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Issue: *Advances in Meditation Research***Yoga in school settings: a research review**Sat Bir S. Khalsa<sup>1,2</sup> and Bethany Butzer<sup>2</sup><sup>1</sup>Division of Sleep Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts. <sup>2</sup>Kripalu Center for Yoga & Health, Stockbridge, Massachusetts

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Research on the efficacy of yoga for improving mental, emotional, physical, and behavioral health characteristics in school settings is a recent but growing field of inquiry. This systematic review of research on school-based yoga interventions published in peer-reviewed journals offers a bibliometric analysis that identified 47 publications. The studies from these publications have been conducted primarily in the United States ( $n = 30$ ) and India ( $n = 15$ ) since 2005, with the majority of studies ( $n = 41$ ) conducted from 2010 onward. About half of the publications were of studies at elementary schools; most (85%) were conducted within the school curriculum, and most (62%) also implemented a formal school-based yoga program. There was a high degree of variability in yoga intervention characteristics, including overall duration, and the number and duration of sessions. Most of these published research trials are preliminary in nature, with numerous study design limitations, including limited sample sizes (median = 74; range = 20–660) and relatively weak research designs (57% randomized controlled trials, 19% uncontrolled trials), as would be expected in an infant research field. Nevertheless, these publications suggest that yoga in the school setting is a viable and potentially efficacious strategy for improving child and adolescent health and therefore worthy of continued research.

**Keywords:** yoga; meditation; schools; education; mind–body; prevention

**Introduction**

Adolescents and children in the United States are confronted with a large number of life stressors from both family and school environments,<sup>1</sup> many of which are known risk factors for the development of mood and other psychological disorders.<sup>2</sup> A survey study on the prevalence of psychiatric conditions in adolescents reported that indicators of stress were the most consistent predictors of the incidence of psychiatric disorders.<sup>3</sup> A recent longitudinal survey following children from ages 9 to 21 found that the cumulative prevalence of psychiatric conditions well exceeds 80% and is therefore virtually universal.<sup>4</sup> Another survey in adults has indicated that the majority of psychiatric conditions have childhood/adolescent onsets.<sup>5</sup> There is therefore a strong need for children and adolescents to acquire behavioral skills that can improve social–emotional learning (SEL), such as stress management and emotional self-regulation. Despite historical arguments dating back over 100 years for the

education of the whole child in school (i.e., mental, emotional, and physical health skills, in addition to academic skills),<sup>6</sup> it is clear that this has not occurred. There is now growing evidence that both academic and cognitive achievements are affected by, and dependent on, student health.<sup>7</sup> However, the education system is under ongoing and continuous pressure to remain focused on student academic performance, with few resources and efforts devoted to instruction in SEL skills. As a consequence, adolescents complete their K–12 education with the training sufficient for securing employment in the workforce, but lack crucial and preventive SEL skills for maintaining their mental health and well-being.<sup>8</sup>

However, the promotion of SEL in U.S. schools has made significant initial progress with the activities of the Collaborative for Academic, Social, and Emotional Learning (CASEL), whose goal is to address problematic behaviors of children and adolescents and their underlying contributing causes, while still supporting academic achievement

in public schools.<sup>9</sup> The recently published CASEL Guide describes existing evidence-based SEL programs that CASEL has determined are worthy and have the potential for broad implementation.<sup>10</sup> The stated CASEL goal of SEL programs is to enhance core competencies in the following five areas: self-management (emotions, including stress), self-awareness (recognizing emotions and having awareness of their influence on behavior), social awareness (appreciating the perspectives of others), relationship skills (establishing and maintaining functional relationships), and responsible decision making (making positive choices about behavior and social interactions).<sup>10</sup> There is currently a call for such initiatives by many educators, parents, and students to provide more in our educational curricula than just academic instruction.<sup>8,9,11,12</sup>

Yoga is a holistic system of practices that, in its traditional form, includes multiple techniques, including physical postures/exercises, breathing exercises, deep relaxation techniques, and meditation/mindfulness practices. Biomedical and psychosocial research on the clinical efficacy of yoga for both adults and children has been growing rapidly in recent years, especially over the past 5 years,<sup>13</sup> and systematic research reviews have suggested that yoga is particularly efficacious for reducing stress and enhancing mood and well-being.<sup>14,15</sup> The therapeutic application of yoga has also been shown to be viable for children and adolescents in improving both physical and mental health.<sup>16–20</sup> Three particular skills or attributes that yoga enhances include mind–body awareness, self-regulation, and physical fitness, which can subsequently promote improvements in mental state, health, behavior, and performance.<sup>21</sup> Through the practice of meditation and mindfulness, mind–body awareness is increased, which contributes to gravitation toward positive behaviors and outcomes as a result of an increasing awareness of the positive feelings associated with healthful behaviors. There is now strong neurobiological evidence for the efficacy of yoga in improving stress management, resilience, and self-regulation of internal state, including emotion regulation.<sup>22</sup> Finally, several aspects of physical fitness, including neuromuscular coordination and strength, flexibility, balance, and respiratory function, are directly improved following yoga practice over time.<sup>23,24</sup> These three core attributes (mind–body awareness, self-regulation, and physical

fitness), with their subsequent positive outcomes on student behavior, mental state, health, and performance, yield many of the improvements targeted by school-based SEL programs. They also likely satisfy the five SEL program goals, while also adding additional important life skills and competencies. Although programs consisting only of meditation/mindfulness practices provide a key and important component of yoga, it could be argued that the additional physical practices of yoga may enhance and facilitate meditation/mindfulness while, at the same time, improving psychophysiological functioning.<sup>25</sup> The physical postures/exercises, breath regulation, and relaxation techniques practiced in yoga may be especially relevant in supporting contemplative/meditative/mindfulness practice in youth, who exhibit high levels of psychophysiological energy and arousal and are not accustomed to sitting in the stillness required for formal meditation for long periods of time. In summary, there is a compelling rationale for the implementation of yoga in school settings.<sup>11,21</sup>

Accordingly, there has been substantial and growing interest in the development and application of meditation- and yoga-based interventions in school settings.<sup>11,25,26</sup> Hyde<sup>27</sup> has described recent government initiatives aimed at educating the “whole child” and suggests that the implementation of yoga in school settings is an important aspect of this movement. A number of organizations have been founded and are active in supporting these initiatives, including the Garrison Institute, the Association for Mindfulness in Education, the International Association for School Yoga and Mindfulness, and the Yoga Service Council, which has published a white book delineating the best practices for yoga in schools.<sup>28</sup> The prevalence of meditation- and mindfulness-based interventions in schools has grown substantially, including programs such as MindUP, the Quiet Time Program, and Learning to BREATHE, among many others.<sup>25</sup> The implementation of yoga in school settings is also growing,<sup>29</sup> as shown by our recent survey of formally organized yoga programs in school settings, which revealed three dozen such programs currently being implemented across North America in over 900 schools, and over 5400 instructors trained by these programs to offer yoga in educational settings.<sup>30</sup> Despite significant variability in the characteristics of implementation among

different school yoga programs, including differences in training requirements, geographical regions served, age ranges, and schools, most of these programs share the traditional implementation of the four basic elements of yoga (physical postures/exercises, breathing practices, relaxation techniques, and mindfulness/meditation). In addition, many programs also include a variety of educational, social–emotional, and didactic techniques designed to further improve mental and physical health and behavior. The Yoga Service Council white book is a useful contribution in this regard.<sup>28</sup>

A significant and growing body of published research studies is now in existence on the efficacy of contemplative meditation-based programs in schools.<sup>25</sup> A recent meta-analysis of such programs examined 24 studies, 19 of which were controlled trials, and found a small-to-medium effect size of 0.40 between groups. The effects were strongest for outcomes related to cognitive performance, followed by outcomes related to resilience and stress. Limitations included a large degree of heterogeneity between studies, small sample sizes, and a lack of active control groups; however, the authors concluded that “mindfulness-based interventions in children and youths hold promise, particularly in relation to improving cognitive performance and resilience to stress.”<sup>31</sup> Similarly, a recent systematic review and analysis of 28 studies of mindfulness-based interventions in school settings suggests that these interventions show promise for improving educational and psychosocial outcomes.<sup>32</sup> For example, school-based mindfulness interventions were associated with decreased psychopathology, increased prosocial attributes, and beneficial physiological outcomes. With regard to research methodology, Felver *et al.*<sup>32</sup> found that the majority of studies used relatively large sample sizes (with an average of over 100 participants per study) and examined a relatively even distribution with respect to gender, age, and school grade. However, only half of the studies used a comparison group, only one-third used random assignment, and most studies relied on student self-report outcomes. In summary, while preliminary research suggests benefits of school-based mindfulness interventions, several limitations related to research design, subject characteristics, intervention characteristics, and outcomes need to be addressed. For example,

more randomized controlled trials with larger sample sizes, objective physiological measures, longer interventions, and long-term follow-up evaluations would allow stronger claims of efficacy.

The aforementioned systematic review and meta-analysis provide a relatively thorough examination of research on school-based mindfulness interventions; however, few studies have attempted to thoroughly review the current literature on school-based yoga interventions. Therefore, the current review addresses this limitation by presenting a bibliometric analysis of peer-reviewed research on yoga in school settings.

### **Review of research on school-based yoga interventions**

Relevant studies were identified through literature searches of PubMed and PsycINFO, using a variety of search terms (e.g., “yoga,” “school,” “education,” “contemplative,” “classroom”). Studies were also identified through communication with experts in the field and by examining the bibliographies of a recent systematic review<sup>33</sup> and meta-analysis<sup>34</sup> of yoga in schools. Non-peer-reviewed studies, including doctoral dissertations, were not included. Studies of school-based mindfulness and/or meditation programs were only included if the intervention explicitly incorporated yoga-based postures and/or breathing exercises. Studies in which children were drawn from a school for a therapeutic clinical trial and the intent was not the evaluation of yoga in the school setting in general, or in which yoga practice was a relatively small component of the intervention, were also excluded.

A total of 47 publications met the search criteria and were analyzed<sup>35–81</sup> (Table 1). Publications of therapeutic clinical trials conducted in a school setting but not included in the analysis included studies of yoga in students with special educational needs or disabilities and/or emotional, behavioral, and learning difficulties, including attention deficits and autism spectrum disorders,<sup>82–92</sup> visual impairment,<sup>93,94</sup> asthma,<sup>95</sup> poor coordination,<sup>96</sup> and mental retardation.<sup>97</sup> Two studies in which yoga practice was a relatively small component of the intervention were also not included.<sup>98,99</sup> The studies in the analyzed publications were conducted mostly in elementary school settings ( $n = 18$ ), followed by high school ( $n = 13$ ), middle school ( $n = 7$ ), and one preschool within an elementary school

**Table 1. Review of research on yoga in schools**

First author	Year	Ref.	Study design	SS	School grade	School venue	Dur (weeks)	No. of sessions	Session dur (min)	Program content	Country
Manjunath	2001	35	RCT	20	MS	IS	4	30	75	Postures, breathing, kriyas, meditation, chanting, relaxation	India
Raghuraj	2003	36	RCT	32	ES	IS	4	30/30	30/45	Postures, breathing, kriyas, meditation, relaxation	India
Napoli	2005	37	RCT	194	ES	IS	24	12	45	Attention Academy Program	USA
Stueck	2005	38	NRT	48	ES	AS	NA	15	60	Training of relaxation with elements of yoga for children	Germany
Rangan	2008	39	NRT	98	MS	IS	1 year	2× daily	45/15	Gurukula Education System	India
Scime	2008	40	NRT	135	ES	AS	10	10	90	Yoga (unspecified), interactive discourse, guided imagery, relaxation	USA
Berger	2009	41	NRT	71	ES	AS	12	12	60	Bent on Learning	USA
Kauts	2009	42	NRT	301	HS	IS	7	Daily	60	Postures, breathing, meditation, prayer, values	India
Case-Smith	2010	43	QLT	21	ES	IS	8	8 & 32	45/15	Postures, movement, breathing, meditation, music, guided imagery	USA
Ehud	2010	44	UCT	122	ES	IS	16	13	NA	Here and Now: Yoga in School	Israel
Mendelson	2010	45	RCT	97	MS	IS	12	48	45	Holistic Life Foundation	USA
Ramadoss	2010	46	NRT	557	HS	IS	18	18–90	15	Transformative Life Skills	USA
Dubey	2011	47	RCT	50	HS	IS	2	15	90	Postures, breathing, chanting, yogic jogging, laughter	India
Chaya	2012	48	RCT	190	ES	IS	12	6/week	45	Postures, breathing, meditation	India
Gould	2012	49	RCT	97	ES	IS	12	48	45	Holistic Life Foundation	USA
Khalsa	2012	50	RCT	109	HS	IS	11	23–32	30/40	Yoga Ed.	USA
Noggle	2012	51	RCT	51	HS	IS	10	28	30	Kripalu Yoga in the Schools	USA
White	2012	52	RCT	155	ES	AS	8	8	60	Mindful Awareness for Girls Through Yoga	USA
Bhardwaj	2013	53	RCT	44	ES/MS	IS	4	6/week	35	Postures, breathing, relaxation	India
Conboy	2013	54	QLT	28	HS	IS	12	32	30	Kripalu Yoga in the Schools	USA
Hagins	2013	55	RCT	30	MS	IS	15	45	50	Postures, breathing, meditation, relaxation	USA
Klatt	2013	56	UCT	41	ES	IS	8	8	45	Move into Learning	USA

*Continued*

**Table 1. Continued**

First author	Year	Ref.	Study design	SS	School grade	School venue	Dur (weeks)	No. of sessions	Session dur (min)	Program content	Country
Sarokte	2013	57	RCT	90	MS/HS	IS	12	Daily	NA	Postures, breathing	India
Sethi	2013	58	UCT	60	HS	IS	1	5	180	Integrated Yoga Module	India
Telles	2013	59	RCT	98	ES/MS	IS	12	60	45	Postures, breathing, chanting, relaxation	India
Bothe	2014	60	RCT	25	ES	IS	16	Daily	10	Stress management intervention	USA
Chen	2014	61	UCT	661	ES/MS	IS	52	Daily	5–15	Yoga Ed.	USA
D’Souza	2014	62	RCT	91	ES	IS	12	60	45	Postures, breathing, meditation	India
Frank	2014	63	UCT	49	HS	IS	16	48	30	Transformative Life Skills	USA
Haden	2014	64	RCT	30	MS	IS	12	36	90	Postures, breathing, meditation, relaxation	USA
Miller	2014	65	QLT	10	HS	IS	7	20	50	Be BOLD mindful yoga program—hatha vinyasa flow	USA
Pandit	2014	66	RCT	171	ES/MS	IS/AS	12	12	NA	Postures, breathing, chanting, daily home practice	India
Parker	2014	67	RCT	111	ES	IS	4	20	15	Master Mind Program	USA
Smith	2014	68	RCT	77	ES	AS	28	56	40	YogaKidz	USA
Verma	2014	69	RCT	71	ES/MS	IS	12	60	45	Postures, breathing, relaxation	India
Verma	2014	70	RCT	71	ES/MS	IS	12	60	45	Postures, breathing, relaxation	India
Bergen-Cico	2015	71	RCT	144	MS	IS	33	100	4	YogaKidz	USA
Bhardwaj	2015	72	UCT	100	HS	IS	13	78	30	Postures, breathing, mantra, yoga nidra	India
Butzer	2015	73	UCT	36	ES	IS	10	10	30	Yoga 4 Classrooms	USA
Butzer	2015	74	RCT	95	HS	IS	12	28 or 29	35–40	Kripalu Yoga in the Schools	USA
Dai	2015	75	UCT	33	ES	AS	12	24	NA	1–2 min meditation followed by 6–10 postures	USA
Daly	2015	76	RCT	37	HS	IS	16	48	40	Bent on Learning	USA
Felver	2015	77	UCT	47	HS	IS	3	15	35	Kripalu Yoga in the Schools	USA
Finnan	2015	78	QLT	NA	ES	IS	2 years	NA	40	YogaKidz	USA
Fishbein	2015	79	RCT	85	MS/HS	IS	7	20	50	Be BOLD mindful yoga program—hatha vinyasa flow	USA
Quach	2015	80	RCT	172	MS	IS	4	8	45	Shanti Generation Yoga	USA
Razza	2015	81	NRT	29	PS	IS	25	Daily	10–30	YogaKids	USA

UCT, uncontrolled trial; NRT, controlled trial without randomization; RCT, randomized controlled trial; QLT, qualitative methods study; SS, total sample size all arms; ES, elementary school; MS, middle school; HS, high school; PS, preschool; IS, in school; AS, after school; Dur (weeks), intervention duration in weeks; Sess dur (min), session duration in minutes; NA, not available.

( $n = 1$ ), with the remaining studies examining a combination of grades, primarily elementary and middle school ( $n = 6$  in both elementary and middle school;  $n = 2$  in both middle and high school). Sample sizes (calculated as the total sample of all subjects in all arms completing the intervention) were often small within individual studies, with a median of 74 and a range of 20–660 in the quantitative studies. The majority of studies were conducted in the United States ( $n = 30$ ), followed by India ( $n = 15$ ), Israel ( $n = 1$ ), and Germany ( $n = 1$ ). The earliest studies were conducted in India and published from 2001 to 2003. In the 5-year interval from 2005 to 2009, there were six publications, and in the next 5-year interval from 2010 to 2014, the number of publications increased to 30, with 11 publications in 2015 alone. This trend is quite remarkable and suggests a rapid exponential increase in research in this field.

Overall, a slight majority of the studies were randomized controlled trials ( $n = 27$ ; 57%), seven (15%) were nonrandomized controlled trials, nine (19%) were uncontrolled studies, and four (9%) were qualitative examinations, suggesting that over half of the existing research on school-based yoga interventions has been conducted with the research trial design that is generally considered the strongest. However, it is important to note that the studies classified as randomized controlled trials varied in the rigor of randomization employed, with some studies being unclear on exactly how participants were randomly selected. Research in schools and with children has typically relied on self-report outcome measures, and the randomized control design is challenging to implement in school settings.

The vast majority ( $n = 40$ ; 85%) of the school-based yoga interventions in the current bibliometric analysis were delivered during school hours (as opposed to after or before school); however, there was a high degree of variability in yoga intervention characteristics. For example, intervention duration varied from 1 to 52 weeks; the total number of yoga sessions implemented varied from 5 to 100 sessions; and the individual session duration varied from 4 to 180 minutes. A majority of studies ( $n = 29$ ; 62%) implemented a formal school-based yoga program (e.g., Yoga 4 Classrooms; Kripalu Yoga in the Schools), with other researchers instead opting to create their own yoga interventions. This is not surprising given that a large number

of formal school-based yoga programs have been developed in the United States.<sup>30</sup>

This high level of heterogeneity makes it difficult to compare results across studies; however, research on school-based yoga interventions has generally yielded positive results. For example, Serwacki and Cook-Cottone<sup>33</sup> recently published a systematic review of studies on yoga in schools, which examined 12 published studies assessing programs applied within the school curriculum, after-school programs, and programs based within residential schools. Four studies were done with special-education students, while the others were completed with typically developing or at-risk youth. They found that most of these studies were conducted in U.S. elementary schools and study methodological quality was low to moderate. Limitations, such as a lack of randomization, small sample sizes, and limited detail on intervention characteristics, prevented the authors from drawing strong conclusions; however, the yoga programs in these studies were found to yield positive outcomes in factors such as emotional balance, attentional control, cognitive efficiency, anxiety, negative thought patterns, emotional and physical arousal, reactivity, and negative behavior. For example, children categorized as following an atypical developmental trajectory exhibited greater social and self-confidence, improved communication and contribution in the classroom, and improvements in attention and concentration following school-based yoga interventions. Children classified as following a typical developmental trajectory showed decreases in body dissatisfaction, anxiety, negative behavior, cognitive disturbances, emotional and physical arousal, and impulsivity, as well as increased perceived self-concept and emotional balance.

Similarly, Ferreira-Vorkapic *et al.*<sup>34</sup> recently conducted a systematic review of randomized controlled trials of school-based yoga interventions, in which they identified 48 published studies, nine of which were randomized controlled trials that met their inclusion criteria. Due to a high degree of heterogeneity between studies, the authors were only able to calculate effect sizes for outcomes that were collected across more than one study, which included measures of mood, tension, anxiety, self-esteem, and memory. The general effect size calculated across these measures for all such studies revealed that half of the studies favored

yoga, whereas the other half favored the control group; however, this overall effect size was not statistically significant, most likely due to the heterogeneity of the outcomes. Effect sizes calculated for each of the outcomes individually suggested that the results favored yoga for mood, tension, anxiety, self-esteem, and memory. The authors concluded that, while the results were promising, additional research needs to be conducted because of limitations such as small sample sizes, absence of control groups, and variability in the frequency and duration of yoga interventions.

Studies not evaluated by the abovementioned systematic review and meta-analysis have also described positive outcomes of yoga in school programs on self-reported measures, such as mood state;<sup>77</sup> self-control;<sup>46,67</sup> aggression and social problems;<sup>67</sup> self-regulation;<sup>71,81</sup> emotion regulation;<sup>76</sup> feelings of happiness and relaxation;<sup>75</sup> anxiety;<sup>51,60,63,67</sup> depression;<sup>63</sup> problematic stress responses;<sup>49</sup> self-esteem;<sup>58,59</sup> social and physical well-being;<sup>61</sup> general distress, physical arousal, and hostility;<sup>63</sup> rumination, emotional arousal, and intrusive thoughts;<sup>45,63</sup> alcohol use;<sup>79</sup> self-concept, tolerance, nonviolence, truthfulness, faith, fidelity, extra-aggression, ego defense, obstacle dominance, need persistence, and introgression of aggressive reactions;<sup>47</sup> overall, general, and social self-esteem;<sup>53</sup> positive health;<sup>66</sup> self-adjustment;<sup>72</sup> and working-memory capacity.<sup>80</sup> There have also been four qualitative studies of school yoga interventions that have noted benefits in the ability to focus, control behavior under stress, enhance a sense of calm, and increase self-esteem;<sup>43</sup> also noted was greater kinesthetic awareness, mood management, stress reduction, and social cohesion;<sup>54</sup> improved stress management;<sup>65</sup> and focus, perseverance, and positive relationships.<sup>78</sup> Taken together, these studies suggest positive effects of school-based yoga on student-reported psychosocial well-being.

However, as noted by other researchers, student reports, particularly self-report questionnaires, are limited in that they provide a narrow, and perhaps biased, perspective on student outcomes. This limitation has been addressed to some extent by studies that have examined teacher-rated characteristics and other objective outcome measures. These studies have reported positive outcomes in teacher-rated factors, including classroom behavior and social-emotional skills,<sup>73</sup> performance

impairment,<sup>88</sup> concentration, mood, ability to function under pressure,<sup>44</sup> hyperactivity,<sup>56</sup> social skills,<sup>79</sup> and attention.<sup>37</sup> Objective data collected from school records and academic tests have shown postintervention improvements in student grades<sup>74</sup> and academic performance.<sup>42</sup> Furthermore, physiological and cognitive outcome measures reported in a few studies have found decreased cortisol concentrations<sup>73</sup> and improvements in cognitive planning and execution,<sup>39</sup> micronutrient absorption, flexibility, grip strength, abdominal strength,<sup>70</sup> respiratory muscle strength,<sup>62</sup> heart rate variability,<sup>60</sup> and stress reactivity, as determined by skin conductance responses.<sup>79</sup>

This review has focused exclusively on studies assessing student outcomes; however, it is important to note that a handful of studies have evaluated the effects of yoga interventions for classroom teachers. For example, Nosaka and Okamura<sup>100</sup> evaluated the effects of a yoga-based stress management program for school employees and found that participants showed significant postintervention increases in calmness, comfort, and cheerfulness, and significant decreases in cognitive mind and body stress. In another study that evaluated a yoga and mindfulness intervention for classroom teachers, Ancona and Mendelson<sup>101</sup> found that while the difference scores on outcomes measuring perceived stress and emotional exhaustion were in the expected direction, the between-groups difference (as compared to a control group) was not statistically significant. Furthermore, Harris *et al.*<sup>102</sup> used the Community Approach to Learning Mindfully program for educators as a brief daily intervention to promote educator social-emotional competencies, stress management, and well-being in a randomized controlled trial in two middle schools, and reported educator improvements in mindfulness, positive affect, classroom management, distress tolerance, physical symptoms, blood pressure, and cortisol awakening response.

## Summary and conclusion

In summary, the results of our bibliometric analysis and literature review suggest that research on yoga in school settings is a recent field of inquiry that is still in its infancy, with only 47 published trials in peer-reviewed journals, all published after 2000, with 75% published within the past 5 years. As one would expect in a relatively new research

field, most of the studies are preliminary in nature and the methodological quality is low to moderate. Many of the studies have been conducted with elementary school students, sample sizes are typically small, self-reported subjective measures have been the most common outcome, many of the studies did not incorporate control groups, and only slightly more than half of the studies employed randomized controlled trial designs. Viewed from a different perspective, it is encouraging that only nine of the 43 published quantitative studies were uncontrolled trials, and several studies used objective outcomes, such as physiological measures and student grades, suggesting that researchers are beginning to heed the call for more methodological rigor in this field. This is particularly interesting in light of a recent systematic review of school-based mindfulness interventions<sup>32</sup> that found that, of 28 published studies, only 10 used random assignment to conditions, 23 of the 28 studies relied solely on self-report questionnaires, and no studies included academic data from school records. It is possible that the physical aspects of yoga, such as postures and breathing exercises, have inspired researchers to collect physiological outcomes.

Two additional limitations of the literature on yoga in schools are that very few studies provide information pertaining to the optimal dose of the intervention with respect to frequency and duration of practice, and both fidelity of intervention implementation and long-term follow-up measures are generally lacking.<sup>103,104</sup> Of more concern is that many of the positive results reported in fact appear as trends (e.g.,  $P < 0.1$ ) rather than statistically significant (i.e.,  $P < 0.05$ ) changes, suggesting relatively weak outcomes in this literature. In the controlled studies, it is not uncommon that very few of the outcomes measured have shown positive changes<sup>50,52,59</sup> or, in some cases, no significant improvements at all.<sup>55,64</sup> In fact, some studies have reported counterintuitive increases in negative mood state<sup>64</sup> and perceived stress<sup>52</sup> with the yoga intervention. However, it is possible that this finding may be due to a yoga-mediated enhancement of an awareness of preexisting negative mental states and behaviors and, therefore, that children may not actually have worsened with the intervention. Finally, one study examining both teacher- and student-rated outcomes reported significant effects for teacher, but not student, ratings.<sup>44</sup> In summary, the conclusions

that can be drawn from the studies to date must be considered as tentative and should therefore be interpreted with caution.

Nevertheless, the published evidence to date does suggest that school-based yoga interventions hold some promise for enhancing student mental state, health, performance, and positive behaviors. The alarmingly high prevalence of adverse psychological conditions in children and adolescence in an education system lacking SEL skill instruction suggests that further research on the implementation of yoga in schools is warranted. Schools are obviously an ideal venue for promoting the establishment of healthy lifestyle skills and behaviors from an early age. The widespread implementation of yoga in schools could have substantial implications not only for student health but also for society as a whole. Additional high-quality research validating the feasibility, efficacy, and cost-effectiveness of yoga in schools would certainly justify its widespread implementation and allow yoga to become a well-accepted and universal component within our education system.

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### Conflicts of interest

The authors declare no conflicts of interest.

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Yoga in school settings: a research review. *Annals of the New York Academy of Sciences*, 1373, 45–55. <https://doi.org/10.1111/nyas.13025>. Article PubMed Google Scholar. Khalsa, S. B. S., Hickey-Schultz, L., Cohen, D., Steiner, N., & Cope, S. (2012). Evaluation of the mental health benefits of yoga in a secondary school: a preliminary randomized controlled trial. *The Journal of Behavioral Health Services & Research*, 39, 80–90. <https://doi.org/10.1007/s11414-011-9249-8>. Article Google Scholar. Research on the psychophysiology of yoga. In S. B. S. Khalsa, L. Cohen, T. McCall, & S. Telles (Eds.), *Principles and practice of yoga in health care* (pp. 49–63). Pencaitland: Handspring Publishing Limited. Research on yoga in schools has grown exponentially over the past 5 - 10 years, and while the results are still preliminary, scientists are beginning to understand why yoga serves as such a valuable component of school curricula nationwide. Research suggests that school-based yoga cultivates competencies in mind-body awareness, self-regulation, and physical fitness. And classroom teachers benefit as well. Taken together, these competencies may lead to improvements in students' behavior, mental state, health, and performance, as well as teacher resilience, effectiveness and overall classroom climate. Recent research using urban elementary school settings, confirms the need for yoga among youth subject to environmental, physical and mental health stress. Harper reaffirms: "The places that are most challenging to teach are also the places where children embrace (and need) Yoga practice the most" (Harper, 2010, p. 99). Brooks (2007) explores yoga's effects on reducing anxiety among elementary school-aged students. The author's review of literature includes coping strategies for children, intervention techniques and the benefits of yoga. Children, like adults, use different strategies depending on the degree of stress. Problem focused strategies are used primarily in academic settings while emotion focused strategies are used in more subjective situations (Brooks, 2007). Yoga in school settings: A research review. *Annals of the New York Academy of Sciences*. 2016; 1373: 45-55. View in Article. Scopus (36). PubMed. Crossref. Yoga research and public health: Is research aligned with the stakeholders' needs. *Journal of Primary Care and Community Health*. 2017; 8: 31-36. View in Article. Scopus (8). PubMed. Crossref. Research with typically and atypically developing Extant research suggests that yoga benefits emotional, school-age (ages 5–21) children was assessed. The PRISMA statement for report- Yoga in school settings must involve the support of ing systematic reviews and meta-analyses of studies that evaluate healthcare inter- stakeholders such as parents, teachers, administrators, and, ventions: explanation and elaboration. *Brit Med J Online*. 2009;339.