga within the school setting that may ultimately serve for widespread implementation in schools. The yoga program used in this study was completely secular and included 4 key elements of classical yoga: physical exercises and postures, breathing exercises, deep relaxation, and meditation techniques. In keeping with principles of Kripalu yoga, the overall emphasis was on self-inquiry and not purely didactic teaching. Furthermore, it incorporated a distinct approach to emotion regulation in Kripalu yoga represented in the instruction to breathe, relax, feel, watch, and allow. Postures were taught as breath-coordinated movements, and breathing is considered the central tool for cultivating nonjudgmental, compassionate self-awareness. The majority of yoga postures were simple and adaptable for all physical fitness levels. Physically demanding techniques were eventually introduced as optional variations of the standard poses toward the end of the program, based on students' progress.

The 30-minute yoga sessions were structured to include a 5-minute centering, a 5-minute warm-up, 15 minutes of yoga postures/exercises, and a 5-minute clos-

ing relaxation. (Durations of each segment were extended to varying degrees in the 40-minute sessions, typically by including more yoga postures/exercises.) Breathing techniques were progressively incorporated during the initial centering. In addition, slow abdominal breathing was a focus throughout the duration of all sessions. Each session had a theme or talking point that was discussed throughout the session by the instructor. Themes included a basic yoga approach and methodology (postures, breathing, relaxation, meditation, and awareness), nonviolence, mind-body interactions and awareness, body systems, stress management, emotional intelligence, self-talk and critical voice, contentment, discipline, decision making, values and principles, commitment, and acceptance.

Physical Education Control

Participants in the PE-as-usual class period met for 30 to 40 minutes, 2 to 3 times a week over the course of the 10-week yoga program. The school's goal of the ongoing upper division PE program was to provide an opportunity for students to engage in programs that will foster lifelong wellness and self-responsibility. Students were graded on participation, responsibility, and skills and knowledge development. The PE curriculum consisted of 2-week units with the first week focused on learning the history, rules, and skills for an activity, and the second week consisting of a tournament or games. Students unable to participate directly in an activity were assigned to support roles (referee, setup, and coach/mentor), thereby still participating. Units included traditional sports such as tennis, volleyball, hockey, football, ultimate frisbee, and baseball. Nontraditional sports were also included, such as a ropes course, backcountry living skills, stress management, first aid/cardiac pulmonary resuscitation, and planned parenthood health and wellness. Yoga was not included as a unit or as a component of any unit during the semester.

The upper division school PE instructor held a bachelor's degree in outdoor education recreation and a Massachusetts state certification for Grades 9 to 12 PE. He also held activity-specific certifications related to many of the units in the PE curriculum. There were no other instructors or assistants during the PE sessions.

Feasibility

To address how well upper division high school students tolerated and accepted the new Kripalu-based yoga program, we administered a Yoga Evaluation Questionnaire (YEQ) at the end of the study to students in the yoga group. The YEQ was an internally created qualitative survey to assess feasibility of conducting a yoga program with adolescents. The YEQ was an 8-item measure of the students' perception of the benefits, utility, and value of the yoga program using a 10-cm visual analog scale on which students mark their degree of agreement with statements from "not at all" to "very

much so.” In addition, there was an open-ended entry for qualitative comments by the participant.

Exploratory Outcome Measures

Both the yoga and control group participants completed self-report questionnaires 1 week before the start of the yoga program and 1 week following the end of the yoga program. Trained study staff administered the surveys in groups by class period, following a script to provide overall instructions for completing questionnaires honestly and individually and to emphasize reading the instructions as they vary by survey especially in terms of time frame. Participants were given 2 sessions to complete the questionnaires using pencil and paper. They were not aware of group assignment at baseline questionnaire administration. Study staff were aware of group assignment at both data collection time points. All questionnaires (except the internally created YEQ) were standardized, validated psychological surveys, and also previously used with normative populations of adolescents when available. Surveys assessed psychosocial well-being, self-regulatory skills, and feasibility of the intervention.

Psychosocial Well-Being

The primary outcomes represented 2 interrelated dimensions of psychosocial well-being: mood and affect. Additional psychosocial well-being outcomes of interest included stress and positive psychological attitudes. These constructs were selected to represent both negative and positive dimensions of well-being that are believed to improve with yoga and they have been supported by existing preliminary studies.

Mood

The Profile of Mood States-Short Form (POMS-SF) is a 30-item version of the POMS consisting of 30 adjectives rated on a 5-point scale ranging from 0 (not at all) to 4 (extremely). Responses are summed (with positive items reverse scored) to provide a total mood disturbance score (range 0–100), as well as subscale scores for 6 mood states (each ranging 0–20): Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment. The POMS has been used in PE and sports psychology studies of adolescent samples.²⁰

Affect

The Positive and Negative Affect Schedule for Children (PANAS-C) is a 30-item measure that contains 15 positive affect and 15 negative affect items. The PANAS-C instructs youth to indicate how often they have felt interested, sad, and so on during the “past few weeks” on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). Summation scores for positive affect and negative affect range from 10 to 75 each. The PANAS-C has demonstrated good convergent and discriminant validity in adolescent samples.²¹

Perceived stress

The 10-item Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the degree to which events are appraised as stressful during the past month. Items are rated on a Likert scale from 0 (never) to 4 (very often), with responses summed to give a total score ranging from 0 to 40. 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 has been previously administered to midadolescents (eight and ninth graders).²²

Positive psychology

The Inventory of Positive Psychological Attitudes-32R (IPPA) is a 32-item, 7-point Likert self-report scale with a total score and subscales that measure Self-confidence During Stress and Life Purpose and Satisfaction. Each score is calculated as a mean, with possible scores ranging from 1 to 7. It has been shown to possess adequate reliability and construct validity in samples of undergraduate college students.²³

Self-Regulatory Skills

Other secondary outcome measures were also included to evaluate students’ self-regulatory skills including resilience, control of anger expression, and mindfulness.

Resilience

The 25-item Resilience Scale (RS) measures the degree of individual resilience, which is considered a positive personality characteristic that enhances individual adaptation. The scale covers 5 factors of resilience, namely meaningful life (purpose); perseverance; self-reliance; equanimity; and coming home to yourself (existential aloneness). Items are scored on a 7-point scale from 1 = disagree to 7 = agree, with possible scores ranging from 25 to 175. Higher scores reflect greater resilience. The scale has internal consistency, reliability, and concurrent validity and has been recommended as the best instrument for measuring resilience in adolescents.²⁴

Anger expression

The State-Trait Anger Expression Inventory-2™ (STAXI-2) is used to assess the experience and expression of anger for people aged 16 years and older (Psychological Assessment Resources, Inc., Lutz, FL). The full STAXI-2 is a 57-item self-report tool that uses a 4-point Likert response format. The instrument is categorized into scales that reflect state anger, trait anger, and anger expression. For each scale, summation scores range from 8 to 32. For this study, we used the subscales measuring anger expression. Anger expression is conceptualized as having 3 major components: anger-out (outward expression of anger), anger-in (anger suppression), and anger control (attempts to control expression of anger).

Mindfulness

The Child Acceptance and Mindfulness Measure (CAMM) is a 25-item measure of mindfulness and assesses the degree to which children and adolescents

observe internal experiences, act with awareness, and accept internal experiences without judging them. It has been used with children aged 9 to 19 years. A total acceptance/mindfulness score is calculated by reverse scoring negatively worded items and summing the item total, yielding a possible range in scores from 0 to 100. Higher scores indicate higher levels of acceptance and mindfulness. The CAMM has demonstrated good internal consistency and concurrent validity with negative correlations to measures of cognitive suppression and psychological inflexibility in a study of 606 middle school students.²⁵

Data Analysis

For this preliminary study of limited sample size, exploratory outcomes were evaluated at the individual student level. Baseline equivalence was tested for potential differences based on group (yoga or PE-as-usual), gender, grade, and class period. Normality and heterogeneity of variance were also tested for parametric assumptions. Between-group effects were assessed by conducting analyses of covariance (ANCOVAs) on end-program scores with baseline scores as the covariate. All enrolled participants were included in analyses, following intention-to-treat principles. Significance level was adjusted for the 2 primary outcomes related to psychosocial well-being (mood and affect) using a Bonferroni correction to establish $\alpha = 0.025$. Feasibility was assessed by examining yoga attendance rates; grouping YEQ responses into 1-cm categories to look at responses graphically; and reviewing the optional YEQ qualitative comments.

RESULTS

Demographics

Three class periods comprising 52 students in total were initially recruited for the study. One student had participated in the yoga study conducted the previous semester and thus was excluded from the analysis leaving 51 students enrolled and randomly allocated 2:1 by class to either yoga or physical education (PE)-as-usual, the control condition. For both yoga and control groups, most of the students were in 11th grade and their average age was 17 years at the start of the study (Table 1). There were more females in the yoga group, although this difference was not statistically significant. No students or parents declined participation in the study at

Table 1. Demographic Characteristics of Participating 11th and 12th Graders by Group (Yoga and PE-As-Usual)

	Yoga (n = 36)	PE-As-Usual (n = 15)
Female	61%	47%
Age (SD)	17.1 (0.6)	17.3 (0.8)
11th grade	69% ^a	80%

PE, physical education. ^a Two students in the yoga group were 10th graders at the age of 16.2 and 16.8 years.

the outset and study attrition was extremely low; only one participant in the yoga group dropped out following baseline questionnaires and before yoga classes, for unknown reason.

Feasibility

In contrast to study attrition, adherence to yoga classes was moderate. (Attendance rates for students in the PE-as-usual control condition could not be accessed without parental release of student information.) Central tendencies for yoga attendance rates were as follows: average 58% ($\pm 26\%$ SD), median 64.3%, and mode 75%. Attendance rates ranged from 0% to 93%, with attendance less than 25% for 7 of 36 students in the 2 yoga-assigned class periods. Attendance rates were not correlated with any of the outcome measures (data not shown).

Despite moderate attendance, students in the yoga group rated yoga fairly high on the Yoga Evaluation Questionnaire (YEQ). Thirty-three of 36 yoga students completed the YEQ. Most of these students reported that, in general, yoga was somewhat (4) to very helpful. (10) Similarly, nearly three-quarters of yoga students reported that they would like (5) to very much like (10) continuing with yoga. Almost three-quarters of students found yoga valuable enough that they would likely (5) to very likely (10) recommend yoga to their friends. When asked whether yoga was helpful or whether they used any yoga skills at school and home, responses were scattered more evenly across the scale (data not shown) indicating perhaps not all students who liked yoga were applying it outside of class.

Half of the write-in comments on the YEQ were favorable as well. When asked to note any comments about the yoga program or one's experience of it, there were 18 positive comments, 5 negative comments, and 10 students did not comment. Comments could be grouped into categories. Positive comments included preferring yoga to gym, saying yoga helped to calm down, was generally good, was fun, and made students more active. For example, a female 11th grader wrote: "It was a good stress reliever for what happens earlier in the day and it was relaxing for the nerves." Within these positive comments, 2 students also suggested the yoga program could be more challenging and engaging. Most (3) of the negative written comments were conveying a neutral outcome, i.e., that yoga did not do anything one way or the other for students. One negative comment suggested that yoga caused overstretching in the foot.

The other negative comment was linked to the only institutional review board-reportable adverse event in this study. An 18-year-old male student experienced Val-salva retinopathy following an inverted yoga posture, resulting in temporary loss of vision in 1 eye which resolved without medical intervention. This event was caused by an existing inherent abnormality for this participant that required avoidance of any kinds of inverted

posture. This participant discontinued participating in yoga classes but completed posttreatment questionnaires.

Psychosocial Well-Being

No statistically significant baseline differences were detected between group, gender, grade, or class period. Hence, for the main analysis by group, data were combined for gender, grade, and class. Normality assumptions were met for total scores and therefore analysis of covariance (ANCOVA) between groups with baseline as the covariate was conducted on end-program scores.

Mood

The Profile of Moods States-Short Form (POMS-SF) had excellent internal consistency (Cronbach's $\alpha = 0.90$). Two aspects of mood were statistically different between groups (Table 2 and Fig. 1). Total mood disturbance (global POMS-SF score) was significantly better following yoga compared with students taking PE-as-usual with a medium-large effect size = 0.689 (Cohen's d). In addition, the Tension-Anxiety subscale was significantly better in the yoga group compared with PE-as-usual with a large effect size = 0.870. There was a similar trend for the Confusion-Bewilderment subscale, although it did not reach statistical significance. The other mood subscales were not significantly different between

groups: Depression-Dejection, Anger-Hostility, Vigor-Activity, and Fatigue-Inertia.

Affect

The Positive and Negative Affect Schedule—Child form (PANAS-C) also had excellent internal consistency (Cronbach's $\alpha = 0.91$). Similar to mood, there were statistically significant differences between groups in affect measured by PANAS-C (Table 2 and Fig. 1). Specifically, negative affect was significantly better in the yoga group than PE-as-usual controls with a medium-large effect size = 0.659. Positive affect was not significantly different between groups.

Perceived stress

The Perceived Stress Scale (PSS) had good internal consistency (Cronbach's $\alpha = 0.86$). There were no statistically significant differences in perceived stress measured by PSS between the yoga and PE-as-usual control groups.

Positive psychology

The Inventory of Positive Psychological Attitudes-32R (IPPA) had excellent internal consistency (Cronbach's $\alpha = 0.97$). Similar to positive affect, between groups there were no statistically significant differences in positive psychological attitudes (total IPPA score), the self-confidence during stress subscale, or the subscale for life purpose and satisfaction.

Table 2. Mean Scores for Psychosocial Well-Being and Self-Regulatory Skills Before and After the Yoga Program

Category	Scale	Construct	Yoga				PE-As-Usual				F-Statistic	p	
			Pre		Post		Pre		Post				
			Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Psychosocial well-being	POMS-SF	Total mood disturbance (−)	42.8	19.3	38.4	16.9	44.5	10.2	51.2	20.1	6.38	.015*	
		Tension-anxiety (−)	6.4	4.7	5.1	3.6	6.7	2.8	9.3	5.8	10.76	.0020*	
		Depression-dejection (−)	5.1	5.0	4.7	4.9	4.9	3.0	6.3	4.2	2.01	.16	
		Anger-Hostility (−)	6.5	4.7	5.7	5.0	6.3	2.7	7.1	4.5	1.03	.31	
		Vigor-activity (+)	9.8	4.4	9.3	4.0	10.2	3.8	10.9	3.5	2.06	.18	
		Fatigue-inertia (−)	8.3	5.7	7.2	5.2	9.8	4.5	9.3	4.6	1.06	.31	
			Confusion-bewilderment (−)	6.8	3.5	6.3	3.5	6.6	2.7	8.3	4.1	3.94	.053
		PANAS-C	Positive affect (+)	50.1	11.5	48.6	11.7	47.7	9.4	49.2	11.3	0.39	.54
	Negative affect(−)		32.1	12.5	29.4	11.5	28.8	7.7	38.4	15.5	8.21	.0061*	
		PSS	Perceived stress (−)	19.2	7.4	18.6	6.2	19.1	3.8	20.3	5.4	1.80	.19
	IPPA	Positive psychological attributes (+)	4.5	1.0	4.5	1.2	4.5	0.78	4.2	0.88	1.84	.18	
		Life purpose and satisfaction (+)	4.7	1.0	4.8	1.1	4.8	0.94	4.6	0.88	2.72	.11	
		Self-confidence during stress (+)	4.2	1.0	4.3	0.98	4.2	0.67	4.0	0.90	1.12	.29	
Self-regulatory skills	RS	Resilience (+)	132.9	18.4	131.9	24.5	132.1	12.4	127.9	23.4	0.38	.53	
	STAXI-2	Inward anger suppression (−)	16.4	4.2	16.8	4.9	15.9	3.3	17.9	4.6	1.62	.21	
		Outward anger expression (−)	17.2	5.7	16.9	5.5	16.5	4.0	17.1	3.7	0.16	.69	
		Anger expression control (+)	22.8	5.5	22.4	6.1	22.7	5.3	20.9	3.7	1.83	.18	
	CAMM	Mindfulness and acceptance (+)	53.9	8.6	53.4	7.8	52.3	6.7	49.4	7.2	2.88	.097	

PE, physical education; ANCOVA, analysis of covariance; POMS-SF, Profile of Mood States-Short Form; PANAS-C, Positive and Negative Affect Schedule for Children; PSS, Perceived Stress Scale; IPPA, Inventory of Positive Psychological Attitudes-32R; RS, Resilience Scale; STAXI-2, State-Trait Anger Expression Inventory-2; CAMM, Child Acceptance and Mindfulness Measure. The valence of each construct is indicated in parentheses. Yoga and PE-as-usual compared via ANCOVA of end-program scores controlling for baseline scores. *Statistically significant when $p < .025$.

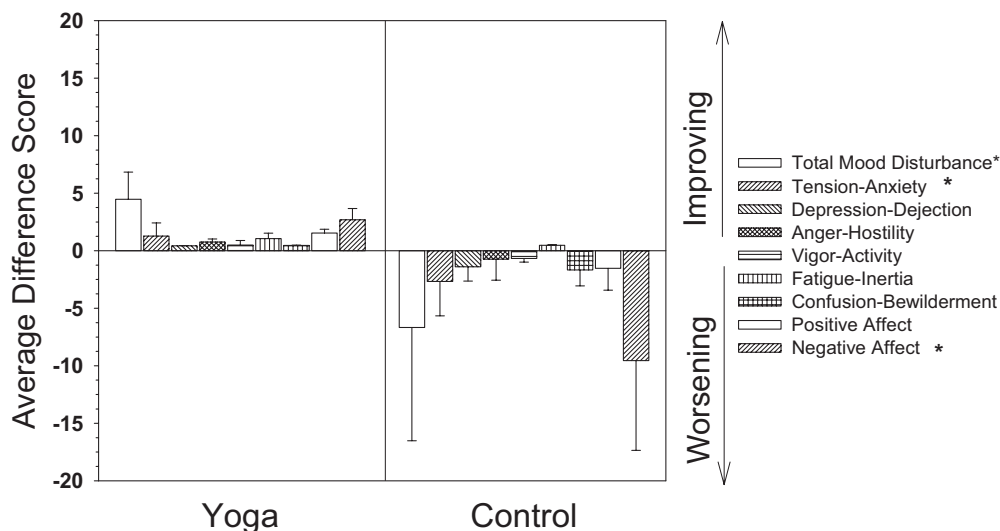


Figure 1. Differences in mood and affect between yoga and PE-as-usual controls. Asterisks indicate statistical significance ($\alpha = 0.025$) between groups at end while controlling for baseline.

Self-Regulatory Skills

As for the constructs measuring aspects of psychosocial well-being, no statistically significant baseline differences were detected between group, gender, grade, or class period. Hence, for the main analysis by group, data were combined for gender, grade, and class. Normality assumptions were met for total scores and therefore ANCOVA between groups with baseline as the covariate was conducted on end-program scores.

Resilience

The Resilience Scale (RS) had good internal consistency (Cronbach's $\alpha = 0.88$). There were no statistically significant differences in individual resilience measured by RS between the yoga and PE-as-usual control groups.

Anger expression

The State-Trait Anger Expression Inventory-2™ (STAXI-2) for anger expression had good internal consistency (Cronbach's $\alpha = 0.87$). There were no statistically significant differences in any of the 3 anger expression subscales (anger-out, anger-in, and anger control) measured by STAXI-2 between the yoga and PE-as-usual control groups.

Mindfulness

The Child Acceptance and Mindfulness Measure (CAMM) had poor internal consistency (Cronbach's $\alpha = 0.58$). Although there were no statistically significant differences in acceptance and mindfulness, there was a trend of greater mindfulness/acceptance in the yoga group compared with PE-as-usual controls.

DISCUSSION

Increasing evidence supports the view that yoga is a practice which addresses multiple mental, emotional, and physical facets of the individual. The postures/exercises, breathing techniques, and deep relaxation practices likely induce the relaxation response and downregulate stress systems.²⁶ The meditation practices, while also downregulating the stress systems, are be-

lieved to improve the control of attention, stress perception, and emotion regulation.²⁷ The acquisition of these self-regulatory skills likely accounts for the demonstrated ability of yoga practice to improve mental health characteristics in both healthy individuals and patient populations. Furthermore, as an acquired skill, there is an expectation that this will serve to maintain mental health characteristics over the long term, if these practices are continued.

We predicted that yoga would improve overall well-being by both decreasing negative and increasing positive aspects of mental health. Although we predicted direct effects of yoga on psychosocial well-being (mood, affect, perceived stress, resilience, and positive psychological traits), we also predicted that yoga may have beneficial effects on the development of self-regulatory skills (mindfulness and emotion regulation/anger expression) which may underlie these improvements. These predictions were only partially supported by the results of this study. Negative affect, total mood disturbance, and Tension-Anxiety were all positively impacted by the intervention and there were also positive trends in Confusion-Bewilderment and Mindfulness. However, no changes were observed in positive affect, perceived stress, positive psychological traits, resilience, or anger expression.

The positive outcomes in this study are generally consistent with those of the few previously published studies of yoga in school settings, although the use of different outcome measures and research designs between studies precludes a precise comparison. Our previous study using a Yoga Ed protocol is very similar to this study, although that study did not use the Positive and Negative Affect Schedule—Child form (PANAS-C), The State-Trait Anger Expression Inventory-2™ (STAXI), or Child Acceptance and Mindfulness Measure (CAMM). In that study, we reported statistically significant improvements in anger control, resilience, and fatigue/

inertia. In contrast, this study did not replicate improvements in resilience or fatigue/inertia. Improvements in anger control were also not observed in this study, although the Yoga Ed study used a different outcome measure for this construct. It is possible that the change in intervention from Yoga Ed to a Kripalu yoga intervention could account for some of this, although the 2 interventions are quite similar. It is possible that a number of other differences may have contributed to the different outcomes such as the small sample size in this study and the execution of the Yoga Ed study in the fall versus the current study in the spring semester.

The research designs of other previous studies of yoga in school settings differ substantially from our studies. All were conducted in elementary school students; most have been single-group trials in special populations or schools; and only one of them examined yoga implementation within the regular school curriculum.¹⁴⁻¹⁷ However, all of these studies reported improvements in mental health-related characteristics, including aggression, helplessness in school, and stress-coping abilities¹⁵; concentration, mood, and ability to function under pressure¹⁷; negative behaviors scores and well-being¹⁴; and problematic responses to stress, including rumination, intrusive thoughts, and emotional arousal.¹⁶

Regarding feasibility, students in the yoga group generally found the Kripalu-based program acceptable and beneficial. Despite moderate attendance to yoga classes (which was higher in the previous study), most students rated the program quite favorably. Overall school attendance may have been moderate due to impending graduation (for 12th graders) and the end of the school year (11th graders), which may have affected attendance to yoga sessions. Unfortunately, we were not able to access school records to corroborate this explanation. Interestingly, outcomes did not correlate with attendance to yoga classes, which implies the observed benefits may not be linearly dose dependent but instead follow a threshold or hormetic effect, and/or the quality of practice is influential in addition to quantity (number of classes in this case). Finally, the one observed adverse event was an unknown preexisting condition exacerbated by an inverted yoga posture. Retinal contraindications have been reported previously in adult case studies.²⁸ Rather than removing inversions from the curriculum, it serves as an important reminder to take extra precautions when teaching inversions to adolescents, such as systematic assessment of preexisting conditions and clearly stating contraindications before teaching inverted poses.

Although results are consistent with effects due to the yoga program, causation cannot be inferred because of the small, imbalanced sample size which also did not allow us to evaluate the impact of clustering. Hence, both positive outcomes (and lack of outcomes) are tentative and require replication in a larger, more definitive trial. The small sample size also precluded analysis of any gender differences which have been shown in adoles-

cents for psychosocial well-being. External validity may not be high, given the student demographic of >90% white and low Hispanic ethnicity. Additional considerations that were not accounted for were lack of information about yoga practice separate from the study, for either group; observer bias (as study staff knew group assignments during survey administration); treatment fidelity and differences in teaching style (2 teachers shared the curriculum); and small irregularities in weekly yoga session frequency (alternating between 2 and 3 times a wk) and session duration (between 30 and 40 min) due to the school setting.

Indeed, several strengths related to the real-world applicability of an education setting also conferred limitations from the standpoint of methodological control. Physical education (PE)-as-usual for the same length and duration as the yoga classes was an appropriate control for potential benefits from physical exertion of yoga breathing and postures. Indeed, systematic review of yoga and exercise suggested that yoga may be as effective or better than exercise for improving health outcomes including mood and stress.²⁹ Exercise at moderate intensity and duration, similar to the control condition, has been clearly shown to improve psychosocial well-being of children and adolescents.³⁰ Although daily PE-as-usual would have reflected more recent government-recommended guidelines of daily vigorous physical activity totaling 60 minutes, we were unable to influence dosage of the control condition; in this way, it was a passive control. Another strength, and limitation, was passive consent: although we were able to access the widest reach of students (not just those with parents involved in their schooling), we were not able to access student information from the school like PE/school attendance or grades.

Another strength/limitation was the conduct of a group-randomized trial. Although ideal to randomize students individually, being in a school setting required allocation at the classroom level. Despite these limitations, preliminary results from this study indicate a similar protective pattern of benefit in psychosocial well-being as seen in previous studies. Thus, yoga may serve a preventive role in adolescent mental health. Larger "field" studies in multiple schools with more active control conditions may yield more definitive conclusions by accounting for more confounders, affording group-level analyses and supporting substudies of more diverse outcomes at the physiological and cognitive levels.

ACKNOWLEDGMENTS

We thank Monument Mountain Regional High School faculty and staff Maeve Hitzenbubler, Andrew Luke Bloom, Michelle Campbell, Mike Powell, Sean Flynn, and Becky Campetti for their facilitation of the study and the student body for their participation. Debbie Cohen coordinated research as the project leader. Technical research assistance was provided by Torrey Baldwin, Tosca Braun, and Janna Delgado. Development of the yoga curriculum was by Janna Delgado and Iona Brigham, and yoga instruction was by Janna Delgado, Iona Brigham, Jane Rosen, Talitha Eustice, Connie Wilson,

Karen Arp-Sandel, and Karlee Fain. We thank Angela Wilson, Vandita Marchesiello, Barbara Bonner, Kelly Baxter Spitz, and Carolyn Butler from the Kripatu Center for Yoga and Health for administrative assistance. We also thank Steve Glick whose financial support made this study possible.

REFERENCES

- Kessler RC, Wang PS. The descriptive epidemiology of commonly occurring mental disorders in the United States. *Annu Rev Public Health*. 2008;29:115-129.
- Roberts RE, Roberts CR, Chan W. One-year incidence of psychiatric disorders and associated risk factors among adolescents in the community. *J Child Psychol Psychiatry*. 2009;50:405-415.
- Lazarus RS. *Stress and Emotion: A New Synthesis*. New York, NY: Springer Publishing Co; 1999.
- Kraag G, Zeegers MP, Kok G, Hosman C, Abu-saad HH. School programs targeting stress management in children and adolescents: a meta-analysis. *J Sch Psychol*. 2006;44:449-472.
- Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. *Natl Health Stat Report*. 2008;(12):1-23.
- Michalsen A, Grossman P, Acil A, et al. Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program. *Med Sci Monit*. 2005;11:CR555-CR561.
- Granath J, Ingvarsson S, von Thiele U, Lundberg U. Stress management: a randomized study of cognitive behavioural therapy and yoga. *Cogn Behav Ther*. 2006;35:3-10.
- Khalsa SBS. Yoga as a therapeutic intervention: a bibliometric analysis of published research studies. *Indian J Physiol Pharmacol*. 2004;48:269-285.
- Birdee GS, Yeh GY, Wayne PM, Phillips RS, Davis RB, Gardiner P. Clinical applications of yoga for the pediatric population: a systematic review. *Acad Pediatr*. 2009;9:212-220.
- Galantino ML, Galbavy R, Quinn L. Therapeutic effects of yoga for children: a systematic review of the literature. *Pediatr Phys Ther*. 2008;20:66-80.
- Jensen PS, Kenny DT. The effects of yoga on the attention and behavior of boys with Attention-Deficit/Hyperactivity Disorder (ADHD). *J Atten Disord*. 2004;7:205-216.
- Carei TR, Fyfe-Johnson AL, Breuner CC, Brown MA. Randomized controlled clinical trial of yoga in the treatment of eating disorders. *J Adolesc Health*. 2010;46:346-351.
- Benavides S, Caballero J. Ashtanga yoga for children and adolescents for weight management and psychological well being: an uncontrolled open pilot study. *Complement Ther Clin Pract*. 2009;15:110-114.
- Berger DL, Silver EJ, Stein RE. Effects of yoga on inner-city children's well-being: a pilot study. *Altern Ther Health Med*. 2009;15:36-42.
- Stueck M, Gloeckner N. Yoga for children in the mirror of the science: working spectrum and practice fields of the training of relaxation with elements of yoga for children. *Early Child Dev Care*. 2005;175:371-377.
- Mendelson T, Greenberg MT, Dariotis JK, Gould LF, Rhoades BL, Leaf PJ. Feasibility and preliminary outcomes of a school-based mindfulness intervention for urban youth. *J Abnorm Child Psychol*. 2010;38:985-994.
- Ehud M, An BD, Avshalom S. Here and now: yoga in Israeli schools. *Int J Yoga*. 2010;3:42-47.
- Khalsa SB, Hickey-Schultz L, Cohen D, Steiner N, Cope S. Evaluation of the mental health benefits of yoga in a secondary school: a preliminary randomized controlled trial. *J Behav Health Serv Res*. 2012;39:80-90.
- Massachusetts Department of Elementary and Secondary Education. 2010. School/District Profiles. Available at: <http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=06180505&orgtypecode=6&&fycode=2009>. Accessed May 10, 2010.
- Newcombe PA, Boyle GJ. High school students' sports personalities: variations across participation level, gender, type of sport, and success. *Int J Sport Psychol*. 1995;26:277-294.
- Wilson K, Gullone E, Moss S. The youth version of the positive and negative affect schedule: a psychometric validation. *Behav Change*. 1998;15:187-193.
- Carlozzi BL, Winterowd C, Harrist RS, Thomason N, Bratkovich K, Worth S. Spirituality, anger, and stress in early adolescents. *J Relig Health*. 2010;49:445-459.
- Kass JD, Friedman R, Leserman J, Caudill M, Zuttermeister PC, Benson H. An inventory of positive psychological attitudes with potential relevance to health outcomes: validation and preliminary testing. *Behav Med*. 1991;17:121-129.
- Ahern NR, Kiehl EM, Sole ML, Byers J. A review of instruments measuring resilience. *Issues Compr Pediatr Nurs*. 2006;29:103-125.
- Coyne LW, Cheron D, Ehrenreich JT. Assessment of acceptance and mindfulness processes in youth. In: Greco LA, Hayes SC, eds. *Acceptance and Mindfulness Treatments for Children and Adolescents: A Practitioner's Guide*. Oakland, CA: New Harbinger Publications; 2008: 37-59.
- Dusek JA, Benson H. Mind-body medicine: a model of the comparative clinical impact of the acute stress and relaxation responses. *Minn Med*. 2009;92:47-50.
- Ospina MB, Bond K, Karkhaneh M, et al. Clinical trials of meditation practices in health care: characteristics and quality. *J Altern Complement Med*. 2008;14:1199-1213.
- de Barros DS, Bazzaz S, Gheith ME, Siam GA, Moster MR. Progressive optic neuropathy in congenital glaucoma associated with the Sirsasana yoga posture. *Ophthalmic Surg Lasers Imaging*. 2008;39:339-340.
- Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med*. 2010;16:3-12.
- Sothorn MS, Loftin M, Suskind RM, Udall JN, Blecker U. The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. *Eur J Pediatr*. 1999;158:271-274.

AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES

1

A—Please check if the edits made to the sentence “Elements of these programs have...” are OK.

B—Please check if the edits made to the sentence “For both yoga and control group,...” are OK.

C—Please confirm whether the affiliations are OK as given.

D—Please confirm whether the disclosure statement is OK.
