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Research Article

Yoga Is as Good as Stretching–Strengthening Exercises in Improving Functional Fitness Outcomes: Results From a Randomized Controlled Trial

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Abstract

Background. Despite yoga's popularity, few clinical trials have employed rigorous methodology to systematically explore its functional benefits compared with more established forms of exercise. The objective of this study was to compare the functional benefits of yoga with the conventional stretching–strengthening exercises recommended for adults.

Methods. Sedentary healthy adults (N = 118; M_{age} = 62.0) participated in an 8-week (three times a week for 1 hour) randomized controlled trial, which consisted of a Hatha yoga group (n = 61) and a stretching–strengthening exercise group (n = 57). Standardized functional fitness tests assessing balance, strength, flexibility, and mobility were administered at baseline and postintervention.

Results. A repeated measures multivariate analysis of variance showed a significant time effect for measures of balance [$F(3,18) = 4.88$, $p < .01$, partial $\eta^2 = .45$], strength [$F(2,19) = 15.37$, $p < .001$, partial $\eta^2 = .62$], flexibility [$F(4,17) = 8.86$, $p < .001$, partial $\eta^2 = .68$], and mobility [$F(2,19) = 8.54$, $p < .002$, partial $\eta^2 = .47$]. Both groups showed significant improvements on measures of balance (left–right leg and four square step); strength (chair stands and arm curls); flexibility (back scratch and sit-and-reach); and mobility (gait speed and 8-feet up and go), with partial η^2 ranging from .05 to .47.

Conclusions. These data suggest that regular yoga practice is just as effective as stretching–strengthening exercises in improving functional fitness. To our knowledge, this is the first study to examine functional benefits of yoga in comparison with stretching–strengthening exercises in sedentary, healthy, community-dwelling older adults. These findings have clinical implications as yoga is a more amenable form of exercise than strengthening exercises as it requires minimal equipment and can be adapted for individuals with lower levels of functioning or disabilities.

Key Words: Functional performance—Yoga—CDC guidelines—Physical activity

Aging is associated with increased functional limitations (1), loss of independence, and reduced quality of life (2). The incidence of functional limitations and disability increases with age and chronic disease, and for many decades, researchers have been testing the efficacy of physical activity–based interventions for enhancing these functions in older adults. Although regular physical activity has been demonstrated to be critical for the promotion of health and function as people age, persons older than 50 years of age represent the most sedentary segment of the adult population. In addition to the 150 minutes/week of moderate intensity aerobic exercise, the 2008 Physical Activity Guidelines for Americans highlight that adults should perform muscle-strengthening activities on 2 or more days of the week targeting all major muscle groups. However, only 19.9% of adults aged 45–64 years meet the Physical Activity Guidelines for muscle-strengthening physical activity, with the numbers dropping to 14.1% for older adults aged 65 years and older (3).

The use of yoga and other complementary and alternative therapies is becoming increasingly popular, especially among older adult populations who use these therapies for aging-related

chronic conditions such as back pain, arthritis, anxiety, depression, and cancer (4–7). Yoga-based randomized controlled trials (RCTs) have shown to reduce the fear of falling (8) and improve balance and flexibility outcomes as assessed by the Senior Fitness Tests (9), including scores on the one-leg stand test, forward-bend flexibility, and chair sit and reach among older adults following a 12-week Iyengar yoga intervention (10,11). More recently, Tiedemann and colleagues (12) found significant improvements in balance and mobility following a 12-week Iyengar yoga intervention among community-dwelling older adults. Single-armed yoga interventions (8) and cross-sectional studies (13) with aging yoga practitioners also demonstrate improvements in strength, flexibility, and balance as measured by the 30-second chair stand, arm curl, balance, and back scratch tests of the Senior Fitness Test battery.

In a recent systematic review, Patel and colleagues (14) summarized the yoga functional fitness literature and compared the benefits of yoga with other exercise interventions in older adults. They concluded that yoga practice may lead to improvements in strength, flexibility, and health-related quality of life. Several limitations were highlighted by the authors, including the need for methodologically sound and well-designed randomized trials, larger sample sizes, and objective measures of functional ability when comparing outcomes across different exercise interventions. In spite of yoga's popularity, there are no RCTs that have examined the effects of Hatha yoga—the most widely practiced form in North America (15) for improving functional fitness among community-dwelling, sedentary older adults. There is also a need to examine how Hatha yoga as well as other forms of yoga compare with conventional muscle-strengthening exercises recommended by the Centers for Disease Control and Prevention (CDC).

The purpose of this RCT was to address these limitations and examine the effects of an 8-week Hatha yoga intervention on objectively assessed functional fitness in comparison with conventional muscle-strengthening exercises. Based on the existing evidence, it was hypothesized that the Hatha yoga group would show similar or improved performance than the stretching–strengthening group, on the standardized functional fitness tests of balance, strength, flexibility, and mobility following the 8-week intervention.

Methods

Participants

Sedentary healthy participants were recruited between March 2012 and January 2013 through University of Illinois LISTSERV, fliers, and postings around campus and local community groups. Using a moderate effect size of f = .30 (16) and a power of 80% (for one-tailed alpha = .05), often recommended as appropriate power in behavioral research (17), and assuming a moderately strong correlation among the repeated measures (r = .50), the power analysis yielded a sample size of 68 participants. Allowing for 15% attrition, we planned to recruit 40 participants per treatment condition to maximize power. For this two-arm RCT, we were successful in meeting the target sample size and recruited N = 118 participants (men = 26; mean age = 62.0 ± 5.6 years) who were randomized to either an 8-week Hatha yoga intervention or a stretching–strengthening control group. The primary objective of this RCT was to examine cognitive performance, and detailed recruitment procedures have been described elsewhere (18). Briefly, participants were between 55 and 79 years of age, English speaking, sedentary for at least the previous 6 months (<2 days per week of structured physical activity, no regular ongoing yoga practice), and able to get up and down from the floor. In addition to these inclusion criteria, participants had to receive physician's consent to participate in the 8-week RCT. Participants who did not meet these criteria or were unable to obtain their physician's consent were excluded from participation.

Procedures

Basic demographic information (age, sex, income, and marital status) and all baseline assessments were conducted prior to randomizing the participants (by age and sex) into the Hatha yoga intervention or stretching–strengthening control group. Both assessors and participants were blind to group placement at the time of baseline assessments. Figure 1 shows the flow of participants through the study following baseline testing and randomization.

Yoga Group

The yoga intervention was led by certified yoga instructors and designed as a beginner but progressive 8-week program. The supervised group sessions were held three times a week for the 8-week duration and included practice of postures, breathing, and meditative exercises. Yoga mats, belts, and blocks were used to perform the yoga postures as needed by participants with varying functional capacities. Sessions were held thrice a week, with the first session introducing new exercises, second session developing concepts while reviewing and adding some new postures, and the final session dedicated to reviewing the week's material to ensure that the yoga practice was gradual and steady through the 8-week intervention. A sample yoga session demonstrating the postures performed in weeks 4–5 is presented in Table 1.

Stretching–Strengthening Control Group

The stretching–strengthening group served as a control to the yoga intervention for the period of 8 weeks. Participants in this group also met on the same days and times, in a separate exercise studio to engage in exercises that met the CDC anaerobic recommendation (19). Each class consisted of a warm up and a cool down, and the participants completed 10–12 repetitions of 8–10 different exercises led by a certified personal trainer. For each exercise, the trainer also demonstrated a modified version of the exercise that allowed the exercise sessions to be adaptable to participants with a wide range of functional capacities (eg, for the standing ab crunch an "easier" modification was to perform the exercise with both feet on the ground at all times, whereas the "regular" version of the exercise was to alternately lift the legs as the participant performed the crunch). Resistance bands, blocks, and chairs were also used to perform these exercises and modifications (eg, bicep curls, tricep extensions, flutter kicks seated in the chair, etc.). A sample stretching–strengthening group session from weeks 4–5 of the intervention is presented in Table 1.

Participants in both groups completed exercise logs where they rated their enjoyment and rating of perceived exertion at the end of each class. The instructors in both groups monitored participants' attendance over the course of the 8-week program.

Measures

In addition to the basic demographic information (age, sex, marital status, date of birth, income, and education), the following

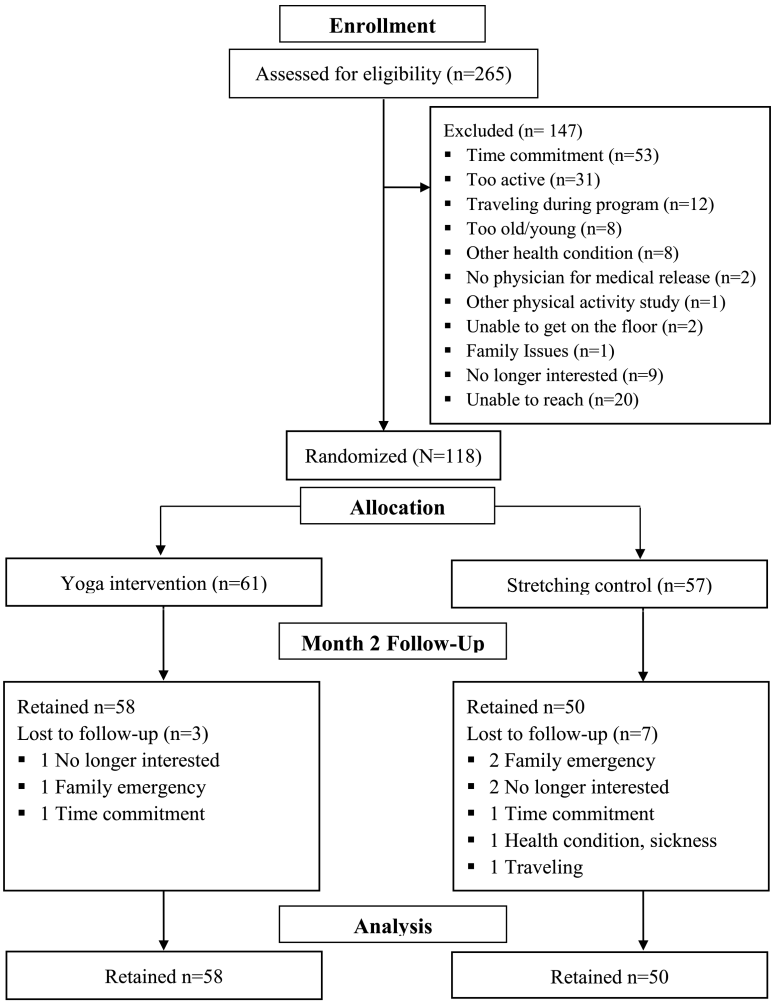

Figure 1. Participant flow through the study.

Table 1. Hatha Yoga and Stretching–Strengthening Exercises Performed During One of the Exercise Sessions

Hatha Yoga	Stretching–Strengthening Exercises
Sukhaasana—seated shoulder/arm stretch	Straight line walking
Garudasana—seated eagle pose	Standing abductions
Ardha Matsyendrasana—modified seated twist	Standing ab crunch
Marjaryasana/Bitilasana—cat-cow pose	Single leg dip
Urdhva Hastasana—upward salute	Seated twist
Ardha Uttanasana—standing half forward bend	Flutter kicks
Vrikshasana—tree pose	Standing bent over row
Virabhadrasana I—warrior 1	Squats
Bhujangasana—cobra pose	Seated military press
Balasana—child's pose	Bicep curls
Savaasana—corpse pose, relaxation	

Sessions were progressive and exercises became more challenging over the 8-week randomized controlled trial.

functional fitness tests were completed by all participants at baseline and postintervention.

Functional Fitness Tests

Participants completed the Senior Fitness Test (9). The tests included 8-Foot Up-and-Go, a test of physical agility and dynamic balance (best of two timed trials); the Arm Curl test, which assesses arm muscle strength endurance, specifically of the biceps (number of reps in 30 seconds); Chair Stand test, which assesses lower body strength (number of reps in 30 seconds); and the Back Scratch and Chair Sit-and-Reach, tests of upper body and lower body flexibility (distance in inches between finger tips, and fingertips and toes, respectively). To assess balance, we used the Four Square Step Test (20), a test of dynamic standing balance where the subject steps into 4 squares and is required to step forward, backward, and sideway to the right and left, and the One-leg Stand Test consisting of balancing on one leg (left and right), unsupported for up to 30 seconds. We also assessed gait speed (meter/second) using a subtest from the Short Physical Performance Battery (21,22), which was the better of two recorded times over a 4-meter course.

Data Analysis

Data were analyzed using SPSS statistical software using an intention-to-treat approach. Prior to all hypothesis testing, independent sample *t*-tests were conducted to examine whether significant mean differences existed in demographic and physical activity variables among the two groups at baseline. Using a repeated measures multivariate analysis of covariance (MANCOVA) with baseline means,

age, and sex as covariates, we examined whether outcomes changed differentially from baseline to postintervention. Effect sizes were expressed as partial η^2 (.01 = small effect, .06 = medium effect, and .14 = large effect). *F* test statistics and effect sizes are reported for the analyses of covariance.

Results

Demographic Variables

Table 2 presents participant characteristics for demographic factors and group attendance over the 8-week intervention. The two randomized groups did not significantly differ on either of these variables at baseline (all *p* values ≥.20). The average attendance at the yoga classes was 80.82% (19.2 ± 3.8 sessions) and was not significantly different from the stretching exercise classes at 81.29% (19.4 ± 3.8 sessions) over the 8-week study duration. The overall attrition rate was 8.47% with 108 participants successfully completing the intervention and follow-up assessments. A series of *t*-tests were conducted to determine whether the completers differed from the dropouts (*n* = 10, see Figure 1 for reasons for dropouts) on any demographic or baseline measures.

Table 2. Participant Demographics by Group

	Yoga	Control
	n = 61	*n* = 57
Age (mean, *SD*)	62.1 (±5.82)	62.0 (±5.39)
Sex (*n*, %)		
Female	49 (80.3%)	43 (75.4%)
Male	12 (19.7%)	14 (24.6%)
Race (*n*, %)		
African American	7 (11.5%)	4 (7.0%)
Asian	2 (3.3%)	2 (3.5%)
American Indian/ Alaskan Native	0 (0%)	2 (3.5%)
More than one race	1 (1.6%)	3 (5.3%)
Caucasian	51 (83.6%)	46 (80.7%)
Education (*n*, %)		
<College degree	14 (23%)	25 (43.8%)
>College degree	47 (77%)	32 (56.2%)
Income (*n*, %)		
<40,000	11 (17.9%)	16 (28.2%)
>40,000	50 (82.1%)	41 (71.8%)
Marital status (*n*, %)		
Married	34 (55.7%)	39 (68.4%)
Separated/ divorced	15 (24.6%)	11 (19.3%)
Widowed	7 (11.5%)	4 (7%)
Single	3 (4.9%)	2 (3.5%)
Partnered/ significant other	2 (3.3%)	1 (1.8%)
Attendance over 8-week intervention (mean, %)	19.2 (80.82%)	19.4 (81.29%)

Functional Fitness Outcomes

Table 3 shows the intervention effects on the functional fitness outcomes for the yoga intervention and stretching control groups at baseline and postintervention. There were no significant group differences between the two groups on any of the outcome variables at baseline (all *p* values ≥.14). Age, sex, and baseline means were used as covariates in all analyses.

Balance

A repeated measures MANCOVA showed a significant time effect for balance measures [$F(3,103) = 16.26$, $p < .001$, partial $\eta^2 = .32$]. Upon closer examination, the significant time effects were observed for the four square step test [$F(1,105) = 39.75$, $p < .001$, partial $\eta^2 = .27$] and right leg balance [$F(1,105) = 5.49$, $p = .02$, partial $\eta^2 = .05$]. Interestingly, a significant Group × Time interaction was observed for left leg balance, favoring the yoga group [$F(1,105) = 4.25$, $p = .04$, partial $\eta^2 = .04$].

Strength

A repeated measures MANCOVA showed a significant time effect for strength measures [$F(2,103) = 61.50$, $p < .001$, partial $\eta^2 = .54$]. The significant effects were observed for both the chair stand test [$F(1,104) = 92.97$, $p < .001$, partial $\eta^2 = .47$] and the arm curl test [$F(1,104) = 93.52$, $p < .001$, partial $\eta^2 = .47$]. No Group × Time interactions were observed for the two strength tests; however, a significant between-subjects main effect was observed for sex [$F(2,101) = 8.374$, $p = <.001$, partial $\eta^2 = .14$] with men completing more chair stands and arm curls than women.

Flexibility

A repeated measures MANCOVA showed a significant time effect for flexibility measures [$F(4,101) = 2.54$, $p = .04$, partial $\eta^2 = .09$]. Upon closer examination, the time effect was observed for back scratch (right side) [$F(1,104) = 3.65$, $p = .05$, partial $\eta^2 = .03$] and sit and reach (right side) [$F(1,104) = 6.27$, $p = .01$, partial $\eta^2 = .06$]. Similar results were observed for back scratch and sit-and-reach for left side: [$F(1,104) = 13.47$, $p < .001$, partial $\eta^2 = .11$] and [$F(1,104) = 59.56$, $p < .001$, partial $\eta^2 = .36$], respectively. Additionally, there was a main effect for sex [$F(4,101) = 4.76$, $p = .001$, partial $\eta^2 = .16$] with women showing greater flexibility than men.

Mobility

A repeated measures MANCOVA showed a significant time effect for mobility measures [$F(4,100) = 12.42$, $p < .001$, partial $\eta^2 = .33$]. Upon closer examination, the time effect was observed for the 8-feet up-and-go test [$F(1,104) = 19.06$, $p < .001$, partial $\eta^2 = .16$], gait speed [$F(1,104) = 30.22$, $p < .001$, partial $\eta^2 = .22$], stairs up [$F(1,104) = 15.97$, $p < .001$, partial $\eta^2 = .13$], and stairs down [$F(1,104) = 9.78$, $p < .01$, partial $\eta^2 = .09$]. Additionally, a between-subjects main effect was observed for age on the 8-feet up and go [$F(1,103) = 22.16$, $p < .001$, partial $\eta^2 = .18$], the gait speed test [$F(1,103) = 6.05$, $p = .02$, partial $\eta^2 = .06$], and the stairs up time [$F(1,103) = 4.79$, $p = .03$, partial $\eta^2 = .04$] with older subjects performing slower on these mobility measures than their younger counterparts.

Discussion

The 8-week Hatha yoga intervention was just as effective as conventional stretching and strengthening exercises in improving functional fitness outcomes among middle-aged and older adults. In addition, a Group × Time interaction was observed for left leg balance, where the yoga participants showed larger improvements than the stretching–strengthening controls. Gender differences were observed on strength and flexibility measures

Table 3. Means and Standard Deviations of the Functional Outcomes by Group and Timepoints

		Yoga		Control		η^2
		Pre	Post	Pre	Post	Time effects
	Unit	*n* = 61	*n* = 58	*n* = 57	*n* = 50	
Balance						
Left leg	s	20.63 ± 11.25	23.42 ± 10.04	18.2 ± 11.42	17.69 ± 11.14	.01
Right leg	s	21.32 ± 10.86	23.54 ± 10.25	18.64 ± 10.36	21.31 ± 10.83	.05*
Four square step	s	7.54 ± 1.41	6.7 ± 1.03	7.68 ± 1.69	7.01 ± 1.28	.27***
Strength						
Arm curls	number of reps	16.31 ± 4.41	20.52 ± 4.63	15.04 ± 4.91	18.62 ± 5.33	.47***
Chair stands	number of reps	11.7 ± 2.28	14.3 ± 3.17	11.2 ± 2.85	13.04 ± 3.37	.47***
Mobility						
4-m gait speed	m/s	1.08 ± .22	1.17 ± .19	1.03 ± .22	1.19 ± .19	.22***
8-feet up-and-go	s	5.69 ± .91	5.23 ± .80	5.93 ± 1.40	5.52 ± 1.03	.16***
Stairs up	s	8.3 ± 1.71	7.72 ± 1.45	8.26 ± 2.22	7.77 ± 1.62	.13***
Stairs down	s	7.39 ± 1.51	6.98 ± 1.63	7.93 ± 2.41	7.38 ± 1.87	.09**
Flexibility						
Back scratch—left	inches	−5.66 ± 4.66	−4.24 ± 4.34	−5.97 ± 5.01	−5.13 ± 4.76	.11***
Back scratch—right	inches	−2.99 ± 4.53	−2.04 ± 4.14	−3.89 ± 5.28	−3.44 ± 4.96	.12***
Sit-and-reach—left	inches	−2.23 ± 4.41	0.12 ± 3.71	−1.44 ± 3.82	0.4 ± 3.28	.36***
Sit-and-reach—right	inches	−2.12 ± 4.43	0.2 ± 3.82	−1.46 ± 4.04	0.36 ± 3.51	.38***

Note: *$p < .05$, **$p < .01$, ***$p < .001$.

across both groups with women demonstrating greater flexibility than men and men demonstrating greater lower and upper body strength. Age was found to be a significant moderator of mobility performance with older participants exhibiting slower scores on mobility tests. Overall, we observed significant time effects for each of the balance, flexibility, strength, and mobility measures, indicating that both groups improved and Hatha yoga was just as effective as the conventional CDC strengthening guidelines in improving these functional fitness outcomes in community-dwelling older adults.

Our results concur with previous findings in the literature where researchers have found similar improvements in balance, mobility, and flexibility measures following yoga interventions. The intervention effect sizes observed in our study ranged from .05 to .47 (medium to large effects), which were also comparable with previous findings (14,15). With the increasing popularity of yoga and larger numbers of older adults adopting alternate modes of physical activity, these findings have significant clinical implications. In fact, for the gait speed test, we observed a mean change of .09 for the yoga group and .16 for the control participants, both of which fall in the range for meaningful and substantial change estimates (23). Poor function has been associated with disability, loss of independence, and reduced quality of life (2). Yoga may serve as an alternate form of therapy to improve balance, mobility, and strength among older adults and combat age-related functional declines. Replication of these results in larger and more diverse samples may enable researchers and practitioners to establish regular practice of yoga as a proxy for meeting anaerobic CDC guidelines for some older adult populations.

It is important to note that a majority of previous studies have utilized Iyengar yoga protocols to examine functional fitness outcomes. There are many different styles of Hatha yoga characterized by the rate at which postures are performed, environmental temperature, physical intensity, level of difficulty, and emphasis on body alignment and relaxation. In addition, the use of aids (eg, blocks and straps) enables those of most functional abilities to participate in yoga (24). Iyengar yoga is one such form of yoga that uses properties including bolsters, belts, and chairs to adapt to an older individual's abilities to perform exercises for all muscle groups (25). We chose to test Hatha yoga in this RCT as it is the most widely practiced form of yoga in North America (15). The adherence to the program was high suggesting that it was well tolerated by the participants, and the sessions were well designed and progressive over the 8-week period. No adverse events were reported in either group, which also is attributable to the supervised progressive nature of the exercise groups.

Regardless of the type of yoga, all yoga postures require the participants to hold and move between a series of stationary positions that use isometric contraction and relaxation of different muscle groups to create specific body alignments. Much like the CDC anaerobic recommendations, yoga practice involves seated, standing, as well as supine postures that target all major muscle groups. Major classifications of poses are standing, forward and backward bending, twists, hand balancing, inversions, and restoratives (26). Although yoga practice does not entail use of weights or resistance bands, the yoga postures, stretches, and holds involve working with the practitioner's own body weight. For instance, the down dog posture (*adho mukha shvanasana*) involves sustaining one's body weight on upper and lower body muscles including the trapezius, triceps, glutes, and hamstrings, forming an inverted V shape. Similarly, practice of the tree pose (*vrikshasana*) focuses on balance by working one side of the body at a time. It is expected that practice of these postures over the course of the 8-week intervention is likely to have resulted in the functional gains reported in this study.

We acknowledge a number of limitations. Firstly, a majority of the sample was women and primarily high income and Caucasian. Overall, the sample was healthy, and all participants were consented by their physicians to participate in the RCT. It remains to be determined whether similar adherence to yoga programs and

improvements in functional outcomes would be observed among other segments of the population such as ethnic and racial minority groups, low income groups, as well as older adults with lower levels of functioning or poor health. Another limitation is the absence of a follow-up timepoint to examine long-term adherence and sustained effects of yoga practice on functional fitness outcomes. It would also be interesting to examine the progression and perceived mastery of the participants over the course of the intervention and its relationship with the objective outcomes. Future research needs to employ multiple yoga intervention groups in order to determine the dose–response relationship and its resulting functional benefits and specific effect sizes for aging populations.

Despite these limitations, our study is the first RCT to examine Hatha yoga effects in comparison with CDC recommended stretching and strengthening guidelines. Hatha yoga is the most common form of yoga practiced in North America, and these findings hold significant implications for Hatha yoga practitioners across all age groups. The use of an exercise comparison group to test the efficacy of Hatha yoga is novel and has been a limitation of previous yoga literature examining functional outcomes. We also employed a comprehensive battery of standardized and well-established, objective measures of balance, strength, mobility, and flexibility to examine the functional fitness benefits.

Overall, the 8-week Hatha yoga program was found to be just as effective as the CDC recommended stretching and strengthening exercises in improving functional fitness in older adults. These findings have important clinical implications as yoga may serve as an alternate form of physical activity for individuals who may be unable to perform stretching and strengthening exercises using resistance bands or free weights. The gentle and modifiable nature of practically all Hatha yoga postures promises to be a well received, safe, and enjoyable exercise that is easy to adopt and maintain for older adults. Future studies should examine functional fitness effects in younger adult practitioners of Hatha yoga as well as frail older adults, individuals with disabilities, and in clinical populations.

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