Review

Clinical Applications of Yoga for the Pediatric Population: A Systematic Review

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Objective.—The aim of this study was to evaluate the evidence for clinical applications of yoga among the pediatric population.

Methods.—We conducted an electronic literature search including CINAHL, Cochrane Central Register of Controlled Trials (CENTRAL), EMBASE, Medline, PsycINFO, and manual search of retrieved articles from inception of each database until December 2008. Randomized controlled trials (RCTs) and nonrandomized controlled trials (NRCTs) were selected that included yoga or yoga-based interventions for individuals aged 0 to 21 years. Data were extracted and articles critically reviewed using a modified Jadad score and descriptive methodological criteria, with summarization in tables.

Results.—Thirty-four controlled studies published from 1979 to 2008 were identified, with 19 RCTS and 15 NRCTs. Many studies were of low methodological quality. Clinical areas for which yoga has been studied include physical fitness, cardiorespiratory effects, motor skills/strength, mental health and psychological disorders, behavior and development, irritable bowel syndrome, and birth outcomes following prenatal yoga. No adverse events were reported in trials reviewed. Although a large majority of studies were positive, methodological limitations such as randomization methods, withdrawal/dropouts, and details of yoga intervention preclude conclusive evidence.

Conclusions.—There are limited data on the clinical applications of yoga among the pediatric population. Most published controlled trials were suggestive of benefit, but results are preliminary based on low quantity and quality of trials. Further research of yoga for children by using a higher standard of methodology and reporting is warranted.

KEY WORDS: behavioral medicine; children; complementary and alternative medicine; pediatric; yoga

Academic Pediatrics 2009;9:212–20

Yoga is a mind-body practice that originated in India at least 2000 years ago. For over 2 millennia, yoga has evolved into different schools of thought, while maintaining the purpose of directing the mind and body. There are common elements to many forms of yoga, which may include some or all of the following: postures (*asanas*), breathing (*pranayama*), and meditation. In 2007, there were over 1.5 million pediatric yoga users in the United States.[1] Within popular culture, yoga is perceived as a way to develop and maintain a healthy mind and body and is commonly taught in health gyms, spas, schools, and colleges, and is featured in wellness magazines.

Recently, there has been increasing interest and research in the therapeutic applications of yoga to prevent or treat medical conditions.[2] Epidemiological research among adults suggests that many individuals use yoga for health maintenance and perceive benefit for overall health, musculoskeletal and mental health conditions.[3] Clinical trials with adults suggest potential benefit for various conditions, including back pain,[4–7] osteoarthritis,[8,9] cardiovascular disease,[10,11] and depression.[12–14] In contrast, very little is known about the safety and efficacy of yoga among the pediatric population. A systematic review performed by Galantino and colleagues[15] in 2008 identified 24 studies of yoga for children, including case-control studies, pilot studies, cohort studies, and randomized controlled trials (RCTs) that focused on studies of relevance to physical therapy. The review concluded that there was evidence for the benefit of yoga in the pediatric population in rehabilitation, but more research is necessary. This study selected and categorized articles most relevant to physical therapy practice; however it may have excluded articles of interest to general pediatrics. The purpose of this systematic review is to identify evidence for applications of yoga for all pediatric conditions. Also, we critically reviewed the methodological quality among selected studies to help inform future research in this field.

METHODS

We systematically searched multiple databases, including CINAHL, Cochrane Central Register of Controlled Trials (CENTRAL), EMBASE, Medline, and

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Received for publication October 7, 2008; accepted April 4, 2009.

PsycINFO. We utilized the Medical Subject Headings terms *infant, child, adolescent,* and *pediatric* and coupled each with *yoga* to perform a search from inception of each database until December 2008. Additionally, we searched the bibliographies of obtained yoga articles for additional publications that would meet our criteria.

Selection Criteria

We included randomized and nonrandomized controlled trials (NRCTs) with subjects in the age range of 0 to 21 years. Trials that combined results with individuals older than 21 years were excluded. Studies were included if they specifically stated that the intervention was yoga or yoga-based exercise. Yoga interventions that incorporated nonyoga modalities (eg, games, massage, interactive discourse, nonspecified relaxation techniques) were included as well. Dissertations, abstracts, and non-English publications were excluded. We also excluded studies that reported meditation in the absence of specifically stating yoga, and excluded studies utilizing mindfulness-based stress reduction, transcendental meditation, or relaxation response.

Data Collection and Synthesis

Data were extracted systematically by 2 of the authors (Gurjeet S. Birdee and Paula Gardiner) independently. Among those studies that met our criteria, we collected data on study population, yoga intervention, nonyoga cointerventions, control or comparison groups, methodology, outcome measures, and adverse events. Age categories were organized as neonate (0–1 month), infant (1 to $<$ 24 months), young child (2 to $<$ 5 years), older child (5 to $<$ 12 years), adolescent (12 to $<$ 18 years), and young adult (18 to $<$ 21 years).

Quality

To evaluate the quality of reporting, we used a modified Jadad score for randomized controlled studies (RCTs). The Jadad score, a well-validated instrument, measures the quality of reporting with a numerical scoring system from 0 to 5 (0 being weak and 5 being strong).[16,17] Values are assigned based on the adequacy of reporting methods, including randomization, double blinding, and withdrawals/dropouts. The modification of the Jadad score we used allows 1 point for single blinding (ie, in the case of yoga, outcome assessor blinded) rather than 2 points for appropriate double blinding, which is difficult to employ in yoga studies. To further describe the methodological quality of the RCTs, we used a method previously reported[18] to collect the following information (yes/no): randomization method described, outcome assessor blinded, withdrawal/dropouts reported, sample size justification, intention-to-treat analysis, appropriate data analysis, adequate description of yoga intervention, adequate description and justification for control group, and description of yoga instructor's qualifications. A second investigator evaluated 20% of the final selected RCTs and we calculated a kappa coefficient for agreement to assess the reliability of our data collection methods. We obtained a kappa score of $r = 1.0$, suggesting excellent reliability.

RESULTS

The Figure portrays the flow of our search and selection process. Our initial search of the databases resulted in 351 studies. We screened and excluded articles that were not yoga or yoga based (127), were adult only or combined data from adults with children (80), not trials (53), lacked a control group (22), non-English (19), dissertations (7), duplicated publications (5), and abstracts (4). We identified 34 studies that met our inclusion criteria, which are detailed in the Appendix that appears online and are organized by medical condition/category (19 RCTs and 15 NRCTs). A large majority of studies were conducted in India (21), followed by United States (9), Australia (2), Canada (1), and Germany (1). We identified 26 studies of

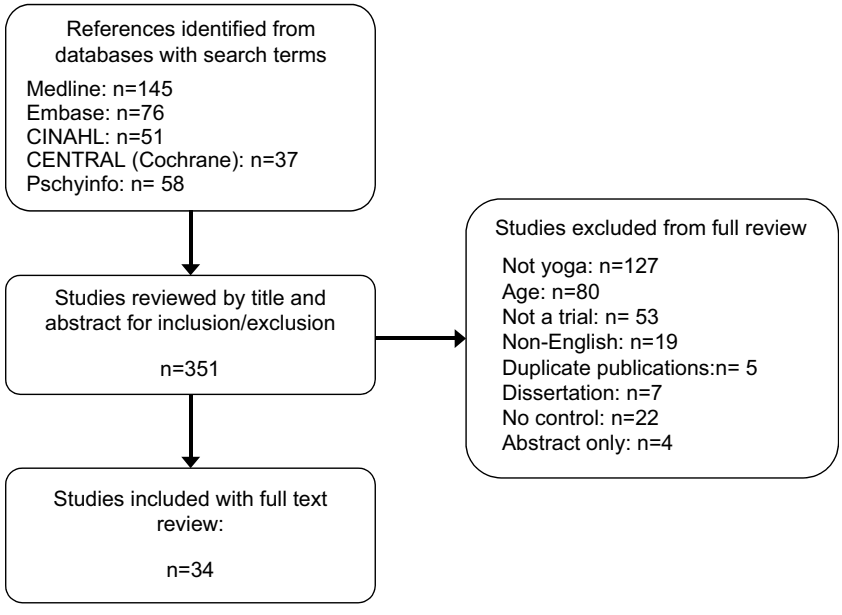

Figure. *Flow diagram of selection process for systematic review.*

children aged <18 years as follows: 11 adolescent, 10 older children, 3 combining adolescent and older children, 1 neonate, and 1 unspecified age. There were no studies of younger children (aged 2–5 years). The pediatric populations studied included healthy, normal children (11), attention-deficit/hyperactivity disorder (2), educational problems (2), domestic/social problems (2), fitness failures (1), irritable bowel syndrome (1), depression/adjustment disorder (1), examination anxiety (1), poor motor coordination/low body satisfaction (1), eating disorder (1), impaired vision (1), mental retardation (1), and prenatal/newborn (1). There were 8 studies of young adults (aged 18–21 years), all of whom were healthy normal subjects. Studies varied in the yoga techniques and co-interventions used, as shown in Table 1. Many studies used common yoga techniques such as postures (79%), breathing (67%), and/or meditation (59%). Although still considered a posture, the corpse pose (*shavasana*) was categorized separately due to the high frequency of use in studies individually or alongside other yoga interventions (26%). Nearly one third of interventions included other yoga techniques such as locks (*bandhas*), cleansing exercises (*kriyas*), hand gestures (*mudras*), lectures on yoga philosophy, yoga diet, and devotional songs. The duration of the interventions varied from a single day to an entire year, with an average length of 9 weeks. Longer studies and those that used techniques other than postures, breathing, and meditation were more commonly conducted in India. No adverse events were reported in any of the studies reviewed.

We report the modified Jadad scores of RCTs in the online Appendix. Generally, the RCTs had low, modified Jadad scores, with few studies receiving a score of 3/5 (2 studies) or 2/5 (4 studies), and a large majority received 1/5 (13 studies), highlighting the poor quality of reporting in these studies. In Table 2, we also analyzed the methodological quality of the 19 RCTs. Among 19 RCTs identified, 2 reported the method of randomization,[19,20] 1 reported single blinding of outcome assessor,[20] and 4 reported withdrawals/dropouts.[19,21–23] None of the RCTs provided sample size justification or an intention-to-treat analysis. Only 12 studies provided details of the yoga intervention, and most lacked information on the qualifications of the yoga instructor. Many of the studies lacked an appropriate data analysis (11/19 RCTs). The most common statistical error was not measuring changes in the intervention group as compared with the control group. Many studies reported significant changes based on differences from preintervention to postintervention for the yoga group and control group separately (within-group analysis).[24–33]

Yoga for Pediatric Physical Health

Yoga was studied as a means to physical fitness in India by Moorthy[31] for children who had failed a fitness test (Online Appendix A1). Although this study reported only within-group analyses, results suggested that yoga increased the number of children that were able to pass the fitness test. The study included a third arm with physical activity, which showed no difference in percentage that passed the fitness test in comparison to yoga. In an RCT using a comprehensive yoga intervention, including dietary modification and philosophy, compared with regular activity, Bera and Rajapurkar[34] reported higher cardiovascular fitness and increased lean body mass among subjects in the yoga group after 1 year. Given the multimodal intervention, it is unclear if the changes in lean body mass were due to diet changes alone. Statistical analysis was also measured as within-group pre-change and post-change rather than between-group comparisons of intervention and control.

With regards to cardiovascular effects, studies seem to suggest that yoga lowers blood pressure, heart rate, and respiratory rate in children and young adults (Online Appendix A2). Bagga and Gandhi[35] demonstrated that corpse pose practiced regularly for 12 weeks by young adult women may reduce systolic blood pressure as compared with regular activity. Other pediatric yoga RCTs also reported changes comparing pre-change and post-change within-group changes in cardiovascular and respiratory parameters: decreased blood pressure response to cold pressor test (a cardiovascular test conducted by immersing 1 hand of subject in cold water and measuring changes in blood pressure and heart rate) among young adults who at baseline had hyperreaction to cold pressor test,[25] improved respiratory capacity in normal adolescents,[27] decreased heart rate and respiratory rate in adolescent girls with domestic social problems,[32] and decreased respiratory rate in adolescents with vision impairment.[33]

We identified 5 studies whose outcomes measured motor skills or strength (Online Appendix A3). Outcomes included balance,[36] fine motor skills,[37] and hand grip strength,[38,39] but these studies were of low quality based on quality of reporting.

Yoga for Pediatric Mental Health and Psychological Disorders

Yoga has been studied to enhance the mental health of children (Online Appendix B1). For example, a single session of yoga prior to a long distance run in high school athletes improved performance of a 1-mile run as compared with a normal routine group. The yoga intervention was to mentally and physically prepare the runners for the 1-mile run. However, there was statistically less improvement in comparison with a motivational group. Two NRCTs examined yoga's impact on mood among healthy young adult students.[40,41] Both studies lacked a detailed description of the yoga intervention. These studies suggested a benefit of yoga, as well as physical activity, on mood by reducing stress and negative emotions. Berger and Owen[40] identified gender differences in outcome, with decreased tension, anger, and fatigue among males who received the yoga intervention in comparison to swimming. West and colleagues[41] reported cortisol increasing among the African dance group and decreasing among the yoga group, with a significant difference between groups.

A single RCT exists for the therapeutic application of yoga, as compared with a dissonance-based intervention, or control group to treat young adult women with eating disorders (Online Appendix B2).[22] Although overall this

Table 1. Types of Yoga Interventions Among Pediatric Yoga Studies

Yoga Study	Meditation	Postures	Breathing	Corpse Pose	Other Yoga*	Non-Yoga Technique
Bagga and Gandhi, 1983[35]	√			√		
Bera and Rajapurkar, 1993[34]		√	√		√	
Berger and Owen, 1992[40]	√	√	√			
Bhattacharya et al, 2002[50]	√	√	√	√		
Bhushan et al 2006[24]	√					
Bose et al, 1987[25]				√		
Clance et al, 1980[26]		√				√ Awareness training
Dash et al, 2001[38]		√	√		√	√ Games
Dhume et al, 1991[36]	√	√	√			
Donohue et al, 2006[51]		√				
Harrison et al, 2004[45]	√					
Hopkins et al, 1979[47]			Not specified			
Jensen et al, 2004[21]	√	√	√		√	
Kuttner et al, 2006[19]		√	√			
Madanmohan et al, 2003[27]		√	√	√		
Malathi and Damodaran, 1999[28]	√	√	√	√	√	
Manjunath et al, 1999[29]	√	√	√			√ Games
Manjunath et al, 2001[30]	√	√	√		√	
Manjunath et al, 2004[48]	√	√	√		√	√ Games
Mitchell et al, 2007[22]	√	√	√			
Moorthy et al,1982[31]	√	√	√	√		
Narendran et al, 2005[52]	√	√	√			
Naveen et al, 1997[49]			√			
Peck et al, 2005[46]	√	√	√	√		
Platania-Solazzo et al, 1992[43]		√			√	X Massage
Raghuraj et al,1997		√		√		
Raghuraj et al, 2003	√	√				
Scime et al, 2008[42]**			Not specified			
Stueck et al, 2005[44]	√	√	√			√ Games
Telles et al, 1993[37]		√	√		√	
Telles et al, 1997[32]	√	√	√	√		
Telles et al, 1998[33]	√	√	√		√	
Uma et al, 1989[23]		√	√			
West et al, 2004[41]	√	√	√			
Frequency of intervention (n = 34), %	59	79	67	26	26	24

*Other yoga techniques included: locks (*bandhas*), cleansing exercises (*kriyas*), hand gestures (*mudras*), lectures on yoga philosophy, yoga diet, and devotional songs.

**Group meetings for interactive discourse, relaxation.

study was well designed, the yoga intervention is minimal (once a week for 45 minutes) and not well detailed. The dissonance intervention showed benefit on multiple outcomes in comparison to the control, whereas the yoga intervention had no difference compared with the control. One NRCT studied normal girls and the effects of multimodal intervention, including yoga, on measures that predict future risks of eating disorders.[42] The intervention group showed positive changes in some—but not all—outcomes measured. Since the intervention group contained other modalities, the role of yoga is uncertain.

Two other NRCTs studied the effects of a relaxation intervention on the mood of inpatients with depression/adjustment disorder[43] and students with abnormal examination anxiety (Online Appendix B3).[44] Although suggestive of benefit, these studies combined yoga with other relaxation modalities, which limits interpretation of the role of yoga in observed outcomes.

Yoga for Pediatric Behavior and Development

There have been a small number of studies using yoga with children that have behavioral or developmental problems (Online Appendix C). We identified 2 studies of the use of yoga for the management of attention-deficit/hyperactivity disorder (ADHD; Online Appendix C1).[21,45] These 2 studies were limited by low adherence and small sample sizes. Comparison of the trials is difficult, since Jensen and Kenny[21] used a yoga intervention composed of meditation, breathing, and postures for children, whereas Harrison and colleagues[45] used *sahaja* yoga, a family meditative intervention. The results of these studies were mixed but suggested a potential benefit of yoga for ADHD symptoms. A third NRCT studied yoga for elementary children with a nonspecific diagnosis of "attention problems in school," which was intended to encompass children with ADHD.[46] This study demonstrated increased attention from pre-yoga intervention and post-yoga intervention, but did not compare changes to the control group. Another controlled trial lacking detail of the subject population was reported by Hopkins and Hopkins in 1979, in which yoga was used for elementary children vaguely categorized with "educational problems."[47] One study examined the effect of yoga on elementary and adolescent children with mental retardation. Although the study reported improvement in intelligence quotient (IQ) and social adaptation in the yoga group

Table 2. Quality of Methodology of Randomized Controlled Trials Among the Pediatric Population*

	Randomization Employed	Randomization Method Described	Sample Size Justified	Characterization of Intervention Well Described	Control Group Justified	Instructor Qualified	Intention to Treat	Withdrawals / Dropouts	Outcome Assessor Blinded	Appropriate Data Analysis
Bagga and Gandhi, 1983[35]	√	–	–	√	–	–	–	–	–	√
Bera and Rajapurkar, 1993[34]	√	–	–	√	–	–	–	–	–	–
Bhushan et al, 2006[24]	√	–	–	√	–	–	–	–	–	–
Bose et al, 1987[25]	√	–	–	–	–	–	–	–	–	–
Clance et al, 1980[26]	√	–	–	√	–	–	–	–	–	–
Donohue et al, 2006[51]	√	–	–	–	√	–	–	–	–	√
Jensen et al, 2004[21]	√	–	–	√	–	–	–	√	–	√
Kuttner et al, 2006[19]	√	√	–	√	–	–	–	√	–	√
Malathi et al, 1999[28]	√	–	–	–	–	–	–	–	–	–
Madanmohan et al, 2003[27]	√	–	–	√	–	–	–	–	–	–
Manjunath et al, 1999[29]	√	–	–	–	–	–	–	–	–	–
Manjunath et al, 2001[30]	√	–	–	–	–	–	–	–	–	–
Mitchell et al, 2007[22]	√	–	–	–	–	√	–	√	–	√
Moorthy et al, 1982[31]	√	–	–	√	–	–	–	–	–	–
Raghuraj et al, 1997	√	–	–	√	–	–	–	–	–	√
Raghuraj et al, 2003	√	√	–	–	√	–	–	–	√	√
Telles et al, 1997[32]	√	–	–	√	–	–	–	–	–	–
Telles et al, 1998[33]	√	–	–	–	√	√	–	–	–	–
Uma et al,1989[23]	√	–	–	√	–	√	–	√	–	√

*√ = reported adequately; - = reported inadequately.

compared with the control group (Online Appendix C4),[23] the study calculated outcome changes incorrectly (difference between yoga and control group measurements at baseline compared with difference between yoga and control group measurements postintervention). Based on the quality of the study, there is no evidence that yoga can improve IQ.

Many studies from India have explored how yoga may influence visual and cognitive skills in children (Online Appendix C2 and C3, respectively). These studies include changes in verbal and spatial memory,[48,49] visual perception,[20,29,39] and executive function.[30] Generally, all these studies reported a benefit of yoga in the capacities listed; however, poor methodology precludes conclusive evidence.

Yoga for Pediatric Gastrointestinal Disorders

An RCT from 2006 with adolescents that had irritable bowel syndrome randomized subjects to yoga or wait-list control (Online Appenix D).[19] The yoga group as compared with the control group had decreased functional disability, emotional-focused avoidance, and anxiety. The investigators combined the data from the yoga group with the wait-list group after these subjects completed the intervention, and reported a preintervention to postintervention reduction in gastrointestinal symptoms.

DISCUSSION

We identified 26 controlled studies of yoga for the pediatric population and 9 for the young adult population. The methodological quality of many studies was low. Areas for which yoga has been studied include physical fitness, cardiorespiratory effects, mental health, behavior and development, irritable bowel syndrome, eating disorders, and prenatal effects on birth outcomes. A large majority of the studies were positive, but due to methodological limitations the evidence provided is preliminary at best.

Our review differs from the recent systematic review of yoga for children published by Galantino and colleagues.[15] These authors used search terms related to yoga, pediatrics (children, developmental disabilities), exercise, and publication types that were of interest. Studies were included with primary outcomes of quality of life, cardiorespiratory fitness, and physical functioning or with secondary outcomes of attention and cognition. The review categorized studies based on relevance to physical therapy into 3 domains: neuromuscular, cardiopulmonary, and musculoskeletal headings. Whereas we identified 34 studies including NRCTs and RCTs, the Galantino review identified 24 studies, including cohort, case control, and RCTs. Among the 34 trials included in our review, 18 studies (11 RCTs and 7 NRCTs) are unique to our study and are not reported by Galantino.* Our study reviewed 16 studies also in the Galantino review,† with the remaining 8 studies excluded here based on our exclusion criteria as follows: age,[53–56] no control group,[57–59] and not a trial.[60] The differences in our review may have stemmed from contrasting search strategies, including different search terms (eg, infant, adolescent), our specific age inclusion criteria (aged 0–21 years), and our inclusion of all outcomes (not only quality of life, attention, and cognition).

Preliminary evidence presented in this review suggests that yoga may be beneficial for physical fitness and cardiorespiratory health among children. As a physical form of exercise, studies suggest that yoga provides low aerobic intensity.[61,62] According to the 2002 National Health Interview Survey, a large majority of adults who use yoga in the United States reported that yoga was important for their health maintenance.[3] Based on our review, yoga may be an option for children to increase physical activity and fitness. In particular, yoga may be a gateway for adopting a healthy active lifestyle for sedentary children who are intimidated by more vigorous forms of exercise. However, studies have been predominately conducted in India, where yoga is culturally more acceptable and adaptable.[63] Studies in different cultural settings are necessary to better evaluate the feasibility of yoga as a form of exercise for children.

More studies outside of India have explored the use of yoga for psychological health. This research focus is consistent with a national survey among adults in the United States, where yoga users were more likely to have mental health conditions, and mental health was one of the most common conditions yoga was used to treat.[3] A systematic review by Pilkington and colleagues[13] in 2005 found yoga may be beneficial for adults with depression. We identified 2 NRCTs that suggested yoga, as well as conventional exercise (swimming or dance), promoted mental health. However, these studies were among young adults and have to be replicated for individuals aged <18 years.

As a means of developing mental and physical discipline and self-awareness, yoga intuitively would have possible benefit for children with ADHD. However, to date initial studies show potential, but are far from conclusive. In general, the clinical applications of yoga for pediatric behavior and development have yet to be determined.

Prenatal yoga has become increasingly popular in mainstream culture in the United States, but surprisingly, we found only 1 study from India that measured health outcomes on neonates. Although a positive NRCT, this study needs to be followed by more rigorous research to evaluate the application of yoga for this population.

Our review suggests need for improved methodology and reporting of yoga studies in children. Many RCTs did not describe randomization methods. None of the studies provided sample size calculations, and many had small sample sizes. These studies may not have sufficient power to measure changes in reported outcomes. In addition, inappropriate statistical analysis of within-group preintervention vs postintervention changes rather than between-group comparisons undermines the principle of conducting an RCT. Studies need to explain the rationale of the control groups, including why the control group is an appropriate comparison to the yoga intervention group.

*References 19, 20, 22, 24,25, 28, 29, 31, 34–36, 40–42, 47, 50–52.
†References 21, 23, 26, 27, 30, 32, 33, 37–39, 43–46, 48, 49.

Most studies did not report withdrawals/dropouts, which is necessary to determine feasibility and adherence to the protocol, along with an intention-to-treat analysis. None of the 34 studies reported adverse events or lack thereof. This may suggest that yoga is a low-risk intervention among children. However, since this was not specifically reported in these trials, it also may represent underreporting of adverse events. The risks of yoga have not been well documented with some case reports in the literature.[64–72] Future prospective controlled studies should collect data on adverse events.

Yoga represents a myriad of practices, and we found that studies lacked adequate description of the yoga interventions. Without detailed description of the specific techniques used, comparison and replication of studies to validate results are difficult. Also, the qualifications of yoga instructors need to be clearly stated due to variations in style and experience. Registration of yoga teachers with organizations that recognize national standards of yoga training, such as the minimum of 200 training hours recognized by the Yoga Alliance (http://www.yogaalliance.org), will help standardize yoga interventions. However, these standards apply to training yoga instructors to teach adults, whereas no standards exist for instructors teaching children. Specific training and experience teaching yoga to children should be described.

There are limitations to our study, including the low number of publications, especially for any given outcome. This precludes further analysis with quantitative methods such as meta-analysis for specific outcomes. The variability of yoga interventions and the lack of detail in yoga description make comparison and interpretation of these studies difficult. Studies spanned a broad age range, and yoga for different age groups is difficult to compare based on varying developmental age and medical conditions. Yoga very likely has different effects and feasibility among different age groups. Based on experienced yoga teachers, younger children are often taught yoga that emphasizes physical exertion with many dynamic postures, and less breathing and meditation. As children grow older, more breathing and meditation are incorporated. This reflects the developmental stage of the child to allow them to be engaged and focused in the practice. This systematic review does not provide sufficient data to identify particular patterns of yoga for specific populations and settings. We excluded studies with mixed populations of children and adults. Generally, studies among all age groups were positive; however, publication bias cannot be ruled out in this descriptive systematic review. We also excluded studies that were not controlled, and these studies may have contributed some valuable information. However, the absence of control groups in trials, particularly behavioral trials, make any result highly suspect with placebo effects and other sources of confounding. Studies published in languages other than English were excluded, which may have caused language bias. Our definition of yoga was narrow and excluded practices that contain similar or co-opted relaxation techniques. For example, mindfulness-based stress reduction commonly incorporates some aspects of yoga in the intervention. For reasons of practicality, we limited our study to interventions that were clearly described as yoga or yoga based. Despite these limitations, our systematic review describes the state of research for yoga in children and can help direct future investigations.

As yoga continues to gain in popularity among children as a recreational activity or a behavioral therapy, there are a wide variety of traditions and styles. These variations are not clearly delineated by age. Although there is a growing body of literature, the existing methodology is very poor. Thus, it is difficult to comment on the clinical efficacy. The trials did not report adverse events, suggesting that yoga has a high safety profile. Further research is necessary to identify clinical applications of yoga for children. As a mind-body modality, applications in pediatric mental health and physical fitness need to be studied. Research on the use of yoga for disorders of behavior and development, such as ADHD, need to be developed. Research needs to be conducted with rigorous methodology in RCTs through detailed description of protocols and reporting of results. RCTs of yoga should utilize guidelines established by the Consolidated Standards of Reporting Trials group for the reporting of trials.[73] In addition, methodological issues specific to mind-body interventions should be addressed, including adequate description of the intervention and control group, and single blinding of the outcome assessor. Evidence-based prescription of mind-body techniques, such as yoga, for overall health maintenance or for specific diseases in children will depend on the development of this research agenda.

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APPENDIX

Yoga for the Pediatric Population by Area of Study*

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
A. Physical Health					
A1. Physical fitness					
Moorthy et al[31] 1982 India	RCT§ 1/5	Older children; N = 120; 50% male; children had failed minimum fitness as measured by Kraus-Weber tests	Yoga (postures, corpse pose) vs physical exercise vs regular activity 6 wk	Physical fitness measured by Kraus-Weber tests as measurement of minimal fitness	Between-group comparisons‖: among males and females ↑ percentage passed minimal fitness test in yoga group (males 76.67%, females 83.33%) vs regular activity group (males 3.30%, females 0.00%); no significant difference between yoga group and physical exercise group
Bera and Rajapurkar[34] 1993 India	RCT 1/5	Adolescent; N = 40; all male; normal child	Yoga (postures, breathing, *mudras, bandhas, kriyas,* yogic diet, lectures on benefits of yoga) vs regular activity 45 min/day, 3 d/wk, for 1 y	Lean body weight; cardiovascular fitness measured by Harvard Step Test; anaerobic power measured by Sargent jump (vertical standing jump)	Between-group comparisons: lean body weight higher in yoga group (44.8 kg) vs regular activity group (40.3 kg); cardiovascular fitness higher in yoga group (72.5 points) vs regular activity group (60.7 points); anaerobic power higher in yoga group (141.2 kg m/s) vs regular activity group (133.6 kg m/s)
Donohue et al[51]¶ 2006 USA	RCT 1/5	Adolescent; N = 90; 54% male; normal child; long-distance runners	Yoga (postures), motivation (motivating statements/group) vs attention control 20 min prior to 1-mile run	Performance of 1-mile run; satisfaction of intervention	Between-group comparisons: improvement in performance of 1-mile run in yoga group (1 ± 49 seconds) vs attention control (−1 ± 54 seconds), $t = 2.17$, but less improvement vs motivation group (5 ± 59 seconds); higher satisfaction scores reported in yoga group (3.71 ± 1.16) vs attention control (2.00 ± 0.96), and no significant difference vs motivation group (4.10 ± 0.85)
A2. Cardiorespiratory health					
Madanmohan et al[27]¶ 2003 India	RCT 1/5	Adolescent; N = 40; NS; normal child	Yoga (postures, breathing, corpse pose) vs regular class, 45 min, 5 d/wk, for 6 mo	Respiratory effects measured by MEP,** FEV_1††; muscle strength measured by hand grip strength	Within-group pre/postintervention comparison: Yoga group: MEP ↑ among yoga group from baseline (20.32 SEM 4.63 mm Hg) to 6 mo (46.05 SEM 5.5 mm Hg); FEV1 ↑ among yoga group from baseline (1.84 SEM 0.07 mm Hg) to 6 mo (2.12 SEM 0.09 mm Hg); hand grip strength ↑ from yoga group from baseline (129.53 SEM 9.96 mm Hg) to 6 mo (147.37 SEM 9.57 mm Hg) Regular class group: no significant changes
Telles et al[32] 1997 India	RCT 1/5	Adolescent; N = 40; all female; girls with "difficulty adjusting to home and society"	Yoga (postures, corpse pose), games/physical activity, 60 min, 5 d/wk, for 6 mo	Heart rate(HR),‡‡ respiratory rate(RR)§§ skin resistance	Within-group pre/postintervention comparison: Yoga group: ↓HR from baseline (81 ± 8.3) to 6 mo (67.2 ± 8.6); ↓RR from baseline (22.5 ± 2.1) to 6 mo (21.3 ± 2.3); no significant changes in skin resistance Games/physical activity group: ↓HR from baseline (81 ± 8.3) to 6 mo (67.2 ± 8.6); no significant changes in RR or skin resistance

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
Telles et al[33] 1998 India	RCT 1/5	Adolescent; N = 24; NS; impaired vision	Yoga (postures, breathing, guided relaxation) vs physical activity 1 h, 5 d/wk, for 3 wk	Autonomic measurements: HR, RR, skin resistance	Within-group pre/postintervention comparison: Yoga group: ↓ RR from baseline (21.4 ± 6.3) to 3 wk (17.5 ± 6.9); no significant changes in HR or skin resistance Physical activity group: no significant changes in HR, RR, or skin resistance
Bagga and Gandhi[35] 1983 India	RCT 1/5	Young adult; N = 18; all female; normal adult	Yoga (corpse pose), transcendental meditation vs regular activity 12 wk	SBP‖‖, DBP¶¶, HR; measured at 6 and 12 wk	Between-group comparisons: ↓ resting SBP in yoga group from baseline (121.6 ± 7.52 mm Hg) to 6 wk (117.6 ± 6.1 mm Hg) and 12 wk (114.33 ± 4.3 mm Hg) vs regular activity group from baseline (119.6 ± 3.19 mm Hg) to 6 wk (120.3 ± 2.65 mm Hg) and 12 wk (119.6 ± 3.87 mm Hg), 6 wk; no significant differences in resting DBP and heart rate at 6 and 12 wk between groups
Bose et al[25] 1987 India	RCT 1/5	Young adult; N = 69; all male; normal individuals that demonstrated hyperreaction to cold pressor test, defined as SBP↑ > 20 or DBP↑ > 15	Yoga (corpse pose) vs control (no intervention) 30 min, once a day, 3 mo	Blood pressure reactivity among "hyperreactors" measured by cold pressor test	Within-group pre/postintervention comparison‖: Yoga group: ↓SBP response to cold pressor test from baseline (25.0 ± 4.5 mm Hg) to 3 mo (15.0 ± 4.6 mm Hg); ↓ DBP response to cold pressor test from baseline (20.0 ± 3.8 mm Hg) to 3 mo (13.2 ± 3.0 mm Hg); statistical test, no detailed, eg, *t* test or other Control group: no significant changes in blood pressure to cold pressor test
A3. Motor skills and strength					
Telles et al[37] 1993 India	NRCT##	Older children; N = 90; 61% male; normal child	Yoga (postures, breathing, cleansing) at yoga camp vs regular school 10 days	Motor skills (number of errors in static motor performance)	Within-group pre/postintervention comparison: Yoga group: ↓errors in static motor performance from baseline (221.2 ± 10.0 errors) to 10 days (183.3 ± 7.1 errors) Regular school group: no significant changes in static motor performance
Madanmohan et al[27]¶ 2003 India	RCT 1/5	Adolescents; N = 40; NS; normal child	Yoga (postures, breathing, corpse pose), regular class 45 min, 5 d/wk, for 6 mo	Respiratory effects measured by MEP, FEV_1; muscle strength measured by hand grip strength	Within-group pre/postintervention comparison: Yoga group: MEP ↑ among yoga group from baseline (20.32 SEM 4.63 mm Hg) to 6 mo (46.05 SEM 5.5 mm Hg); FEV1 ↑ among yoga group from baseline (1.84 SEM 0.07 mm Hg) to 6 mo (2.12 SEM 0.09 mm Hg); hand grip strength ↑ from yoga group from baseline (129.53 SEM 9.96 mm Hg) to 6 mo (147.37 SEM 9.57 mm Hg) Regular class group: no significant changes
Raghuraj et al[39]¶ 1997 India	RCT 1/5	Adolescent; N = 80; all female; girls from community home (broken homes)	Yoga (postures, corpse pose) vs physical activity, regular school 6 mo	Muscle strength (hand grip strength); motor skills (tweezer dexterity), visual perception (critical flicker fusion frequency) degree of optical illusion for visual perception (Müller-Lyer lines)	Between-group comparisons: ↑ critical flicker fusion frequency in yoga group vs physical activity group, but no significant difference vs regular school group; ± degree of optical illusion; no significant differences in muscle strength and motor skills among groups

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
Dhume et al[36] 1991 India	NRCT	Young adult; N = 18; all male; normal adult	Yoga (with 1 y of yoga training) vs medication (amphetamine) vs placebo (pills) 10 days	Muscle control and concentration (10 days of consecutive attempts on balance board, calculated as balance index)	Between-group comparisons: Higher balance index on day 10 in yoga group (2.19) vs medication group (1.87), and placebo group (1.11)***
Dash et al[38] 2001 India	NRCT	Children with no age specified; N = 172; 71% male; normal child	Yoga (*pranayama,* asanas) and "games" to improve memory at yoga camp vs matched control in community not attending yoga camp 10 days	Motor strength (hand grip strength)	Within-group pre/postintervention comparison: Yoga group: ↑hand grip strength in yoga group among males (increase in left hand by 8.9% and right hand 12.2%) and females (increase in left hand 11.9% and in right hand 15.8%) Control group: no significant changes in hand grip strength
B. Psychological Health B1. Mental wellness					
Donohue et al[51]¶ 2006 USA	RCT 1/5	Adolescent; N = 90; 54% male; normal child; long-distance runners	Yoga (postures), motivation (motivating statements in group) vs attention control 20 min prior to 1-mile run	Performance of 1-mile run; satisfaction of intervention	Between-group comparisons: improvement in performance of 1-mile run in yoga group (1 ± 49 seconds) vs attention control (-1 ± 54 seconds), $t = 2.17$, but less improvement vs motivation group ($5 \pm$ seconds); higher satisfaction scores reported in yoga group (3.71 ± 1.16) vs attention control (2.00 ± 0.96), and no significant difference vs motivation group (4.10 ± 0.85)
Berger and Owen[40] 1992 USA	NRCT	Young adult; N = 87; NS; normal adult	Yoga for 80 min, once a week, swimming 40 min, twice a wk, vs health science lecture 14 wk	POMS,††† STAI‡‡‡	Between-group comparisons: Swimming and yoga groups vs health science lecture group demonstrated ↓ anger ($F_{1,78} = 24.29$), ↓ confusion ($F_{1,78} = 13.35$), ↓ tension ($F_{1,78} = 11.05$), ↓ depression ($F_{1,78} = 6.67$); among men, yoga group vs swimming group demonstrated ↓ tension($F_{1,82} = 14.22$), ↓ fatigue ($F_{1,82} = 9.34$), and ↓ anger ($F_{1,82} = 6.79$); among women, yoga group vs swimming group demonstrated greater ↓ fatigue ($F_{1,82} = 4.10$) and less ↓ vigor ($F_{1,82} = 5.14$)

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
West et al[41] 2004 USA	NRCT	Young adult; N = 69; 35% male; normal child	Yoga (unspecified) vs African dance vs biology lecture 90 min/1 class	Perceived Stress Scale, positive and negative affect, salivary cortisol	Between-group comparisons: ↓ stress among yoga group from before (70.2 ±10.4) to after class (57.7 ± 10.4) vs biology lecture group from before (66.3 ± 10.6) to after class (65.9 ± 9.0), but no difference vs African dance group; ↓negative affect among yoga group from before (31.5 ± 10.7) to after class (27.7 ± 8.9) vs biology lecture group from before (31.1 ± 12.9) to after class (33.4 ± 12.6), but no difference to African dance group; ↑positive affect among African dance group from before (68.8 ± 12.8) to after class (27.7 ± 8.9) vs biology lecture group from before (62.2 ± 16.0) to after class (53.2 ± 18.1), but no significant difference vs yoga group;↓cortisol in yoga group from before (0.46 ± 0.1 g/dl) to after class (0.38 ± 0.2 g/dl) vs ↑cortisol in African dance group from before (0.35 ± 0.1 g/dl) to after class (0.58 ± 0.1 g/dl), no difference vs biology lecture group
B2. Body image and eating disorders					
Clance et al[26] 1980 USA	RCT 1/5	Older children; N = 12; 25% male; poorly coordinated and low body satisfaction identified from gym class	Yoga (postures) with awareness training vs routine physical education 30 min, 3 d/wk, for 3 wk	Body satisfaction (Children's Body Satisfaction Test and Human Figure Drawing Test with number of emotional indicators as measure of body dissatisfaction)	Within-group pre/postintervention comparison: Yoga group: ↓ negative responses in Children's Body Satisfaction Test in yoga group from baseline (13.3 points) to 3 wk (6.8 points) and ↓ number of emotional indicators in human figure drawing test in yoga group from baseline (4.0) to 3 wk (2.7) suggestive of an increase in body satisfaction Routine physical education group: no significant changes in body satisfaction
Scime et al[42] 2008 USA	NRCT	Older children; N = 75; all female; normal girls recruited for "girls group"	Girls group with yoga (not specified), interactive discourse and relaxation, vs females attending either same school or same school district (n = 55) and on wait-list (n = 14) 90 min, once a week, 10 wk	The Eating Disorder Inventory-2 with body dissatisfaction scale, drive for thinness scale, and bulimia scale; Current and Future Intentions of Eating Disorder Behavior; Treatment Efficacy Scale; Perceived Stress Scale; Multi-Dimensional Self-Concept Scale (measuring competence scale, social scale, and physical scale)	Between-group comparisons: ↓ body dissatisfaction scale among girls group from baseline (1.01 ± 0.75) to 10 wk (0.72 ± 0.72) vs comparison group from baseline (0.85 ± 0.73) to 10 wk (0.91 ± 0.69);↓ bulimia scale among girls group from baseline (0.26 ± 0.40) to 10 wk (0.12 ± 0.21) vs comparison group from baseline (0.16 ± 0.23) to 10 wk (0.17 ± 0.35);↑ social scale of the Multidimensional Self-Concept Scale among girls group from baseline (3.06 ± 0.43) to 10 wk (3.21 ± 0.42) vs comparison group from baseline (3.26 ± 0.45) to 10 wk (3.30 ± 0.47);no significant differences in Drive for Thinness Scale, Current and Future Intentions of Eating Disorder Behavior scales, Treatment Efficacy Scale, or Perceived Stress Scale

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
Mitchell et al[22] 2007 USA	RCT 2/5	Young adult; N = 93; all female; eating disorders	Yoga (integral yoga not further specified), dissonance-based intervention, vs control (no intervention) 45 min, once a week, for 6 wk	Multiple measures, including eating disorder diagnostic scale, binge eating scale, STAI, depression, Eating Disorder Inventory	Between-group comparisons: No differences between yoga group vs control group; dissonance group vs control group demonstrated ↓disorder eating, drive for thinness, body dissatisfaction, alexithymia, and anxiety
B3. Depression and anxiety					
Stueck et al[44] 2005 Germany	NRCT	Older children; N = 48; NS; abnormal examination anxiety	Yoga (breathing, postures), group games and relaxation, vs control (no intervention) 6o min	Psychological and physiological anxiety related outcomes (immediate effects, long term—3 mo after)	Within-group pre/postintervention comparison: Intervention group (effect estimates not reported): immediate effects (↓ aggression and feelings of helplessness); long-term effects included ↑ in emotional balance; no changes in immediate or long-term self efficacy, examination anxiety Control group: not reported
Platania-Solazzo et al[43] 1992 USA	NRCT	Older children and adolescents; N = 60; 43% male; children admitted to inpatient psychiatry for depression (n = 30) or adjustment disorder (n = 30)	Relaxation therapy with progressive relaxation, massage, and yoga (not specified) vs relaxing video tape for same duration as intervention group 60 min/twice a week	Immediate effects of intervention on STAI for Children, POMS, behavior observation ratings, salivary cortisol	Between-group comparisons: ↓ STAI in relaxation therapy group from baseline (32.7) to posttreatment (29.1) vs relaxing video tape group from baseline (33.1) to posttreatment (32.9); ↓ POMS in relaxation therapy group from baseline (14.0) to posttreatment (9.6) vs relaxing video tape group from baseline (14.4) to posttreatment (13.6); ↓in self-reported anxiety among relaxation therapy group from baseline (1.9) to posttreatment (1.5) vs relaxing video tape group from baseline (1.8) to posttreatment (1.8); ↓ observer rate anxious behavior among relaxation therapy group from baseline (1.9) to posttreatment (1.5) vs relaxing video tape from baseline (1.8) to posttreatment (1.8); ↑ positive affect among relaxation therapy group from baseline (2.0) to posttreatment (2.3) vs relaxing video tape from baseline (1.9) to posttreatment (2.0); nonsignificant decreases in cortisol of patients with depression and adjustment disorder among relaxation therapy group vs relaxing video group
Malathi and Damodaran[28] 1999 India	RCT 1/5	Young adult; N = 50; NS; healthy students	Yoga (breathing, postures, and meditation) vs control (no intervention) 60 min, 3 times/wk, for 3 mo	Anxiety measured by STAI before and after a yoga practice 1 mo prior to and day of exam; number of exam failures (measurement not clearly explained so results not included here)	Within-group pre/postintervention comparison: Yoga group: reduction of STAI 1 mo before exam from before (30.9 ± 2.4) and after practice (20.4 ± 2.1) of yoga; reduction of STAI on day of exam from before (30.9 ± 2.4) and after practice (20.4 ± 2.1) of yoga Control group: no significant changes

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
C. Behavior and Development					
C1. Attention-deficit hyperactivity disorder and attention/concentration skills					
Harrison et al[45] 2004 Australia	NRCT	Older children; N = 48; 85% male; ADHD§§§	Yoga (meditation) with family vs wait-list (15 families) 90 min, 2 times/wk, for 6 wk	Connors Parent-Teacher Questionnaires, quantity of psychostimulant medication	Within-group pre/postintervention comparison: Yoga group: ↓ADHD symptoms as measured by Conners Parent-Teacher Questionnaire from mean baseline (22.54 ± 4.61) to 6 wk (14.62 ± 5.15); among 20 children on psycho-stimulant medication, 11 reduced the dosage at 6 wk, with significant improvement in symptoms from mean baseline (24.0 ± 4.90) to 6 wk (13.81 ± 4.79) Wait-list group: no change in ADHD symptoms Between-group comparisons (no effect estimates reported): better performance in coding task after yoga and exercise as compared to control period (F = 37.33, $P < .0001$); no significant difference in coding task between yoga and exercise
Hopkins et al[47] 1979 USA	NRCT with crossover	Older children; N = 34; NS; "educational problems" without clear clinical definition	Yoga (not specified), exercise, vs control (fine motor activities such as paper games and tasks involving fine-motor manipulation) 15 min	Concentration measured by "coding task"	
Jensen et al[21] 2004 Australia	RCT with crossover 2/5	Older children; N = 19; all male; ADHD, controlled on medication	Yoga (meditation, postures, breathing), and progressive relaxation vs cooperative groups/activities 1 hour, once a week, for 20 wk	Connors Parent Rating Scale, Connors Teach Rating Scale, Test of Variables of Attention, Motion Logger Actigraph	Within-group pre/postintervention comparison: Yoga group only: improvements in Connors Parent Rating Scale for subscales, including Oppositional, Global Index Emotional Lability, Global Index Total, Global Index Restless/Impulsive, and ADHD Index Cooperative groups/activities only: improvements in Connors Parent Rating Scale for subscales, including hyperactivity, anxious/shy, and social problems; both yoga and cooperative groups/activities; improvements in Connors Parent Rating Scale for subscales including perfectionism, DSM_IV hyperactive/ impulsive, and DSM_IV; no significant changes in Connors Teaching Rating Scale or Test of Variables of Attention; Motion Logger not reported due to technical difficulties
Peck et al[46] 2005 USA	NRCT	Older children (first-, second-, third-grade students); N = 20; 30% male; attention problems in school	Yoga (postures, breathing, meditation) with videotape vs regular activity (within same class) 30 min, twice a week, for 3 wk	Attention measured by time on task (percentage of intervals observed with students having eye contact with teacher-assigned task and performed assigned task)	Within-group pre/postintervention comparison: Yoga group: improvement in time on task among first-, second-, and third-grade students (1.5–2.7 effect size)‖ Regular activity: no significant changes

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
C2. Visual perception					
Raghuraj et al[20] 2003 India	RCT 3/5	Older children; N = 32; all female; normal child	Yoga (meditation, postures, awareness, relaxation, visualization) vs physical activity without awareness (standing exercises, sit-ups, sitting exercises, jogging, weights) 75 min, daily, for 1 mo	Visual perception (depth perception with 5 trials to align rods 2.5 m away)	Between-group comparisons: ↓ in error distance, indicating better depth perception in yoga group as compared to physical activity group
Manjunath et al[29] 1999 India	RCT 1/5	Adolescents; N = 28; NS; normal child	Yoga (postures, breathing, meditation) and "games" at yoga camp vs normal routine 10 days	Visual perceptual sensitivity measured by critical flicker fusion frequency	Within-group pre/postintervention comparison: Yoga group: ↑visual perceptual sensitivity Normal routine: no significant changes
Raghuraj et al[39] 1997 India	RCT 1/5	Adolescent; N = 80; all female; girls from community home (broken homes)	Yoga (postures, corpse pose) vs physical activity vs regular school 6 mo	Muscle strength (hand grip strength), motor skills (tweezer dexterity), visual perception (critical flicker fusion frequency, optical illusion)	Between-group comparisons: ↑ critical flicker fusion frequency in yoga group vs physical activity group, but no significant difference vs regular school group; ± degree of optical illusion; no significant differences in muscle strength and motor skills among groups
C3. Cognitive function					
Manjunath et al[30] 2001 India	RCT 2/5	Older children and adolescents; N = 20; all female; normal child	Yoga (postures, breathing, cleansing, meditation, devotional songs) vs physical training (standing/sitting exercises; jogging, bending forward, backward, sideways; lifting dumbbells) 75 min, once a day, for 1 mo	Executive function (Tower of London test with 3 domains, including planning time, execution time, number of moves to complete task)	Within-group pre/postintervention comparison: Yoga group ; improvement from baseline to day 30 in planning time, execution time, and number of moves to complete task Physical training: no significant changes
Manjunath et al[48] 2004 India	NRCT	Adolescents; N = 90; 48% male; normal child	Yoga (postures, breathing, meditation, devotional songs) and "games" at yoga camp vs fine arts camp vs regular activity 10 days	Verbal memory, spatial memory	Within-group pre/postintervention comparison: Yoga group: improvement in spatial memory from baseline (4.0 ± 1.9) to 10 days (5.7 ± 1.9); no significant changes in verbal memory Fine arts camp and regular activity groups: no differences in spatial or verbal memory

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
Naveen et al[49] 1997 India	NRCT	Adolescent; N = 135; NS; normal child	Yoga (4 types of breathing techniques) at yoga camp, vs regular school 10 days	Verbal memory, spatial memory	Within-group pre/postintervention comparison: Yoga groups: ↑ spatial memory among all 4 breathing types (mean scores ↑ 84%); no differences in verbal memory Control groups: no significant changes in verbal or spatial memory
C4. Mental retardation					
Uma et al[23] 1989 India	RCT 2/5	Older children and adolescents; N = 90; 64% male; mental retardation	Yoga (postures, breathing, cleansing, corpse pose, meditation) vs regular school 1 hour, 5 d/wk, for10 mo	Intelligence test (Binet-Kamath Test, IQ test developed in India; Sequin Form Board , nonverbal intelligence test); social age (Vineland Social Maturity Scale)	Within yoga group pre/postintervention comparison: Binet Kamath Test scores increased in yoga group from baseline (46.6 ± 13.1) to 10 mo (57.5 ± 17.0); Seguin Form Board mental age scores increased in yoga group from baseline (4.47 ± 1.76) to 10 mo (5.68 ± 2.26); Vineland Social Maturity Scale scores increased in yoga group from baseline (7.1 ± 2.7) to 10 mo (7.6 ± 3.0)
D. Gastrointestinal Disorders					
Kuttner et al[19] 2006 Canada	RCT 3/5	Adolescents; N = 28; 29% male; irritable bowel syndrome by Rome I||||||	Yoga (postures, breathing) vs wait-list control 1 hour, once a day, 4 wk	Pain intensity, gastrointestinal symptoms, functional disability inventory	Between-group comparisons: ↓ functional disability in yoga group from baseline (24.87 ± 12.85) to 4 wk (24.36 ± 12.90) vs wait-list control from baseline (31.55 ± 11.60) to 4 wk (34.00 ± 12.55); ↓ use of emotional-focused avoidance from baseline (1.29 ± 0.58) to 4 wk (1.07 ± 0.54) vs wait-list control from baseline (1.64 ± 0.87) to 4 wk (1.66 ± 1.10), and anxiety from baseline (10.90 ± 5.32) to 4 wk (10.64 ± 5.20) vs wait-list control from baseline (14.62 ± 7.19) to 4 wk (14.75 ± 6.42) Within-group pre/postintervention comparison (combined data with wait-list subjects): ↓ gastrointestinal symptoms in yoga group from preintervention (1.42 ± 0.57) to postintervention (0.93 ± 0.66)
E. Prenatal Yoga Effects on Neonates					
Narendran et al[52] 2005 India	NRCT	Neonates; N = 335; NS; healthy pregnant women	Yoga (postures, breathing, meditation), 1 hour, every day, vs control (walk) for 1 hour, 2 times a day Starting at 18–20 wk gestation until delivery	Birth outcomes (preterm delivery, birth weight, pregnancy-induced hypertension, intrauterine growth restriction for pregnancy-induced hypertension)	Between-group comparisons: ↓ preterm delivery in yoga group (14%) versus control group (29%); ↑ births above 2.5 kg in yoga group (80%) versus control group (67%); ↓intrauterine growth restriction/intrauterine growth restriction with pregnancy-induced hypertension in yoga group (4%) versus control group (10%)
F. Oxidative Stress					
Bhattacharya et al[50] 2002 India	NRCT	Young adult; N = 60; all male; normal adult	Yoga (postures, breathing, meditation, corpse pose) vs sedentary volunteers 30 min, once a day, for 10 wk	Oxidated stress measured by lipid peroxide levels (malondialdehyde content), superoxide dismutase levels	Within-group pre/postintervention comparison: Yoga group:↓ lipid peroxide levels from baseline ($9.57 \pm 0.56 \times 10^{-6}$mole/ml) to 10 wk ($8.21 \pm 0.76 \times 10^{-6}$ mole/ml); no significant change in superoxide dismutase levels Sedentary volunteers group: no significant changes

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Yoga for the Pediatric Population by Area of Study* (*Continued*)

Reference	Study Design†	Sample Characteristics‡	Type and Duration of Intervention	Outcomes Measured	Results
G. Outcomes Based on Traditional Indian Medicine###					
Bhushan et al[24] 2006 India	RCT 1/5	Adolescent; N = 188; 48% male; normal child	Yoga (meditation) vs control group (no intervention) 60 min, 7 d/wk, for 1 mo	Effect of yoga on 3 *gunas* based on shortened version, tridimensional inventory (*sattva, rajas, tamas*)	Within-group pre/postintervention comparison: Yoga group: among males, ↑ *sattva* guna from baseline (53.9 ± 12.2) to 1 mo (58.1 ± 7.4) $t = 2.27$; among females, ↑ *sattva guna* from baseline (54.3 ± 6.6) to 1 mo (59.2 ± 7.4), ↓ in *rajas gunas* from baseline (58.0 ± 7.6) to 1 mo (50.7 ± 6.7), and ↓*tamas gunas* from baseline (41.6 ± 6.53) to 1 mo (35.9 ± 6.1) Control group: no significant changes

*Controlled trials with between-group comparisons or within-group comparisons were significant at $P \leq .05$ unless otherwise noted.

†Modified Jadad scores are given for randomized controlled trials.

‡Age categories were organized as neonate (0<1 month), infant (1 to < 24 months), young child (2 to < 5 years), older child (5 to < 12 years), adolescent (12 to < 18 years), and young adult (18 to < 21 years).

§RCT = randomized controlled trial.

||Within-group preintervention and postintervention comparisons or between-group comparisons were reported as significant without *P* values.

¶Study is duplicated in appendix because outcomes measured are in multiple categories.

#NS = not specified.

**MEP = Maximum expiratory pressure.

††FEV_1 = forced expiratory volume in first second.

‡‡HR = heart rate per minute.

§§RR = respiratory rate per minute.

||||SBP = systolic blood pressure.

¶¶DBP = diastolic blood pressure.

##NRCT = nonrandomized controlled trial.

***No statistical analysis provided.

†††POMS = Profile of mood states.

‡‡‡STAI = State-Trait Anxiety Index

§§§ADHD = attention-deficit/hyperactivity disorder.

||||||Rome I is diagnostic criteria for irritable bowel syndrome.

¶¶¶Between-group or within-group comparisons were with significance at $P \leq .10$.

###*Gunas* represent 3 traditional categories from a traditional Indian medical system (Ayurveda) used to describe personality traits and physical and emotional characteristics. Each category needs to be balanced with an attempt to maximize one of the *gunas: sattvas*. There is limited evidence on the validation of tridimesional inventory to measure *gunas*.