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An Evaluation of Yoga and Meditation to Improve Attention, Hyperactivity, and Stress in High-School Students

Kirti Saxena, MD,[1] Christopher D. Verrico, PhD,[1] Johanna Saxena, BS, BA,[1] Sherin Kurian, MD,[1] Stefanie Alexander, MD, PhD,[2] Ramandeep Singh Kahlon, MD,[1] Ruchir P. Arvind, MD,[3] Adam Goldberg, MD,[3] Nicholas DeVito, BA,[1] Mirza Baig, BS,[1] Anastasia Grieb, BS,[1] Jafar Bakhshaie, MD, PhD,[1] Alessio Simonetti, MD, PhD,[1,4] Eric A. Storch, PhD,[1] Laurel Williams, DO,[1] and Lex Gillan, BS[5]

Abstract

Objective: Problems with attention and stress are common in children and predict academic difficulties and other behavioral and emotional problems. Mind–body interventions such as yoga and meditation improve attention and reduce stress. In this study, we examined the impact of Hatha yoga on attention and stress in ninth graders.

Design: A total of 174 ninth graders from a Texas high school were enrolled in the study. Teachers assigned students to a yoga group (YG) or control group (CG) based on their class schedule. The YG participated in 25-min Hatha yoga classes twice weekly over 12 weeks ($n = 123$). The CG included 51 students. Student self-reports on measures of inattention and hyperactivity (the strengths and weaknesses of ADHD [attention-deficit/hyperactivity disorder] symptoms and normal behavior rating scale for ADHD) and stress (perceived stress scale) were obtained at baseline and at 12 weeks.

Results: There were no significant differences in baseline levels of inattention ($p = 0.86$), hyperactivity ($p = 0.25$), and perceived stress ($p = 0.28$) between the YG and CG. Regarding inattention scores, there was a significant interaction of group and time ($b = -1.09$, standard error [SE] $= 0.30$, $p < 0.001$). Pairwise t-tests showed a significant reduction in inattention for the YG ($d = 0.27$) but a significant increase in inattention for the CG. Regarding hyperactivity, there was no significant interaction of group and time ($b = -0.43$, SE $= 0.26$, $p = 0.1$). Pairwise t-tests demonstrated a significant reduction in hyperactivity for the YG ($d = 0.22$), but not the CG. The interaction of group and time was not significant in predicting the slope of change in perceived distress ($b = -0.93$, SE $= 1.19$, $p = 0.43$). Pairwise t-tests did not show a significant reduction in perceived distress for either group.

Conclusion: These findings suggest that Hatha yoga may improve attention and hyperactivity in high school students.

Keywords: yoga, high school students, attention, hyperactivity, stress

[1]Department of Psychiatry and Behavioral Sciences, Baylor College of Medicine, Houston, TX, USA.
[2]Department of Psychiatry and Behavioral Sciences, Vanderbilt University Medical Center, Nashville, TN, USA.
[3]Department of Psychiatry, University of Texas Health—McGovern Medical School, Houston, TX, USA.
[4]Department of Neurology and Psychiatry, Sapienza University of Rome, Rome, Italy.
[5]Institute for Spirituality and Health, Houston, TX, USA

Introduction

THE CONCEPT OF A ''COMPLETE EDUCATION'' is gaining popularity within schools worldwide. With focus on social, emotional, and physical wellbeing together with academic achievement, children and adolescents can acquire lifelong tools and skills to improve attention capacity and manage stress. Mind–body interventions, which utilize physical postures, breathing exercises, relaxation techniques, and meditation practices, produce overall improvements in wellbeing.[1–4]

For thousands of years, yoga has been taught and practiced throughout the world in various forms with the ultimate goal being the union of mind, body, and spirit.[5] The practice of yoga aims to develop and maintain good physical and mental health.[6–9] The six branches of yoga include Raja, Bhakti, Jnana, Karma, Mantra, and Hatha yoga. Hatha yoga encompasses the practices of physical postures, breathing exercises, and meditation.[5] Its goal was to develop strength and flexibility of the body, a calm and clear mind, and overall good health.[10–12] In the West, Hatha yoga is the most popular practice.[13]

Given the accessibility of yoga (i.e., can be offered without equipment) and its cost-effective nature (i.e., group format), schools are an ideal environment to incorporate this practice. Children spend most of their day at school, so yoga practice can be incorporated into the curriculum.[3,14] There are over 36 yoga-based programs utilized in more than 940 schools across the United States. Across programs, the length (i.e., number of weeks), number of sessions, session duration, and formality (i.e., school-based vs. self-motivated) vary.[1,15] However, the common theme across programs include physical posturing, breathing exercises, relaxation techniques, and mindfulness practices.

Khalsa and Butzer[1] reviewed 47 yoga studies conducted in elementary, middle, and high schools primarily in India and the United States. Comparison across studies was not possible as yoga interventions differed in length, number of sessions, session duration, and curricula across schools—from formal curricula to instructors creating their own. Furthermore, the methodological quality was low to moderate; there were often small sample sizes and a lack of control group. Yet, the implemented yoga classes have yielded both positive and negative outcomes.

Serwacki and Cook-Cottone[16] reviewed 12 quantitative school-based yoga studies and encountered similar methodological limitations. Yet, the school-based programs deemed beneficial for the students. Ferreira-Vorkapic et al.[17] reported the usefulness of school-based yoga to be uncertain because of few randomized controlled trials, methodological concerns, small sample sizes, lack of control groups, varying yoga interventions taught, and varying duration of yoga sessions. They found that positive and negative outcomes often cancelled each other out.

Some studies suggest that yoga may improve inattention, and early intervention techniques that diminish attention-deficit/hyperactivity disorder (ADHD) symptoms are important for favorable outcomes[18]; an 8-year longitudinal study[19] revealed that lower school retention rates, failure to graduate secondary school, and lower level academic performance were accurately predicted by inattention and hyperactivity symptoms. Sethi et al.[20] found that 60 low-income high school girls who participated in an integrated yoga module (IYM) for 5 days[21] had improved attention. Similarly, Sheela et al.[22] found improvements in sustained attention in 66 university students who also practiced an IYM. Thus far, self-reported outcomes on inattention and hyperactivity in high school students participating in a school-based yoga intervention have not been studied.

In addition, the presence of life stressors are a consistent predictive factor for the emergence of mental health conditions.[23,24] Given that many adults report the onset of their own mental health problems during childhood and adolescence, addressing these problems at a young age is particularly important.[1,25]

Positive findings have emerged suggesting that yoga may reduce stress. West et al.[26] found significant reductions in perceived stress scores of 18 college students who practiced Hatha yoga compared with students who had participated in physical exercise. Among 14- to 15-year-old students in India, those students with lower stress scores and practiced yoga performed significantly better in academics.[27]

However, the current body of literature around school-based yoga is fewer than 20 years old, and is oftentimes inconclusive due to varying methodologies of studies. There is no consensus on dose of yoga intervention across age groups, fidelity of implementing the intervention, and the measurement of long-term outcomes. Even the highest quality studies yield both positive and negative results.[17]

The aim of this study was to determine the impact of a Hatha yoga and meditation intervention on self-reported measures of inattention, hyperactivity, and stress in ninth graders. We hypothesized that in comparison with students in the control arm, those receiving yoga for 25 min twice a week for 12 weeks would report improved inattention and hyperactivity and decreased stress.

Methods

Study participants

The local school district and the Institutional Review Board (IRB) at Baylor College of Medicine approved this study. The teachers assigned ninth graders to two groups, yoga group (YG) or control group (CG), and selected those students in the second-period health science class to participate in the YG. The yoga classes took place in the morning during the students' health science class, a required course for all ninth graders. The students enrolled in a health science class at a different time of day constituted the CG.

Every student received a parental consent and a child assent form that informed the minimal risks and that participation is voluntary. Each student read and signed the assent form demonstrating their own understanding of and willingness to participate in the study. Parents of each student read and signed the consent form to approve their child's participation in the study. Only those students with signed consent and assent forms were enrolled. In total, 184 students provided consent for the study. Demographics of our sample are given in Table 1. Of that group, 174 ninth-grade students completed the baseline and post measurements, with 123 students in the YG and 51 students in the CG.

Hatha yoga intervention

The yoga classes consisted of 25-min sessions of Hatha yoga and meditation, twice per week for 12 weeks. Each

Table 1. Demographics

	Yoga group (N = 123), n (%)	*Control group (N = 51), n (%)*	p
Sex			
Female	74 (60.2)	38 (74.5)	0.07
Male	49 (39.8)	13 (24.5)	
Age (mean years ± SD)	14.73 ± 0.41	14.84 ± 0.47	0.79
Race			
Asian	37 (30)	13 (26)	0.48
African American	22 (18)	14 (27)	
Caucasian	58 (47)	22 (43)	
Other	6 (5)	2 (4)	
Ethnicity			
Hispanic or Latino	43 (35)	18 (36)	0.90
Not Hispanic or Latino	80 (65)	32 (64)	

SD, standard deviation.

lesson consisted of 18 min of yoga poses and 7 min of meditation. The classes were led by a yoga instructor (L.G.) with 46 years of experience who was assisted by five yoga instructors. L.G. composed a 12-lesson curriculum intended for daily yoga and meditation practice during and outside class, which was provided to the YG in a written format. All the yoga instructors are nationally certified by L.G. and registered with the YogaALLIANCE at the Registered Yoga Teacher level (200 h) and the National Association of Certified Yoga Teacher 200 h level.

All yoga instructors followed the curriculum by L.G. However, the consistency in teachings was not objectively measured. Therefore, intervention fidelity data are lacking, which is a limitation to this study.

Outcome measures

One week before the beginning of the study and week 12 of the study, each student completed self-report questionnaires.

The strengths and weaknesses of ADHD symptoms and normal behavior rating scales. The strengths and weaknesses of ADHD symptoms and normal behavior (SWAN) is an 18-item questionnaire, consisting of two 9-item subscales: an inattentive subscale (IA; items 1–9) and a hyperactive/impulsive subscale (HI; items 10–18). The scores range from 0 to 18 (Refs.[28,29]). A score of six or greater on the IA indicates ADHD—inattentive type, the HI indicates ADHD—hyperactive/impulsive type, and both the IA and HI indicate ADHD—combined type.

The SWAN self-report was used in 2763 adolescents (13–17 years) in a study at the Ontario Science Centre in Toronto, Canada,[30] where self-report versions of the SWAN included the same 18 items, but with reference to ''your child'' instead of ''me.'' High internal consistency of the SWAN has been reported,[31,32] which was confirmed by this study. The SWAN-self in adolescents has good sensitivity and specificity for diagnosis, high internal consistency, and good convergence with the Conners–Wells' Adolescent Self-Report Scales.[33]

Perceived stress scale. The perceived stress scale (PSS) is a widely used instrument for measuring the perception of stress. This 10-item scale assesses the degree to which situations in one's life are appraised as stressful. Items tap into how unpredictable, uncontrollable, and overloaded respondents have found their lives within the past month. Scores on the PSS can range from 0 to 40: scores ranging from 0 to 13 are considered low stress, 14 to 26 moderate stress, and 27 to 40 high perceived stress.[34] The PSS had sufficient internal reliability with a Cronbach's α of 0.68. A mean composite of perceived stress was subsequently created. The scale has high internal consistency and test–retest reliability.[34] Studies with children have used the PSS, but it is yet to be statistically validated in children.[25,35–38]

Yoga and meditation questionnaire

We created an IRB-approved self-assessment questionnaire for the yoga and meditation practice (Table 2), which was distributed after the 12-week intervention. Our aim was to understand which component of the practice the students most liked, so we divided the questionnaire into yoga and meditation practice.

Data analyses

Data analysis was conducted using SPSS version 24. First, data were examined for normality and presence of outliers. No outliers were detected, and none of the variables showed highly non-normal distributions.[39] Next, sample descriptive statistics and a series of *t*-tests and chi-square tests were conducted to examine differences across the treatment groups regarding demographic characteristics and baseline levels of each dependent variable. The powers of these tests considering the sample size were all >0.8.

The primary statistical analyses included multilevel modeling with the scores on the scales/subscales of inattention, hyperactivity, and stress as the dependent variables, and time (baseline—1 week before classes started—and week 12) and group (YG vs. CG) as the two independent variables. The models included two levels, where repeated assessments across time (level 1; time) were nested within participants (level 2; group). The baseline levels of perceived stress were controlled for models with inattention and hyperactivity as dependent variables. The estimation of missing data in the models was based on restricted maximum-likelihood estimation. Satterthwaite approximation was used to calculate the degrees of freedom.[40]

Post hoc moderation analyses were also conducted to examine the moderator role of baseline levels of perceived

Table 2. Yoga and Meditation Questionnaire

Self-assessment questionnaire for yoga meditation and practice	
1	Did yoga help you in any way? In a sentence, please tell us how yoga was helpful
2	How many times did you practice yoga at home?
3	Will you continue yoga?
4	Did meditation help you in any way? In a sentence, please tell us how meditation was helpful
5	How many times did you practice meditation at home?
6	Will you continue meditation?

Table 3. Average Scores

Variable	Mean (±SD)	
	Baseline	Week 12
Yoga		
ADHD inattentiveness	2.11 (±2.001)	1.57 (±1.904)
ADHD hyperactive	1.80 (±1.949)	1.39 (±1.795)
PSS	17.76 (±7.775)	17.41 (±7.761)
Control		
ADHD inattentiveness	2.06 (±1.964)	2.67 (±2.197)
ADHD hyperactive	1.45 (±1.474)	1.51 (±1.837)
PSS	19.10 (±6.703)	19.92 (±7.256)

ADHD, attention-deficit/hyperactivity disorder; PSS, perceived stress scale; SD, standard deviation.

stress for the effect of group membership on the slope of change in inattention and hyperactivity. Furthermore, the perceived helpfulness of yoga and meditation (a mean score derived from separate reports on yoga and meditation perceived helpfulness) and amount of yoga and meditation practice at home (a mean score derived from separate reports on yoga and meditation practiced at home) were examined as moderators of the relationships between the effect of time on inattention and hyperactivity, after controlling for baseline levels of perceived stress. Similar *post hoc* analyses were conducted for perceived stress as a dependent variable with no control variables. Cohen's d[41] was reported as estimates of effect size.

Results

Chi-square tests revealed no significant group differences in gender ($p=0.07$), race, ($p=0.48$), or ethnicity ($p=0.90$). A two-tailed t-test revealed no significant group difference in age ($p=0.79$) (Table 1). The t-test comparisons did not show any significant differences regarding the baseline levels of inattention ($p=0.86$), hyperactivity ($p=0.25$), and perceived stress ($p=0.28$) between the yoga and control groups. See Table 3 for average scores.

Inattention and hyperactivity

Regarding the change in the score of SWAN subscale of inattention, after controlling for baseline levels of perceived stress, there was a significant interaction of group and time ($b=-1.09$, standard error [SE] $=0.30$, $p<0.001$). Pairwise t-tests showed a significant reduction in inattention for YG ($t=3.239$, $p=0.002$; Cohen's $d=0.27$) and a significant increase in inattention for the CG ($t=-2.574$, $p=0.013$) (Fig. 1). *Post hoc* analysis did not show a significant moderator effect for perceived stress in the relationship ($b=-0.02$, SE $=0.04$, $p=0.66$). There was also no significant moderator effect for the perceived helpfulness and home practice of intervention for the effect of time on inattention within the YG ($b=0.32$, SE $=0.61$, $p=0.59$, and $b=0.10$, SE $=0.23$, $p=0.65$, respectively).

For predicting the change in the SWAN subscale of hyperactivity, after controlling for baseline levels of perceived stress, there was no significant interaction of group and time ($b=-0.43$, SE $=0.26$, $p=0.1$). Pairwise t-tests demonstrated a significant reduction in hyperactivity for the YG ($t=2.670$, $p=0.009$; Cohen's $d=0.22$), but not the CG ($t=-0.323$, $p=0.748$) (Fig. 2). *Post hoc* moderator analysis did not support the moderator role of perceived stress ($b=0.03$, SE $=0.04$, $p=0.43$). Neither perceived helpfulness nor home practice of intervention moderated the effect of time on hyperactivity within the YG group ($b=-0.14$, SE $=0.56$, $p=0.79$, and $b=0.22$, SE $=0.21$, $p=0.30$, respectively).

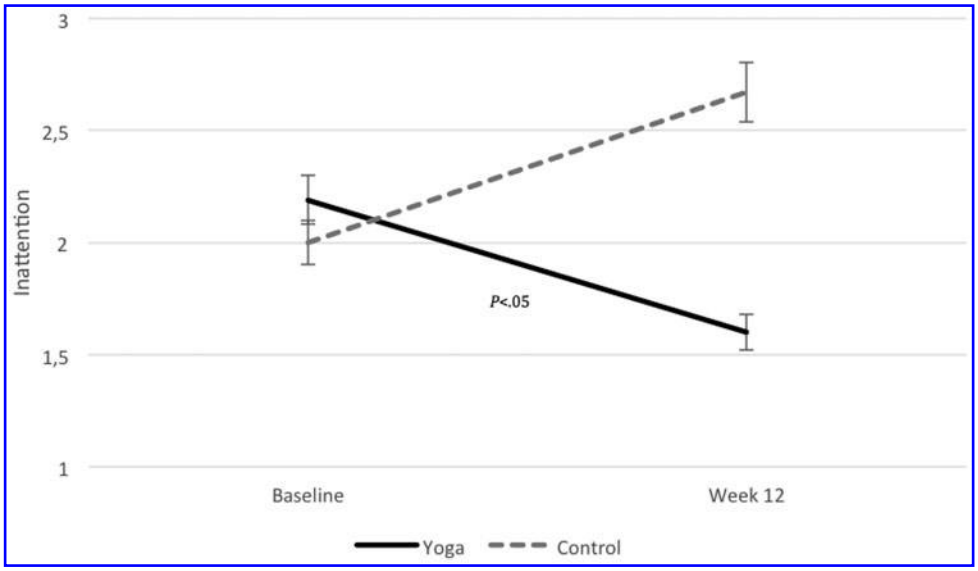

FIG. 1. SWAN rating scale for ADHD—inattention. At baseline, the average scores for the YG (2.11 ± 2.001) and the CG (2.06 ± 1.964) were comparable ($p=0.86$). At week 12, the average scores of the YG (1.57 ± 1.904) and the CG (2.67 ± 2.197) were significantly different ($p<0.001$). Within the YG, the average scores significantly decreased ($d=0.27$). Within the CG, the average scores significantly increased ($p=0.013$). ADHD, attention-deficit/hyperactivity disorder; CG, control group; SWAN, the strengths and weaknesses of ADHD symptoms and normal behavior; YG, yoga group.

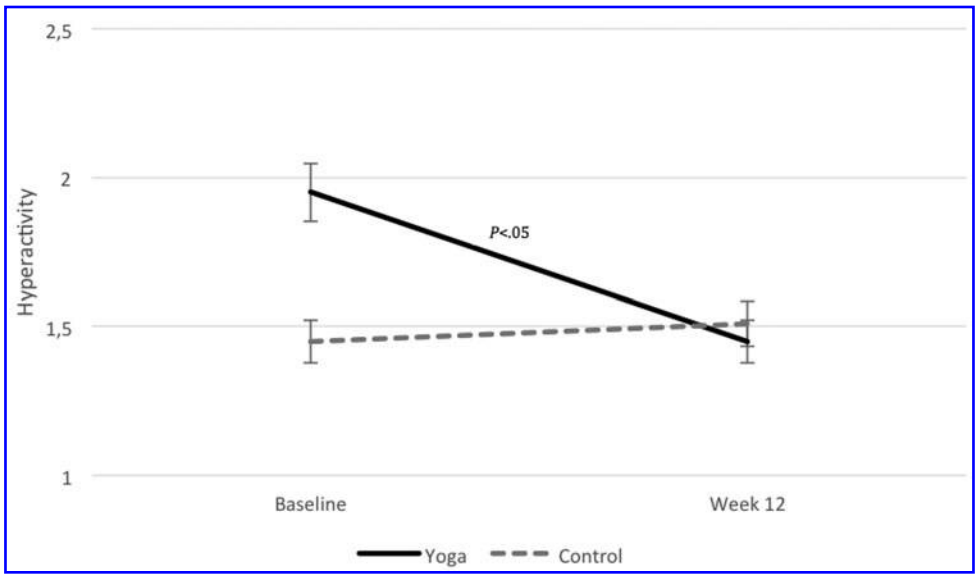

FIG. 2. SWAN rating scale for ADHD—hyperactivity. At baseline, the average scores for the YG (1.80 ± 1.949) and the CG (1.45 ± 1.474) were not significantly different ($p = 0.25$). At week 12, the average scores of the YG (1.39 ± 1.795) decreased from baseline significantly ($d = 0.22$) and the CG average scores somewhat increased (1.51 ± 1.837). ADHD, attention-deficit/hyperactivity disorder; CG, control group; SWAN, the strengths and weaknesses of ADHD symptoms and normal behavior; YG, yoga group.

Perceived stress scale

The interaction of group and time was not significant in predicting the slope of change in perceived stress ($b = -0.93$, SE = 1.19, $p = 0.43$). Pairwise *t*-tests did not show a significant reduction in perceived stress for either YG ($t = 0.223$, $df = 118$, $p = 0.824$) or CG ($t = -0.604$, $df = 49$, $p = 0.549$) (Fig. 3). Perceived helpfulness and home practice of intervention did not moderate the effect of time on change in perceived stress ($b = -1.11$, SE = 1.90, $p = 0.56$, and $b = 0.70$, SE = 0.73, $p = 0.34$, respectively).

Yoga and meditation questionnaire

Eighty-seven students completed this questionnaire. The majority of students reported the practice of yoga (65.5% of students) and meditation (74.1% of students) to be helpful, stating it ''gave them a chance to relax, calm down, and relieve stress.'' Further results of the survey are given in Tables 4 and 5.

Discussion

This 12-week study aimed to determine the effectiveness of 24 Hatha yoga sessions in improving attention and hyperactivity, and decreasing stress in ninth graders. Studies have reported benefits in high school students who practiced yoga for 10–18 weeks one to five times per week. This study design is within these parameters: high school students, 12-week intervention conducted two to three times per week.[42] Results from this study indicate reduced inattention and hyperactivity in those students who participated in the Hatha yoga practice in comparison with the students in the CG.

In this study, the PSS assessed students' stress levels before and after the Hatha yoga practice and, no significant differences were found over time or in comparison with the CG. The final yoga session and the rating scales were administered about 2 weeks before the end of semester examinations, which may have contributed toward no significant differences in the stress levels between the two groups. Other studies yielded similar results. For example, Noggle

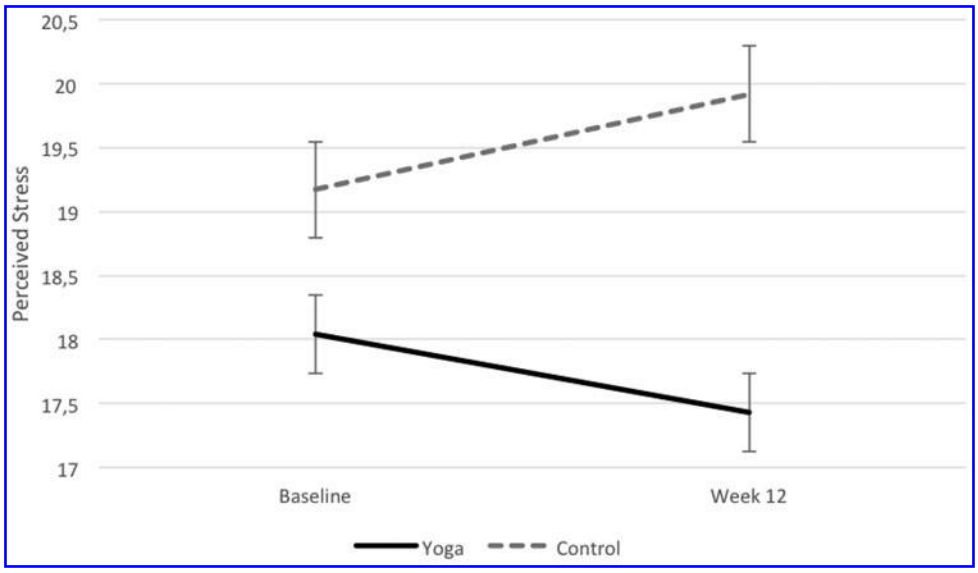

FIG. 3. Perceived stress. At baseline, the average scores for the YG (17.76 ± 7.775) and the CG (19.10 ± 6.703) were not significantly different ($p = 0.28$) At week 12, the YG scores somewhat decreased to 17.41 ± 7.761 and the CG somewhat increased to 19.92 ± 7.256. There was no significant difference found within or between groups. CG, control group; YG, yoga group.

Table 4. Yoga and Meditation Perceived Helpfulness

	Yoga was helpful	*Yoga was NOT helpful*	*TOTALS*
Meditation was helpful	49	16	65
Meditation was NOT helpful	8	14	22
TOTALS	57	30	87

et al.[37] found no statistically significant differences in PSS scores between yoga ($n=36$) and PE-as-usual ($n=15$) groups after 28 sessions over 10 weeks. Khalsa et al.[25] also did not find significant reductions in PSS scores in high school students (67 yoga and 33 controls) that participated in two to three yoga classes per week.

Potential reasons for different findings across studies are several. For instance, the frequency, amount, and duration of sessions across studies have differed. In addition, there is no standardized curriculum currently outlining what dose and for how long yoga needs to be taught for results to be deemed generalizable.

Clinical significance

Results from the SWAN self-report were not in the clinically significant range as none of the mean scores were above 6 (Table 3). Nonetheless, with the practice of Hatha yoga, inattention and hyperactivity symptoms diminished. In a clinical context, Hatha yoga, if practiced consistently, might be a tool that could delay or potentially prevent onset of a clinical diagnosis of ADHD.

This study was not designed for clinical outcomes, but can serve as a preliminary assessment of stress levels that may warrant clinical intervention. All our students' mean scores fell in the moderate stress range (Table 3). With the practice of Hatha yoga, the PSS scores from the YG did decrease, whereas the scores from the CG increased, but neither change was significant. Perhaps if their practice had been extended past 12 weeks, the decrease in stress levels may have reached significance.

Limitations

There are several limitations. First, students were not randomly assigned to groups. Second, students in the yoga group only participated in 25-min sessions. Most studies have reported benefits from longer sessions. In our case, 45 min were allotted for the yoga session, however the transit time between classes shortened the available time for yoga practice. Third, although it was emphasized that the yoga exercises should be practiced daily, there was no objective way that assessed whether this practice occurred. Fourth, objective ratings from teachers on student outcomes were not assessed. Finally, our yoga class size was about 50 students, whereas data from other studies suggest that smaller yoga classes (i.e., 10 or fewer students per class) yield improvements.[43]

Table 5. Yoga and Meditation Continuation

	Will continue yoga	*Will NOT continue yoga*	*TOTALS*
Will continue meditation	26	20	46
Will NOT continue meditation	5	36	41
TOTALS	31	56	87

Conclusions

Within these limitations, this study adds to the literature because it shows feasibility of a Hatha yoga practice in a school setting with positive outcomes for the students, particularly in improving inattention and hyperactivity. However, several important questions remain to be answered. Indeed, for the best possible benefits, the optimal dose for the yoga intervention and frequency and duration of practice still need to be determined. Furthermore, use of more objective outcomes including both symptomology and functional outcomes is needed. In summary, school is an ideal place to teach the practice of yoga. It is a skill and tool that can be incorporated into the daily routine of students to improve academic performance and mitigate stress.

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Author Disclosure Statement

The authors declare that they have no conflicts of interest to disclose.

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Address correspondence to:
Kirti Saxena, MD
Department of Psychiatry and Behavioral Sciences
Baylor College of Medicine
8080 North Stadium Drive, Suite 180.35
Houston, TX 77054
USA

E-mail: kirti.saxena@bcm.edu

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