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A Comparison of Preschoolers' Motor Abilities Before and After a 6 Week Yoga Program

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Abstract

Objective: While studies have demonstrated the beneficial effects of yoga for school-aged children and adults, there is limited research on the influence of yoga on preschoolers' motor abilities. The purpose of this study was to investigate how young children respond to Hatha yoga training by comparing preschoolers' strength, flexibility, coordination and balance before and after a 6-week yoga program.

Method: A cross-over design was used to compare performance of two groups of preschool children aged 3-5 before and after a 6-week developmentally appropriate yoga training program. The short form of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) and long jump were used to quantify strength, balance and bilateral coordination. Knee extension strength was measured with hand-held dynamometry and functional flexibility of low back and hamstrings was quantified by the Sit and Reach Test (SRT).

Results: When compared to a control group, the group participating in yoga demonstrated a statistically significant increase in static balance and functional lower extremity strength with a strong effect size, (d) =1.52, (d) = 0.82 respectively. When comparing individual's performance before and after participating in the yoga program, individuals showed statistically significant improvements in at least one measure of strength, flexibility and coordination indicating moderate effects of the yoga training.

Conclusion: The gross motor development of pre-school children may be enhanced by participation in a 6 week long developmentally appropriate group yoga program.

Keywords: Yoga; Preschoolers; Strength; Balance; Coordination; Flexibility; Gross motor development.

Introduction

The mind-body practice of yoga has become increasingly popular in recent years as a way to improve overall health and fitness across age ranges [1]. Yoga's integration of poses (asanas), breathing (pranayama) and meditation provides benefits to multiple body systems [2]. Current research suggests that yoga may produce therapeutic benefits for adults with a variety of conditions, including but not limited to back pain, osteoarthritis, cardiovascular disease and depression [2]. While the majority of research has focused on the effects of yoga on adults, studies have also demonstrated improvements in children 6 years of age and older in the areas of endurance [3,4], strength [3,4], motor planning and motor performance [4,5,6]. Study results have also suggested potential improvement in cardiovascular health in children, as demonstrated by a reduction in blood pressure, heart rate and respiratory rate after participating in a yoga program [2].

While studies have suggested potential therapeutic benefits of yoga for school-aged children, the quantity and rigor of such studies are limited [2]. Even fewer studies have specifically considered the implementation of yoga programs for very young children especially with respect to their motor development. Some authors support the use of yoga with preschoolers as it is safe, inexpensive, and relatively easy for pre-school teachers to integrate into the classroom routine [7]. While benefits experienced by older children would most likely translate to younger children, empirical testing has been limited to only a few studies. The results of one quazi-experimental study conducted with pre-schoolers who were at risk for developmental delays indicated that participation in a yoga program twice weekly over a four week period yielded slight improvements, but little to no statistically significant benefits in behavior, fine and gross motor skills or academic performance [8,9]. Similarly, no significant changes occurred in preschoolers' attention after participation in a 4 week yoga program, but a trend toward improved attention in girls was identified [10]. Participation in yoga programs was associated with diminished aberrant behavior in typically developing preschoolers [11] as well as those with autism [12]. The positive effects of yoga for older children and the trends toward improved performance in younger children warrants controlled study of yoga in a preschool population.

The present study was conducted to investigate how young children's motor performance responds to Hatha yoga training by comparing preschoolers' strength, flexibility, coordination and balance before and after a developmentally appropriate 6-week yoga program.

Methods

Subjects

A convenience sample was used consisting of children enrolled in one of two regular education preschool classrooms in the UCONN Child Development Labs. The sample consisted of 27 healthy students (13 in Classroom A and 14 in Classroom B), whose ages ranged from 3-5 years. The study sample was representative of a typical preschool classroom population relative to gender, ethnicity and level of ability.

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Motor Component	Test Item
Bilateral Coordination	Jumping in place - Same sides synchronized
	Tapping feet and fingers - Same sides synchronized
Balance	Walking forward on a line
	Standing on one leg on a balance beam - eyes open
Strength	Knee push-ups
	Sit Ups

Table 1: Motor Components and Associated Test Items in the Short Form of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2).

Test Item	Group not receiving yoga	Group participating in yoga
Push up	.333	.002
Sit up	.096	.048
Long jump	.135	.001
Right hand strength	.301	.034
Sit-and-reach	.472	.002
Jumping in place- Same sides synchronized	.192	.033

Table 2: Within subject change (p value) during yoga session 2 where $p < 0.05$ indicates significant change.

Classroom A consisted of 13 children (6 females, 7 males) with an average age of 43 months and Classroom B consisted of 14 children (6 females, 8 males) with an average age of 49 months. All children were invited to participate in the yoga activities with no exclusion. The University of Connecticut's Institutional Review Board approved the study and parental consent forms were received from all children participating in the study.

Design

A prospective, crossover design was used. Pre-test assessments were performed on all 27 participants before the onset of the program. Upon completion of pre-test assessments, children in Classroom A participated in a 6-week yoga training (yoga session 1) while Classroom B served as the control by not receiving yoga training. At the end of the 6-week yoga program, mid-test assessments were administered to all 27 children. Upon completion of mid-test assessments, children in Classroom B participated in the 6-week yoga program (yoga session 2), consisting of the same activities performed in the first session. Children in Classroom A did not receive yoga training during the second 6-week period. At the conclusion of the second 6-week yoga program, post-test assessments were administered to all 27 children.

Outcome measures

Three outcome measures were administered: 1) the short form of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) to quantify strength, balance and bilateral coordination along with the long jump (see Table 1); 2) hand-held dynamometry (HHD) to measure knee extension strength; and 3) the Sit and Reach Test (SRT) to quantify functional flexibility of low back and hamstrings.

The BOT-2 was purposefully chosen for this study, as it specifically quantifies many of the factors influenced by yoga in older populations, namely bilateral coordination, core and extremity strength, along with static and dynamic balance. The BOT-2 has demonstrated good inter-rater reliability ($r > 0.90$), good test-retest reliability ($r \geq 0.8$) and good internal consistency ($r \geq 0.8$) [13]. When compared with the gold standard, the Peabody Developmental Motor Scales, Second Edition, the BOT-2 demonstrated moderate to strong correlation for total motor score, strength and agility and fair correlation for body coordination [13].

The HHD has demonstrated moderate to high validity as a measure of knee extension strength in children ages 4-11. Knee extension strength, as measured by HHD in children, has been shown to have moderate to high discriminative value as indicated by areas under the receiver operator curve (AUC) of 0. 85 for the dominant side and 0.75 for the non-dominant side [14]. The HHD has also demonstrated moderate to high test-retest reliability, with a mean intraclass correlation (ICC) of 0.87 (0.76-0.93) on the dominant side and mean ICC of 0.86 (0.75-0.93) on the non-dominant side [14].

The SRT is a commonly used test of functional flexibility in school-aged children and is a component of the Presidential Fitness Test. During the SRT the child sits on a firm surface with legs extended and reaches as far as possible without bending his/her knees. The SRT has demonstrated excellent intra-rater reliability ($ICC \geq 0.94$), but questionable validity as a measure of isolated hamstring flexibility [15]. When compared with goniometric hip measurements in passive straight leg raise, it has shown weak criterion-related reliability ($r^2 = 0.281$) for children ages 6-12 [16]. It has also shown poor concurrent validity when compared with the straight leg raise ($r = 0.65$) and knee-extension angle ($r = 0.57$) [15]. Despite these limitations, the SRT met this study's needs to quantify functional flexibility, which reflects flexibility of the low back in conjunction with hamstrings.

Yoga Training

A 200-hour registered yoga teacher, with assistance from the preschool staff, conducted a 20-minute Hatha yoga session each week for six weeks for each preschool class as part of the weekly classroom activities, with the same series of activities being done with each group of students during the designated intervention time. Each session consisted of breathing exercises, balancing poses (one-leg tree pose, staggered stance warrior pose), backbends, forward bends, relaxation poses and seated meditation. Preschool staff rated children's participation for each yoga activity using a rating scale of 0-2 (0 = no participation, 1 = some participation, 2 = full participation). The instructor modified traditional yoga to accommodate the age and developmental levels of the participants; poses were repeated, the time held in each pose was shortened and approximations of poses were accepted. Auditory cues and reference to familiar objects were incorporated to enhance preschoolers' engagement (e.g., cat/cow pose; washing machine and dryer).

Analysis

SPSS version 15 was used for statistical analyses with an alpha level of .05. The change in mean outcome values for the group that participated and the group that did not participate were calculated and compared to identify trends in motor performance in both yoga sessions. Analysis of variance was done to determine between group differences and paired t-tests were done to compare individual's pre- and post-test performances.

Results

All children in each group were able to actively engage in the yoga program with modifications to address the children's developmental attention and comprehension levels. A comparison of the two preschool classes prior to any intervention based on initial test item performance indicated that the only statistically significant difference in performance occurred with children in Classroom B having greater mean hand strength than those in Classroom A (p =0.01).

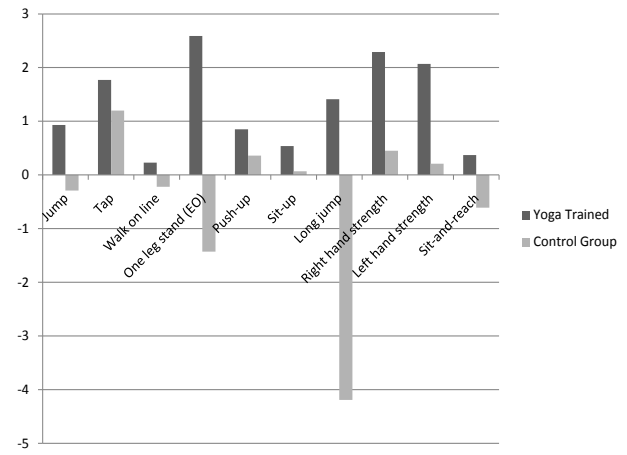

Figure 1: Change in groups test performance following yoga session 1.

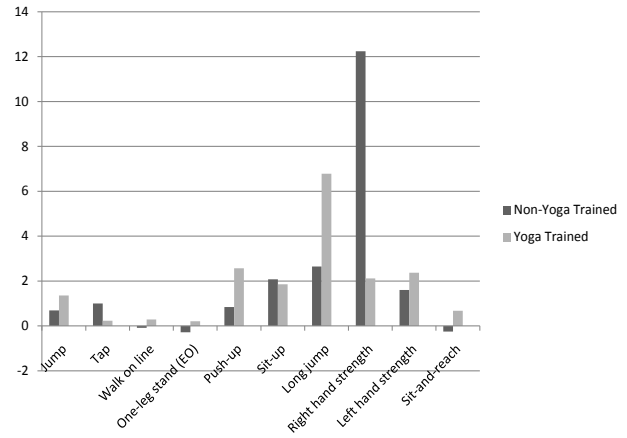

Figure 2: Change in groups' test performance following yoga session 2.

Test item	*p*		Effect Size
Jumping in place - Same sides synchronized	.006	.37 - 1.93	.58
Tapping feet and fingers - Same sides synchronized	1.39	-2.26 - .33	.29
Walking forward on a line	.166	-.63 - .11	.27
Standing on one leg on a balance beam - eyes open	.007	.62 -3.53	.56
Knee push-ups	.003	.63 – 2.85	.62
Sit ups	.05	-2.48 - .04	.38
Sit and reach	.009	.15 - .94	.63
Long jump	.001	1.97 -6.42	.74

Table 3: Comparison of before and after yoga training - paired t-test analysis.

At the time of the completion of yoga session 1, children who participated in yoga session 1 demonstrated improvement that exceeded the change experienced by the control group in 100% of the variables measured (Figure 1). Children who participated in yoga session 2 demonstrated improvements in 70% of the variables measured when compared to those children who were no longer receiving yoga training (Figure 2). When comparing performance after yoga session 1, where children in Classroom A participated in yoga and those in Classroom B served as the control, analysis of variance demonstrated that children in Classroom A experienced significantly greater improvements than those in Classroom B in static balance (p=000; 95%; CI=3.94-7.99; d= 1.52) and in functional lower extremity strength measured by long jump (p=0.03; 95% CI=0.57-10.62; d=.82). The mean change in static balance, as measured by the change in one leg stance time on a balance beam with eyes open, was 5.97 seconds more in the group participating in yoga compared to the control group. The mean change in distance jumped was 5.6" more for the participating group than the control group. No statistically significant differences occurred between the control group and the group receiving yoga for the other test measures.

After participating in the yoga training, those children in Classroom A did not demonstrate continued improvements at a statistically significant level as determined by a paired t-test. A paired t-test within subject comparison of mid-test and post-test assessments showed that children participating in yoga session 2 demonstrated statistically significant improvements ($p < .05$) in 6 test items (Table 2). Comparison of each child's performance before and after yoga using a paired t-test indicated significant improvements on the majority of test measures with effect sizes ranging from .38 to .75 (Table 3).

Discussion

This study set out to determine how yoga influences preschoolers' performance of motor-related tasks to address the gap in research for this particular age group. This study's findings indicate that yoga may have positive benefits for preschoolers' static balance, strength, bilateral coordination and flexibility. Children demonstrated significantly improved performance on the majority of measures after participating in yoga training. The study design allowed maturational effects to be mitigated by the use of a control group. Comparison of children receiving yoga and those who did not in the control portion of this study, indicated that participation in yoga has a strong effect in increasing static balance (d=1.52) and in improving functional lower extremity strength (d=0.82) [17]. Study findings were consistent with those that identified yoga's positive influence on motor planning and performance, coordination, physiological function, strength and overall health for school-aged children [18]. The trends identified in this study are in agreement with the existing literature that endorses yoga's benefits across multiple age ranges and confirms these positive effects with very young children.

The yoga regimens referenced in the literature vary widely, with most programs consisting of 30-90 minute sessions at a frequency of 3 or more times per week and lasting between 1 and 6 months [2]. The improvements in the components of gross motor performance observed in this study occurred following relatively brief duration and low intensity 20 minute yoga sessions once weekly. With increased frequency and/or duration from that conducted, an even greater improvement in balance, strength and flexibility would likely occur. The importance of specific training was substantiated by the observation that children who were not participating in yoga did not significantly lose acquired skills, but did not advance to the same degree as those who were receiving specific yoga training.

Like other authors, we found that the postures and principles of breathing that are characteristic of yoga can be incorporated fairly easily into therapeutic and educational experiences of preschoolers [7]. As little as 20 minutes of yoga activities incorporated weekly into gross motor groups for preschoolers engaged the children and led to improved strength, balance, coordination and flexibility. More profound effects than the current results may be experienced with increased frequency and intensity of programming [7]. Yoga is one form of exercise that can be used to promote children's development and health, thus bringing

therapists closer to the profession's 2020 vision as practitioners of choice in health promotion and disease prevention.

The study had some limitations with the most salient being the relatively small sample size. The limited intensity, frequency, and duration of yoga training may have diminished the effects of the yoga intervention thus contributing to the lack of statistically significant changes in areas other than those identified. The outcome measures selected may have also led to limitations. For example, the use of the BOT-2 may have resulted in possible floor effects for the younger children who had difficulty performing some of the tasks, primarily in the bilateral coordination subset. Possible ceiling effect on some items (e.g., walk the line, where all of the children in Classroom B were able to perform this task) may have lessened the ability to discriminate progress. While the SRT has questionable validity as mentioned earlier, it did provide a mechanism to quantify functional flexibility and was adequate for the purposes of this study.

Based on the results of this study and current research in the field, yoga has demonstrated possible therapeutic benefits to people of all ages, including preschoolers. Moreover, intervention at an early age may show promise in improving balance, coordination, strength and flexibility in typically developing children. Future research investigating the influence of increased frequency and/or duration of yoga programs on preschoolers' motor abilities would help substantiate yoga's health-related benefits. Expanding sampling to include children with identified special needs would also provide additional information for using yoga as an intervention strategy to remediate developmental delays.

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