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,\(^1\) many of which are known risk factors for the development of mood and other psychological disorders.\(^2\) 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.\(^3\) 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.\(^4\) Another survey in adults has indicated that the majority of psychiatric conditions have childhood/adolescent onsets.\(^5\) 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),\(^6\) 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.\(^7\) 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.\(^8\)

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.

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in public schools. The recently published CASEL Guide describes existing evidence-based SEL programs that CASEL has determined are worthy and have the potential for broad implementation. 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). 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.

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, and systematic research reviews have suggested that yoga is particularly efficacious for reducing stress and enhancing mood and well-being. The therapeutic application of yoga has also been shown to be viable for children and adolescents in improving both physical and mental health. 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.

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. Finally, several aspects of physical fitness, including neuromuscular coordination and strength, flexibility, balance, and respiratory function, are directly improved following yoga practice over time. 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.

Yoga is particularly efficacious for reducing stress and enhancing mood and well-being. The therapeutic application of yoga has also been shown to be viable for children and adolescents in improving both physical and mental health. 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. 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. Finally, several aspects of physical fitness, including neuromuscular coordination and strength, flexibility, balance, and respiratory function, are directly improved following yoga practice over time. 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.

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The prevention 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. The implementation of yoga in school settings is also growing, 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. 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.  

A significant and growing body of published research studies is now in existence on the efficacy of contemplative meditation-based programs in schools. 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.” 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. 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. 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 and meta-analysis 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 (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, visual impairment, asthma, poor coordination, and mental retardation. Two studies in which yoga practice was a relatively small component of the intervention were also not included. 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 setting.
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<td>NA</td>
<td>1–2 min meditation followed by 6–10 postures</td>
<td>USA</td>
</tr>
<tr>
<td>Daly</td>
<td>2015</td>
<td>76</td>
<td>RCT</td>
<td>37</td>
<td>HS</td>
<td>IS</td>
<td>16</td>
<td>48</td>
<td>40</td>
<td>Bent on Learning</td>
<td>USA</td>
</tr>
<tr>
<td>Felver</td>
<td>2015</td>
<td>77</td>
<td>UCT</td>
<td>47</td>
<td>HS</td>
<td>IS</td>
<td>3</td>
<td>15</td>
<td>35</td>
<td>Kripalu Yoga in the Schools</td>
<td>USA</td>
</tr>
<tr>
<td>Finnan</td>
<td>2015</td>
<td>78</td>
<td>QLT</td>
<td>NA</td>
<td>ES</td>
<td>IS</td>
<td>2 years</td>
<td>NA</td>
<td>40</td>
<td>YogaKidz</td>
<td>USA</td>
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<tr>
<td>Fishbein</td>
<td>2015</td>
<td>79</td>
<td>RCT</td>
<td>85</td>
<td>MS/HS</td>
<td>IS</td>
<td>7</td>
<td>20</td>
<td>50</td>
<td>Be BOLD mindful yoga program—hatha vinyasa flow</td>
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<tr>
<td>Quach</td>
<td>2015</td>
<td>80</td>
<td>RCT</td>
<td>172</td>
<td>MS</td>
<td>IS</td>
<td>4</td>
<td>8</td>
<td>45</td>
<td>Shanti Generation Yoga</td>
<td>USA</td>
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<tr>
<td>Razza</td>
<td>2015</td>
<td>81</td>
<td>NRT</td>
<td>29</td>
<td>PS</td>
<td>IS</td>
<td>25</td>
<td>Daily</td>
<td>10–30</td>
<td>YogaKids</td>
<td>USA</td>
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</table>

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 qualitative examinations, and four (9%) were 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.

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 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. 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; self-control, aggression and social problems; self-regulation; emotion regulation; feelings of happiness and relaxation; anxiety; depression; problematic stress responses; self-esteem; social and physical well-being; general distress, physical arousal, and hostility; rumination, emotional arousal, and intrusive thoughts; alcohol use; self-concept, tolerance, nonviolence, truthfulness, faith, fidelity, extra-aggression, ego defense, obstacle dominance, need persistence, and introgression of aggressive reactions; overall, general, and social self-esteem; positive health; self-adjustment; and working-memory capacity. 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; also noted was greater kinesthetic awareness, mood management, stress reduction, and social cohesion; improved stress management; and focus, perseverance, and positive relationships. 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, performance impairment, concentration, mood, ability to function under pressure, hyperactivity, social skills, and attention. Objective data collected from school records and academic tests have shown postintervention improvements in student grades and academic performance. Furthermore, physiological and cognitive outcome measures reported in a few studies have found decreased cortisol concentrations and improvements in cognitive planning and execution, micronutrient absorption, flexibility, grip strength, abdominal strength, respiratory muscle strength, heart rate variability, and stress reactivity, as determined by skin conductance responses.

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 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 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. 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 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. 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 or, in some cases, no significant improvements at all. In fact, some studies have reported counterintuitive increases in negative mood state and perceived stress 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. 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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