

# Evaluation of the Mental Health Benefits of Yoga in a Secondary School: A Preliminary Randomized Controlled Trial

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## Abstract

*The goal of this study was to evaluate potential mental health benefits of yoga for adolescents in secondary school. Students were randomly assigned to either regular physical education classes or to 11 weeks of yoga sessions based upon the Yoga Ed program over a single semester. Students completed baseline and end-program self-report measures of mood, anxiety, perceived stress, resilience, and other mental health variables. Independent evaluation of individual outcome measures revealed that yoga participants showed statistically significant differences over time relative to controls on measures of anger control and fatigue/inertia. Most outcome measures exhibited a pattern of worsening in the control group over time, whereas changes in the yoga group over time were either minimal or showed slight improvements. These preliminary results suggest that implementation of yoga is acceptable and feasible in a secondary school setting and has the potential of playing a protective or preventive role in maintaining mental health.*

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## Introduction

Adolescents are confronted with a variety of life stressors from both school and home. Unmanaged stress is now believed to be a contributing and/or causal factor in the development of mental health and behavioral problems that are prevalent in adolescents, including anxiety, depression, and behavioral problems<sup>1</sup>. A recent survey study indicated that 7.5% of adolescents meet the *Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition (DSM-IV)* criteria for one or more mental health conditions. The authors concluded that life stressors were the most consistent predictive factor across disorders. Furthermore, personal resources such as mastery were consistently associated with enhanced resilience to the onset of mental health disorder episodes<sup>2</sup>. Reinforcing the rationale for addressing adolescent mental health needs, it is estimated that one half of the adult population will experience at least one *DSM-IV* mental health disorder. The age of onset of most of these disorders, including the most seriously impairing conditions, occurs in childhood and adolescence<sup>3</sup>. It has therefore been suggested that greater attention and effort should be devoted to interventions for the treatment of the mild and currently largely untreated child–adolescent disorders. This would address the significant adolescent mental health burden and also possibly prevent the high severity and prevalence of adult primary and comorbid mental health disorders<sup>3</sup>.

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<sup>4,5</sup>. Elements of these programs include cognitive restructuring, social skills, problem solving training, emotional self-control techniques, modeling, role play, and relaxation skills training<sup>4,5</sup>. However, few programs have incorporated mind–body skills approaches such as yoga and meditation, which are known to be effective self-regulatory and stress management skills.

Yoga is a holistic system of multiple mind body practices for mental and physical health that include physical postures and exercises, breathing techniques, deep relaxation practices, cultivation of awareness/mindfulness, and meditation. Yoga and meditation techniques have been shown to reduce perceived stress<sup>6,7</sup> and improve mood<sup>8</sup>. Research documenting the therapeutic benefits of yoga has grown steadily for the past three decades and now includes controlled clinical trials on a variety of mental health conditions such as depression and anxiety. A bibliometric analysis of published research studies on yoga as a therapeutic intervention has revealed almost 50 published studies up to 2003 evaluating yoga for mental health conditions, all of which reported some positive benefits<sup>9</sup>. Furthermore, yoga has been recommended and used clinically for both children and adolescents<sup>10</sup>. Two recent systematic reviews of yoga research in pediatric populations concluded that there is credible preliminary evidence for the efficacy of yoga for a variety of mental and physical health outcomes<sup>11,12</sup>.

Yoga and meditation techniques seem ideally suited to prevent or alleviate the psychological issues encountered by secondary school adolescents. Components of yoga practice have been incorporated into stress management programs in schools, including relaxation techniques such as muscle relaxation and regulation of breathing<sup>4,5</sup>. There is currently substantial interest in the development and application of meditation-based interventions in school settings for improvement of both mental health and performance<sup>13–16</sup>. There is some research support for meditation-mediated improvements, and this literature has been increasing recently. For example, studies have shown improvements in: (1) test anxiety and field independence in elementary school students<sup>17</sup>; (2) objective measures of stress including heart rate and blood pressure in prehypertensive African American adolescents<sup>18,19</sup>; (3) work habits, cooperation, and academic performance in middle school students<sup>20</sup>; and (4) restful alertness, emotional intelligence, and academic performance in middle school students<sup>21</sup>. There is also a preliminary report of benefits from a combined Tai Chi and mindfulness-based stress reduction program<sup>22</sup>.

Although it is likely that there is increasing implementation of yoga in school settings,<sup>10</sup> there are few published research studies. Most of these have been single-group trials and in special populations or schools. All of them were conducted in elementary school children and only one of them examined yoga implementation within the regular school curriculum. A pair of early studies reported benefits of yoga on tension and concentration in children with educational problems in a specialty school<sup>23,24</sup>. A 4-year German school study of a relaxation program incorporating yoga for fifth grade students with abnormal examination anxiety showed significant improvements in aggression, helplessness in school, static balance ability, physical complaints, and stress-coping abilities<sup>25</sup>. A single-group study in four Israeli elementary schools of a 13-session, 4-month yoga intervention within the school curriculum reported improvements in children's concentration, mood, and ability to function under pressure as evaluated by the school teachers<sup>26</sup>. A controlled study of an after-school yoga program in inner city elementary school students showed improvement in negative behaviors scores and well-being<sup>27</sup>. Finally, in a randomized controlled trial in four urban Baltimore elementary schools, a 12-week after-school yoga program was shown to have a positive impact on problematic responses to stress, including rumination, intrusive thoughts, and emotional arousal<sup>28</sup>. The purpose of the present study was to employ a preliminary, exploratory evaluation to identify which psychological constructs may be useful to include in future studies to evaluate the psychological benefits of an in-curriculum yoga program in secondary school adolescents.

## Methods

### Study population

Adolescents in 7 grade 11 and 12 classes in a Massachusetts rural secondary school were enrolled in the study through a passive consent, opt-out procedure. The school had a 90% white student body demographic and a 17% low-income population. All students and parents or guardians were informed that the students would be participating in a yoga study and could be assigned to either the active intervention or the control condition. There were no exclusion criteria. The research protocol was approved by the Institutional Review Board of Brigham and Women's Hospital. Participants were randomly assigned by class to a physical education-classes-as-usual group (no treatment control; three classes) or to a yoga group (active treatment; four classes).

### Intervention

Participants in the yoga intervention attended two to three yoga sessions per week during the 11-week program during which either 23, 25, 31, or 32 sessions were held (depending upon the class). Yoga sessions were 30 min (three classes) or 40 min (one class) long and were held either two times (two classes) or three times (two classes) per week. (For the sake of clarity, a yoga instruction period will be referred to as a yoga "session", whereas a "class" refers to the grouping of students).

The yoga program was a modified version of the Yoga Ed program for secondary schools that is currently being implemented in a number of schools across the United States (<http://www.yogaed.com>). This secular program includes simple yoga postures, breathing exercises, visualization, and games with an emphasis on fun and relaxation and minimizing risk without unduly complex or physically athletic or demanding techniques. An important component of the program also includes development and training in the cognitive skills of mindfulness and self-awareness and a yoga-based psychological and philosophical attitude. Each of the yoga instructors underwent a formal Yoga Ed training course had also both undergone a 200-h yoga teacher training program in the Kripalu yoga style.

Typical 30-min Yoga Ed sessions were structured to include a 5-min initial relaxation or “time in,” a 5-min warm-up, 15 min of yoga poses, and a 5-min closing relaxation (times were extended for the 40-min sessions). Breathing techniques were incorporated during the initial relaxation and throughout the sessions. Each of the sessions had a theme or talking point that was discussed by the instructor during the session including the following: yoga philosophy and methodology (postures, breathing, relaxation, meditation, awareness), non-violence, 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.

## Measures

Study staff administered a battery of self-report questionnaires to all classes in two sittings just prior to the start of the yoga program in mid-September, 2008, and again shortly after the end of the yoga program in mid-December. A few subjects ( $N=6$ ) who missed the mid-December class-administered questionnaire sitting completed their questionnaires 3 weeks later. Yoga session attendance and spontaneous student comments, responses, and reactions to the yoga were recorded by the instructors.

The Self-Report of Personality (SRP) version of the Behavior Assessment Survey for Children Version 2 (BASC-2) for children aged 12 to 21 years provides insight into thoughts and feelings and includes validity scales for helping judge the quality of completed forms. It provides a global score, subscale scores, and composite subscale scores (see Table 1) calculated as T-scores which provide cutoff thresholds for at-risk and clinically significant scores. The SRP includes 179 items with either true/false questions or four-point Likert-type scale questions for which higher response options indicate greater frequency and takes about 30 min to complete. Extensive BASC-2 psychometric properties are reported in the manual and are, overall, considered strong<sup>29</sup>.

The Profile of Mood States short form (POMS-SF) is a shortened version of the POMS and provides a total mood disturbance score as well as subscale scores for six mood states (Table 1)<sup>30</sup>. It consists of 30 mood-related adjectives that are rated on a five-point scale ranging from 0 (not at all) to 4 (extremely). The POMS-SF is a reliable and internally consistent self-report questionnaire that has been validated on adult and college student populations although not with adolescents.

The Resilience Scale (RS)<sup>31</sup> measures the degree of individual resilience, commonly defined as a positive personality characteristic that moderates the negative effects of unmanaged stress and enhances individual adaptation. It is the capability of successfully coping with challenge, change, or misfortune. All 25 items in this scale are scored on a seven-point scale from 1=disagree to 7=agree. All items are worded positively and possible scores range from 25 to 175 with higher scores reflecting higher resilience. The scale has demonstrated internal consistency, reliability, and concurrent validity and has been recommended as the best instrument for measuring resilience in adolescents<sup>32</sup>.

The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress<sup>33</sup>. It is a 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. Respondents complete 10 items answering on a Likert scale from 0 (never) to 4 (very often) as to how often they felt a certain way over the past month. The PSS has adequate internal reliability although it has not been validated in adolescents.

The Inventory of Positive Psychological Attitudes-32R (IPPA) provides a total score and subscales that measure Self-confidence during Stress and Life Purpose and Satisfaction. This self-report instrument includes 32 items answered on a seven-point Likert scale. It has been shown to

possess adequate reliability and construct validity in adults but has not been validated in adolescents<sup>34</sup>.

## Data analysis

Subjects in separate classes were pooled together into yoga and control groups for analysis. To test whether there was an effect of class, ANOVAs were conducted on each outcome variable with the seven-category class variable as a predictor, and no effects of class were found. All global and subscale scores of the questionnaires were analyzed with a series of independent-sample *t* tests on the difference scores (posttest minus pretest) of the yoga and control groups. When significant differences were found between the yoga and control groups, separate one-sample *t* tests were performed on the difference scores for the two groups to examine the pattern of the within-group differences. Standardized effect sizes for each outcome measure were calculated as the difference between the mean changes of the yoga and control groups divided by the standard deviation. Secondary analyses included Pearson product-moment correlations to examine the effects of attendance on the outcomes as well as independent-sample *t* tests to test for gender differences. The statistical analyses were performed with SAS, v. 9.2 (SAS Institute, Inc.); the alpha level used to determine significance was  $p < 0.05$  for all analyses.

## Results

Parents or guardians of 136 students received a consent letter. Of these, 11 students changed their class elective schedule options and four students/parents declined participation for religious reasons. The remaining 121 students (51 females, 70 males) age 15–19 years ( $M = 16.8$  years,  $SD = 0.6$ ) began participation in the study and were randomly assigned by classes: 74 students in four classes to the Yoga Ed group (34 females, 40 males,  $M = 16.8$  year,  $SD = 0.6$ ), 47 students in three classes to the control group (17 females, 30 males,  $M = 16.9$  year,  $SD = 0.8$ ). Of these 121 students, ten students dropped the physical education elective (two Yoga Ed, eight controls), one student (yoga) was suspended, and one additional student declined to participate in the yoga for religious reasons. Although outcome data are not available for these 12 students, their baseline data were compared with those of the students who remained in the study. Only one significant difference was found between the dropouts and the other participants on the pretest variables: the dropouts scored significantly higher on the PSS (20.6 vs. 17.3;  $t = -2.05$ ,  $p = .042$ ).

Of the 74 students in the yoga group, 73 took at least one yoga session. Yoga sessions for some of the classes were cancelled due to school events (e.g., student assembly, bomb scare, etc.) on six different days. Attendance was analyzed both in terms of number of sessions attended and the percentage of available sessions attended. The average number of sessions attended for all 73 students was 20.5 ( $SD = 7.7$ ), for the students with ~2 sessions per week was 18.0 ( $SD = 5.1$ ) and for the students with ~3 sessions per week was 23.7 ( $SD = 9.2$ ). The average number of missed sessions for all students was 7.4 ( $SD = 6.0$ ), and the percentage of available sessions attended was 73.4% ( $SD = 0.2\%$ ). Yoga session attendance was just over 80% at the beginning of the yoga program and declined to just under 70% by the end. Although control group attendance was not taken, historically, the level of yoga attendance was similar to that of the physical education classes.

No significant baseline differences were detected between groups. Three variables showed statistically significant change from baseline to end-program in the yoga group compared with the control group (Fig. 1). The amount of change in resilience as measured by the RS was significantly different between the yoga and control groups ( $p = 0.014$ ). The yoga group had an insignificant increase in resilience from 131.5 ( $SD = 15.4$ ) to 133.6 ( $SD = 16.0$ ), ( $p = 0.192$ ), whereas the control group significantly decreased from 131.2 ( $SD = 18.5$ ) to 126.5 ( $SD = 21.9$ ), ( $p = 0.040$ ). There was a significant difference in change between the groups for the BASC-2 subscale of Anger Control ( $p =$

**Table 1**Difference score means and *t* tests by intervention group for study variables

	Intervention group				Standardized	
	Control		Yoga		Effect size	$\rho$ Value
	Mean	SD	Mean	SD		
<b>BASC-2</b>						
Emotional Symptoms Index (-)	1.10	(5.3)	0.11	(5.2)	0.19 <sup>a</sup>	0.39
School Problems Composite (-)	0.50	(7.0)	-0.04	(4.7)	0.09 <sup>a</sup>	0.70
Attitude to school (-)	2.53	(8.9)	-0.23	(6.3)	0.36 <sup>a</sup>	0.13
Attitude to teachers (-)	1.23	(7.7)	0.66	(5.1)	0.09 <sup>a</sup>	0.71
Sensation seeking (-)	-2.43	(6.6)	-0.73	(6.6)	0.26 <sup>b</sup>	0.24
Internalizing Problems Composite (-)	0.97	(4.8)	-0.43	(5.3)	0.28 <sup>a</sup>	0.22
Atypicality (-)	0.67	(6.2)	-0.70	(5.6)	0.23 <sup>a</sup>	0.28
Locus of control (-)	1.00	(7.5)	-0.23	(6.2)	0.18 <sup>a</sup>	0.40
Social stress (-)	1.03	(5.7)	0.17	(5.3)	0.16 <sup>a</sup>	0.15
Anxiety (-)	0.97	(5.6)	-0.86	(5.8)	0.32 <sup>a</sup>	0.15
Depression (-)	0.33	(6.6)	-0.43	(6.1)	0.12 <sup>a</sup>	0.58
Sense of inadequacy (-)	1.60	(6.8)	0.27	(7.0)	0.19 <sup>a</sup>	0.49
Somatization (-)	-1.50	(5.5)	-0.44	(7.4)	0.16 <sup>b</sup>	0.49
Inattention/Hyperactivity Composite (-)	-0.50	(6.8)	-0.07	(6.0)	0.07 <sup>b</sup>	0.75
Attention problems (-)	-0.10	(7.7)	-0.14	(7.2)	0.06 <sup>a</sup>	0.98
Hyperactivity (-)	-0.77	(7.3)	-0.03	(6.6)	0.11 <sup>b</sup>	0.62
Personal Adjustment Composite (+)	-0.69	(6.5)	-0.97	(4.8)	0.05 <sup>b</sup>	0.83
Relations with parents (+)	-0.41	(6.0)	-1.04	(6.1)	0.11 <sup>b</sup>	0.64
Interpersonal relations (+)	-1.80	(6.9)	-0.16	(4.8)	0.28 <sup>a</sup>	0.24
Self-esteem (+)	0.60	(6.6)	-0.01	(5.2)	0.10 <sup>b</sup>	0.62
Self-reliance (+)	-1.50	(9.5)	-1.56	(6.0)	0.01 <sup>b</sup>	0.98
Test anxiety (-)	0.80	(5.8)	-1.34	(7.1)	0.33 <sup>a</sup>	0.15
Anger control (-)	1.69	(5.8)	-0.97	(5.2)	0.48 <sup>a</sup>	0.03*
Mania (-)	0.97	(6.6)	-0.47	(6.8)	0.21 <sup>a</sup>	0.33
Ego strength (+)	-1.17	(5.2)	-0.87	(5.5)	0.06 <sup>a</sup>	0.80
<b>Other Questionnaires</b>						
PSS (-)	-0.19	(7.2)	-0.60	(4.2)	0.07 <sup>a</sup>	0.77
POMS Total Mood (-)	1.27	(19.4)	-3.55	(15.1)	0.28 <sup>a</sup>	0.17
Tension/anxiety (-)	-0.03	(4.7)	-0.48	(3.8)	0.10 <sup>a</sup>	0.61
Depression/dejection (-)	0.03	(5.7)	-0.59	(3.9)	0.13 <sup>a</sup>	0.57
Anger/hostility (-)	-0.18	(4.6)	-1.00	(3.6)	0.20 <sup>a</sup>	0.33
Fatigue (-)	0.80	(4.9)	-1.42	(4.3)	0.48 <sup>a</sup>	0.02*
Confusion/bewilderment (-)	0.41	(4.0)	0.25	(3.3)	0.05 <sup>a</sup>	0.82
Vigor/activity (+)	-0.24	(3.9)	0.31	(4.0)	0.14 <sup>a</sup>	0.51
IPPA (+)	0.00	(0.8)	0.07	(0.5)	0.12 <sup>a</sup>	0.67
Life satisfaction (+)	0.06	(1.0)	0.03	(0.6)	0.04 <sup>b</sup>	0.86
Self-confidence (+)	-0.07	(0.8)	0.11	(0.6)	0.26 <sup>a</sup>	0.25
RS (+)	-4.69	(12.8)	2.08	(12.8)	0.53 <sup>a</sup>	0.01*

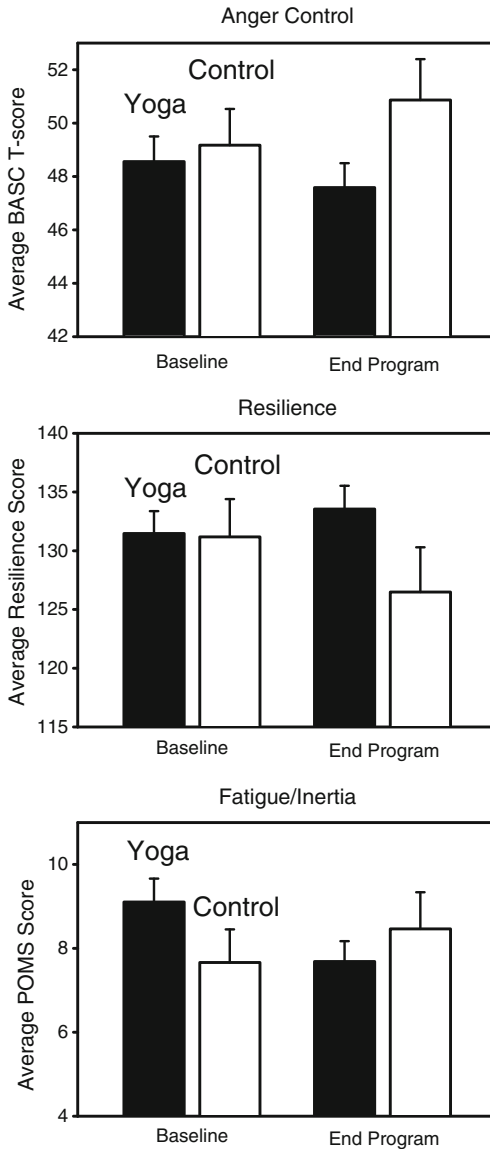
Sample sizes for completers: BASC-2 (70 yoga, 30 controls), RS (66 yoga, 34 controls), POMS-SF and IPPA (67 yoga, 34 controls), and PSS (67 yoga, 33 controls)

*Plus sign* indicates a positive trait, *minus sign* indicates a negative trait (i.e. improvements are indicated by an increase in a positive trait score or a decrease in a negative trait score)

<sup>a</sup>Indicates that effect size favored improvement in yoga

<sup>b</sup>Indicates that effect size favored improvement in control group

\* $p < 0.05$  is indicated between groups



**Figure 1**

Relative changes in Anger, Resilience, and Fatigue. Mean scores are plotted for yoga (*solid bar*) and control (*open bar*) groups at baseline and at the end of the program for the Anger Control subscale of the BASC-2, the Resilience Scale, and the Fatigue/Inertia subscale of the POMS-SF. *Error bars* represent standard errors of the mean

0.028), although the changes within groups were insignificant; the yoga group decreased from 48.6 (SD=7.9) to 47.6 (SD=7.6), ( $p=0.123$ ), whereas the control group increased from 49.2 (SD=7.2) to 50.9 (SD=8.1), ( $p=0.132$ ). A statistically significant between-group difference over time was observed in the Fatigue/Inertia subscale of the POMS-SF ( $p=0.022$ ); the yoga group showed a strong decrease in fatigue from 9.1 (SD=4.5) to 7.7 (SD=3.9), ( $p=0.009$ ), whereas the control group showed a statistically insignificant increase from 7.7 (SD=4.5) to 8.5 (SD=5.0), ( $p=0.344$ ). There were no statistically significant changes in other measures. The outcomes for all of the BASC-2 subscales are shown in Table 1.

## Secondary analyses

Yoga session attendance data for students in the yoga intervention group showed significant positive correlations with the change in IPPA total score ( $r=0.25, p=0.041$ ) and the change in IPPA Life Purpose and Satisfaction subscale score ( $r=0.26, p=0.035$ ). There was also a significant negative correlation between attendance and the change in Total Mood Disturbance Score on the POMS-SF ( $r=-0.31, p=0.012$ ; with a significant decrease in the subscale of Tension/Anxiety ( $r=-0.25, p=0.041$ ). A significant correlation was also observed between attendance and change in the BASC-2 subscale Attitude to School ( $r=-0.24, p=0.046$ ). There were no significant gender differences in the amount of change in study variables.

General observations, anecdotes, and spontaneous student comments recorded by the yoga instructors included issues affected by yoga practice related to mental state and behavior. Students frequently commented on the relaxing effect of the yoga sessions and their learned ability to relax, such as: "...enjoyed being able to let go of everything, zone out and relax."; "...felt like the class was a relaxing prep for the rest of the day."; and "Savasana [supine deep relaxation] made me relax and calmed me down." Improvements in coping with stress were also commonly noted in comments such as: "...an opportunity to de-stress in the middle of the day and recollect myself...it gave me tools to use in everyday life, now I have techniques to de-stress myself on my own." General improvements in mood and positive affect were also commonly reported, as reflected in comments such as: "I could reflect on my day in a positive way. This class gave me more energy and made me more content."; "...helped me improve my posture. I've had feedback from friends and family that I'm more centered."; and "The challenging postures were positive for me, I liked pushing myself. I always felt more relaxed after the class." Some students remarked on improvements in sleep. Yoga instructors noted that many students made visible improvements in proper execution/alignment of the yoga postures and understanding of the yoga practices in general.

## Discussion

This study demonstrated that inclusion of a semester-long regular yoga intervention is feasible in a high school setting within the school curriculum. Out of 136 potential participants in the study, only five declined to participate for religious reasons, whereas most all other non-participants dropouts were due to schedule/class elective changes. Among students randomly assigned to the yoga intervention, attendance was high and similar to the school's typical physical education class attendance levels. This attendance and the generally positive qualitative feedback suggest that the yoga was perceived as an acceptable practice by both parents and students in this setting.

Although statistically significant differences between groups were found for only a few outcome measures, each of these favored the yoga group (Table 1). On most measures, findings suggested relatively small positive effects in the yoga group but marked declines in the control group, as illustrated in the BASC-2 Anger Control and Attitude to School subscales and the RS (Fig. 1 and Table 1). One exception to this was the Fatigue/Inertia subscale in which there was a relatively strong improvement in the yoga group (Fig. 1). Given that this study was conducted over a single fall semester and the post-program outcome measures were near the end of term, it is possible that the pattern of worsening in the controls was due the end-of-term exam stress.

Three constructs were identified with statistically significant improvements among yoga participants versus controls: Anger (BASC-2 Anger Control subscale), resilience (RS), and Fatigue/Inertia (POMS-SF). The beneficial effect on anger control (and a trend in the POMS-SF Anger/Hostility subscale) are consistent with the hypothesized improvements in emotional intelligence/stability (self-control, self-reflection/awareness, and flexibility in emotional response) for meditative interventions in adolescents<sup>16</sup>, with the few previous studies that have reported



improvements with meditation <sup>21</sup> or yoga <sup>25,27</sup>, and with reports of positive mood changes in most of the elementary school-based yoga studies <sup>23,24,26,28</sup>. The maintenance in resilience by the yoga participants, as compared with the significant decrements in control subjects, suggest that yoga may promote the kind of equanimity and personal resources that are associated with successful coping with stress and adversity and a protective/preventive effect of yoga on mental health. This positive role of yoga for stress management has been demonstrated repeatedly in adult studies of yoga practice <sup>6,7</sup>, represents a major reason for participation in yoga practices <sup>35</sup>, and has also been reported in all of the elementary school-based studies <sup>23-28</sup>. Although it is plausible that improvements in fatigue/inertia are associated with yoga practice, it was somewhat surprising given the lack of statistically significant improvements of a number of other outcome measures that would have been more expected with a yoga intervention such as perceived stress, tension/anxiety, self-esteem, self-reliance, and somatization. One explanation could be the improvement in sleep anecdotally reported by beginning yoga students and also noted by some of the students in this study, which would improve daytime wakefulness and reduce sleepiness and fatigue <sup>36</sup>.

### **Study limitations**

Only a few showed outright statistical significance or trends between groups. There are several possible methodological reasons for this. For instance, the BASC-2 is a clinical instrument designed for identifying psychopathology in adolescents. Given that the high school participating was a rural high school with a largely normative population, the BASC-2 may not be the best instrument to identify subtle improvements in psychological variables. Another limitation may be that the duration of the intervention was only one semester long and perhaps insufficient to yield more significant outcomes. Finally, it should be borne in mind that this study was actually a comparative evaluation between Yoga Ed sessions and regular physical education classes, which themselves have psychological and physical benefits that overlap those of yoga. A comparative study of a curriculum of both physical education and yoga sessions combined with a curriculum of only physical education classes may reveal a stronger improvement in the yoga outcomes. However, such a study protocol might require a reduction in the number of yoga sessions due to scheduling constraints, and it also may be difficult to implement in many schools.

Other study limitations were related to the exploratory nature of the investigation. The statistical analysis did not include adjustments for intention to treat or for multiple comparisons, so these results must be interpreted rather cautiously. In fact, at least two significant associations could be expected just by chance alone (type I errors), and any correction for multiple comparisons would render all of the results as not statistically significant. The strategies adopted to address these issues (i.e., comparing dropouts on baseline measures and limiting the number of tests conducted by using summary measures rather than all subscales) mitigate the limitations somewhat. In addition, subjects from each of the classes were pooled into yoga and control conditions. Although the effects of nesting in classes were tested, the small number of total classes limited a comprehensive investigation of a number of potentially important within-class factors such as the different instructors, time of day, specific curriculum differences, and any other characteristics shared by students in each class. Furthermore, the lack of blinding of subjects may have influenced the results with a positive expectation. There were also a number of irregularities in the study execution due to the constraints of incorporating the study into an ongoing curriculum. These included variable lengths of intervention, session frequency, duration of sessions, late acquisition of some outcome measures at end-treatment, and cancelled sessions.

The goal of this preliminary and exploratory study was to identify potential mental health characteristics that might be influenced by a yoga intervention; thus, while the above study limitations require caution in interpretation of results, a range of mental health constructs have been identified which may benefit from further study.

## Implications for Behavioral Health

The results of this study are particularly important and currently relevant given the association between psychosocial stressors and the risk of first incidence of mental health conditions in adolescents<sup>2</sup>. If future studies of the delivery of a yoga intervention to adolescents in the secondary school setting detect improvements in stress-related measures, this may prove to be a useful preventive/protective practice for mental health in adolescents. This is especially noteworthy given the lack of existing school resources dedicated to stress management and resilience enhancement. Further studies of yoga interventions in urban public schools with a variety of outcome measures and longer treatment protocols would fulfill a stated need to preventively treat what are initially mild child-adolescent disorders<sup>3</sup>.

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## References

1. Suldo SM, Shaunessy E, Hardesty R. Relationships among Stress, Coping, and Mental Health in High-Achieving High School Students. *Psychology in the Schools*. 2008;45:273–290.
2. Roberts RE, Roberts CR, Chan W. One-Year Incidence of Psychiatric Disorders and Associated Risk Factors among Adolescents in the Community. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. 2009;50:405–415.
3. Kessler RC, Wang PS. The Descriptive Epidemiology of Commonly Occurring Mental Disorders in the United States. *Annual Review of Public Health*. 2008;29:115–129.
4. Kraag G, Zeegers MP, Kok G, et al. School Programs Targeting Stress Management in Children and Adolescents: A Meta-Analysis. *Journal of School Psychology*. 2006;44:449–472.
5. Hampel P, Meier M, Kummel U. School-Based Stress Management Training for Adolescents: Longitudinal Results from an Experimental Study. *Journal of Youth and Adolescence*. 2008;37:1009–1024.
6. 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. *Medical Science Monitor*. 2005;11:CR555–CR561.
7. Granath J, Ingvarsson S, von Thiele U, et al. Stress Management: A Randomized Study of Cognitive Behavioural Therapy and Yoga. *Cognitive Behavioural Therapy*. 2006;35:3–10.
8. Khalsa SB, Cope S. Effects of a Yoga Lifestyle Intervention on Performance-Related Characteristics of Musicians: A Preliminary Study. *Medical Science Monitor*. 2006;12:CR325–CR331.
9. Khalsa SBS. Yoga as a Therapeutic Intervention: A Bibliometric Analysis of Published Research Studies. *Indian Journal of Physiology and Pharmacology*. 2004;48:269–285.
10. White LS. Yoga for Children. *Pediatric Nursing*. 2009;35:277–83, 295.
11. Birdee GS, Yeh GY, Wayne PM, et al. Clinical Applications of Yoga for the Pediatric Population: A Systematic Review. *Academic Pediatrics*. 2009;9:212–220.
12. Galantino ML, Galbavy R, Quinn L. Therapeutic Effects of Yoga for Children: A Systematic Review of the Literature. *Pediatric Physical Therapy*. 2008;20:66–80.
13. Angus SF. Three Approaches to Stress Management for Children. *Elementary School Guidance and Counseling*. 1989;23:228–233.
14. Saltzman A, Goldin P. Mindfulness-based Stress Reduction for School-Age Children. In: Greco LA, Hayes SC, Greco LA, Hayes SC, eds. *Acceptance and mindfulness treatments for children and adolescents: A practitioner's guide*. Oakland, CA US: New Harbinger Publications; 2008;139–161.
15. Jennings PA. Contemplative Education and Youth Development. *New Directions for Youth Development*. 2008;101–5, 9.
16. Thompson M, Gauntlett-Gilbert J. Mindfulness with Children and Adolescents: Effective Clinical Application. *Clinical Child Psychology and Psychiatry*. 2008;13:395–407.

17. Linden W. Practicing of Meditation by School Children and Their Levels of Field Dependence-Independence, Test Anxiety, and Reading Achievement. *Journal of Consulting and Clinical Psychology*. 1973;41:139–143.
18. Barnes VA, Pendergrast RA, Harshfield GA, et al. Impact of Breathing Awareness Meditation on Ambulatory Blood Pressure and Sodium Handling in Prehypertensive African American Adolescents. *Ethnicity and Disease*. 2008;18:1–5.
19. Barnes VA, Treiber FA, Davis H. Impact of Transcendental Meditation(R) on Cardiovascular Function at Rest and During Acute Stress in Adolescents with High Normal Blood Pressure. *Journal of Psychosomatic Research*. 2001;51:597–605.
20. Benson H, Wilcher M, Greenberg B et al. Academic Performance among Middle-School Students after Exposure to a Relaxation Response Curriculum. *Journal of Research and Development in Education*. 2000;33:156–165.
21. Rosaen C, Benn R. The Experience of Transcendental Meditation in Middle School Students: A Qualitative Report. *Explore (NY)*. 2006;2:422–425.
22. Wall RB. Tai chi and Mindfulness-Based Stress Reduction in a Boston Public Middle School. *Journal of Pediatric Health Care*. 2005;19:230–237.
23. Hopkins LJ, Hopkins JT. Yoga in Psychomotor Training. *Academic Therapy*. 1976;11:461–465.
24. Hopkins JT, Hopkins LJ. A Study of Yoga and Concentration. *Academic Therapy*. 1979;14:341–345.
25. 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 Development and Care*. 2005;175:371–377.
26. Ehud M, An BD, Avshalom S. Here and Now: Yoga in Israeli Schools. *International Journal of Yoga*. 2010;3:42–47.
27. Berger DL, Silver EJ, Stein RE. Effects of Yoga on Inner-City Children's Well-Being: A Pilot Study. *Alternative Therapies in Health and Medicine*. 2009;15:36–42.
28. Mendelson T, Greenberg MT, Dariotis JK, et al. Feasibility and Preliminary Outcomes of a School-Based Mindfulness Intervention for Urban Youth. *Journal of Abnormal Child Psychology*. 2010;38:985–994.
29. Reynolds CR, Kamphaus RW. *Behavior Assessment System for Children - Second Edition*. 2nd ed. Circle Pines, MN: AGS, 2004.
30. McNair DM, Lorr M, Droppleman LF. *Manual for the Profile of Mood States*. San Diego: Educational and Industrial Testing Services, 1992.
31. Wagnild GM, Young HM. Development and Psychometric Evaluation of the Resilience Scale. *Journal of Nursing Measurement*. 1993;1:165–178.
32. Ahern NR, Kiehl EM, Sole ML, et al. A review of instruments measuring resilience. *Issues in Comprehensive Pediatric Nursing*. 2006;29:103–125.
33. Cohen S. Perceived Stress in a Probability Sample of the United States. In: Spacapan S, Oskamp S, eds. *The Social Psychology of Health*. Sage Publications, Inc; 1988;31–67.
34. Kass JD, Friedman R, Leserman J, et al. An Inventory of Positive Psychological Attitudes with Potential Relevance to Health Outcomes: Validation and Preliminary Testing. *Behavioral Medicine*. 1991;17:121–129.
35. Quilty MT, Goldstein R, Khalsa SBS, et al. Yoga in the Real World: Motivations and Patterns of Use [abstract]. *Alternative Therapies in Health and Medicine* 2009;15:S154
36. Carskadon MA, Acebo C, Jenni OG. Regulation of Adolescent Sleep: Implications for Behavior. *Annals of the New York Academy of Sciences*. 2004;1021:276–291.