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YOGA PRACTICE IMPROVES PHYSICAL FITNESS AND PSYCHOMOTOR COORDINATION IN OLDER ADULTS

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ABSTRACT

Background. There is evidence that yoga practice can improve cardiovascular endurance, and that physically fit individuals have better psychomotor functioning, however, to the best of our knowledge, no information is available regarding yoga effects in population aged 60 years and older.

The aim of the study was to test the hypothesis that 10 weeks of yoga practice would improve physical fitness and psychomotor coordination in older adults.

Methods. Thirty-three older adults aged 66.9 ± 6.0 years were randomly assigned to the control group and the experimental group, which had 90-min yoga practice twice a week, for 10 weeks. Attendance and adherence ratios, and changes in cardiovascular endurance, flexibility, grip strength, and psychomotor coordination were assessed.

Results. Attendance of the experimental group subjects in yoga practice was 96.4 ± 4.1%. Yoga practice increased ($p < 0.05$) hand grip strength, flexibility in hips, thighs and spine, and decreased ($p < 0.05$) the distance from target in the psychomotor task, whereas no changes in peak oxygen consumption were observed.

Conclusion. Nevertheless, regular 10-week yoga practice had no effect on cardiovascular endurance, but it produced beneficial changes in muscular strength, flexibility and psychomotor coordination for older adults.

Keywords: aging, cardiovascular endurance, strength, flexibility, exercise.

INTRODUCTION

Worldwide the number of populations aged 60 years and older is dramatically increasing (WHO, 2018). It is well established that aging process reduces physical fitness (strength, endurance, agility, and flexibility). As a result, the prevalence of individuals suffering from the limitations of daily life activities and normal functioning (Milanović et al., 2013) is increasing. It is suggested that in order to enhance physical fitness and to delay health deterioration, the elderly should be encouraged to promote physical activity (Chen et al., 2010).

Growing evidence suggests that yoga as an alternative and complementary therapy can also increase physical activity and reduce sedentary behavior (Lau et al., 2015). In addition to the beneficial yoga effects on flexibility and strength (Gothe, McAuley, 2016; Groessl et al., 2018), some yoga postures (asanas) may achieve the recommended level of intensity for endurance improvement (Hagins et al., 2007). Nevertheless, there is evidence that yoga can improve cardiovascular en-

durance (Lau et al., 2015), however, to the best of our knowledge, no information is available regarding population aged 60 years and older. Furthermore, previous studies showed that physically fit individuals have better psychomotor functioning (Spirduso, 1980), and that yoga practice can improve fine motor skills in young adults (Manjunath, Telles, 1999). However, we are not aware of any previous studies on the effect of yoga on psychomotor function in older adults.

Thus, based on the existing evidence, it was hypothesized that yoga practice would result in improved physical fitness and psychomotor coordination in older adults. Therefore, the aim of this study was to estimate the effect of 10 weeks of yoga practice on grip strength, flexibility, cardiovascular endurance, and psychomotor coordination in older adults.

METHODS

Subjects. Inclusion criteria were: aged 60 years and older; *sedentary* behavior for at least 6 months; no previous experience of yoga practice; good physical health determined by Physical Activity Readiness Questionnaire as confirmed by medical history; and no cognitive impairments determined by baseline Mini-Mental State Examination score of ≥ 45. In total, thirty-three healthy older subjects (age 66.9 ± 6.0 years; weight 72.6 ± 11.5 kg) were recruited in the study. The subjects read and voluntarily signed an informed consistent based on the Declaration of Helsinki. All procedures were approved by the Kaunas Regional Biomedical Research Ethics Committee.

Protocol. Firstly, flexibility and hand grip strength was measured. Afterwards, visuomotor task was performed and endurance was evaluated. Then, subjects were classified into two groups: yoga practice (experimental group) and control group. Experimental group subjects (n = 18; 17 women) were involved in a biweekly 10-week yoga practice (90 minutes per session) with a qualified and experienced yoga teacher from Yoga Academy, Kaunas. Each yoga session included warm-up, asanas (physical postures), breathing exercises (Himalayan Kriya techniques) and relaxation in shavasana. During the intervention, subject's adherence and attendance ratio were assessed. Control group subjects (n = 15; 13 women) were asked to maintain their daily activities. After 10 weeks all measurements were repeated.

Measurements. *Endurance*. The measurement of aerobic endurance was determined by peak oxygen consumption (VO_2peak). An incremental cycling exercise test on an electronically braked cycle ergometer "Ergometrics-800S" (Ergo Line, Medical Measurement Systems; Binz, Germany) at a pedal cadence of 70 rpm was performed. The test was started with 3 min of baseline pedaling at 40 W and continued until the intensity of cycling could not be maintained at the required level

for longer than 10 s. The highest oxygen consumption value during the 15 seconds of the increasing pedaling test was calculated as the Vo_2peak.

Grip strength. Hand grip strength was measured using a hydraulic handheld dynamometer (Jamar, Model J00105, Sammons Preston, Bolingbrook, Illinois). Subjects completed 3-second maximal contractions with the dominant arm in a neutral position three times. Verbal encouragement was used to ensure maximal contractions. There was a rest interval of 1 minute to ensure sufficient recovery between each contraction. An average value was then taken of these three scores (Horsley el al., 2016).

Flexibility. Flexibility was tested by two tests: sit and reach test and lateral-bending test. Sit and reach test measures hip region flexibility, including the lower back and hamstring. The subject sat on the floor with outstretched and supported legs in the measuring box. The ruler was placed on the ground between the subject's legs or on the top of the step. The subject was asked to place one hand on top of the other with the fingertips together, then reach slowly forward while keeping legs straight. At the point of greatest reach, the subject was asked to hold position for a few seconds, and the distance reached by the ruler was measured. The test was performed three times, and the greatest reached distance was taken for further analysis.

Lateral bending test measures flexibility of thoracic and lumbar spine and pelvis. The subject stands with heels and buttocks touching the wall, knees straight, shoulders back, outer edges of the feet 30 cm apart, the feet being parallel. We measured the minimal fingertip-to-floor distance in full lateral flexion, without flexion, extension or rotation of the trunk or bending the knees. The subject was asked to bend to the side as far as possible without stepping away from the wall. While the subject was bending, their straight arms slid down. At the lowest point, the subject was asked to hold this position for 3 seconds and the distance between the middle finger and the floor was assessed with a tape measure.

Psychomotor coordination. To assess psychomotor performance, the Automated Neuropsychological Assessment Metric (ANAM-4, Vista Life Sciences, USA) was administered during the pursuit tracking task. The subjects were instructed to move the computer mouse so that the mouse cursor tracked a moving box with a + symbol inside. The cursor was required to remain inside the box and be kept as close to the + as possible as it moved across the screen in a circular pattern for 120 s. The mean distance from the + target and time on target was recorded.

Statistical analysis. Statistical analysis of the data was performed using *Microsoft Office Excel 2010* and *IBM SPSS Statistics 23.0*. The data are presented as mean ± standard deviation (SD). Normal distribution of the data was verified by the Shapiro–Wilk test. Student's t test for independent samples with normal distribu-

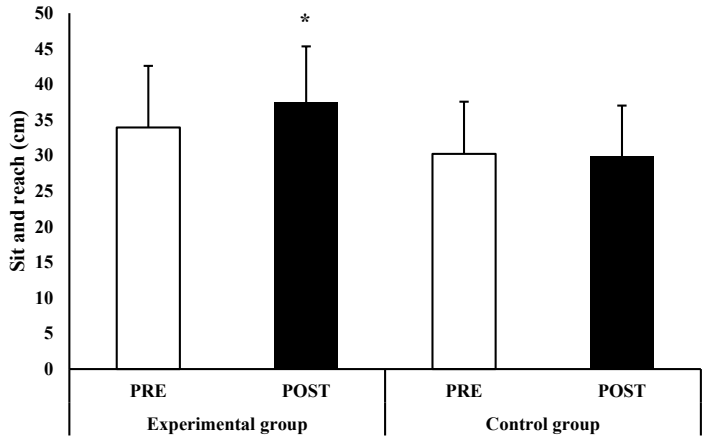
tion and Mann–Whitney's test for non-normal distribution were used to compare the control and experimental groups. The Student's t test for dependent samples compared to baseline was used to assess the changes. The effect size was estimated by Cohen's *d*. The difference is considered statistically significant if $p < 0.05$.

RESEARCH RESULTS

Attendance and adherence ratio at intervention. Ten weeks of 20 yoga sessions resulted in single session attendance rate of 96.4 ± 4.1% and overall adherence ratio of 99.3 ± 0.8% in experimental group.

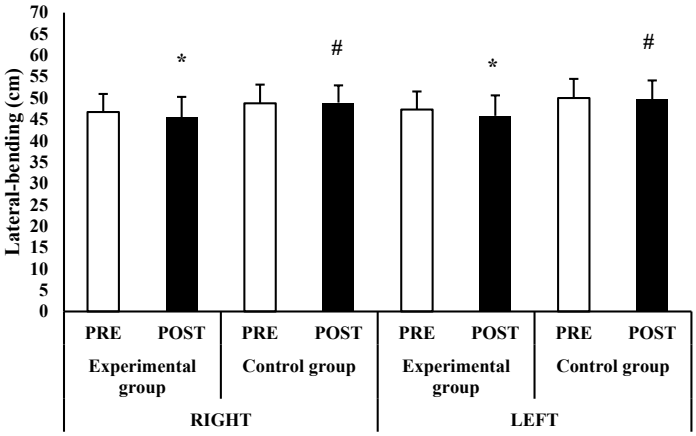
Flexibility. Sit and reach flexibility test results are presented in Figure 1. Flexibility significantly increased ($p < 0.0001$) in the experimental group after 10-week yoga practice and no changes were observed in the control group. Furthermore, a greater flexibility ($p = 0.0071$) was observed in the experimental group than in the control group.

Lateral bending flexibility test results are presented in Figure 2. Flexibility significantly increased on the right ($p = 0.033$) and left ($p = 0.0092$) sides of spine in the experimental group after 10-week yoga practice and no changes were observed in the control group. A greater lateral bending flexibility on the right ($p = 0.0342$) and left ($p = 0.0203$) sides was observed in the experimental group than in the control group.



Note. Data are presented as mean ± standard deviation. *$p < 0.05$, compared with values before; #$p < 0.05$, compared to the experimental group.

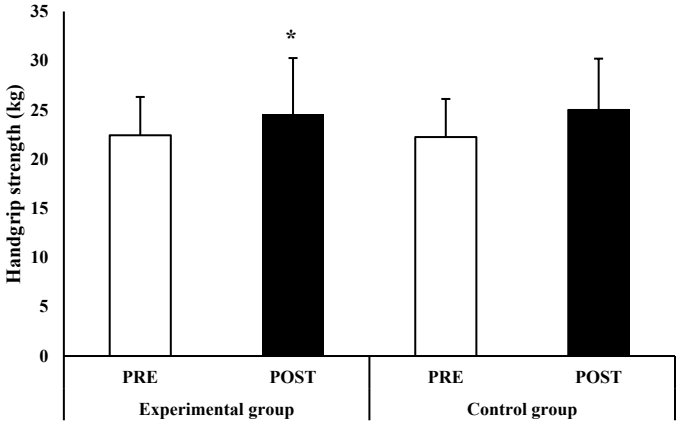
Figure 1. **Changes in "Sit and Reach" flexibility test**



Note. Data are presented as mean ± standard deviation. *p < 0.05, compared with values before; #p < 0.05, compared to the experimental group.

Figure 2. **Changes in "Lateral bending" flexibility test**

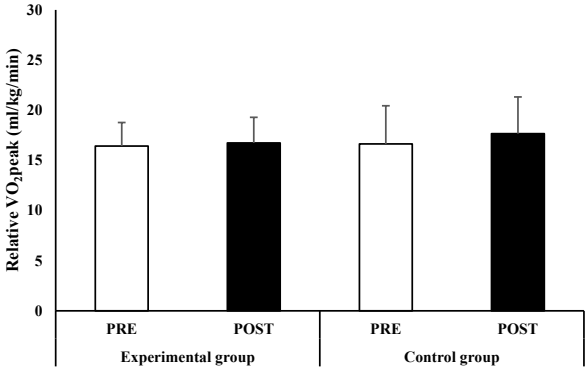
Grip Strength. Hand grip strength significant increased ($p < 0.000.1$) in the experimental group after the intervention. No changes were observed in the control group. These results are presented in Figure 3.



Note. Data are presented as mean ± standard deviation.
*$p < 0.05$, compared with values before.

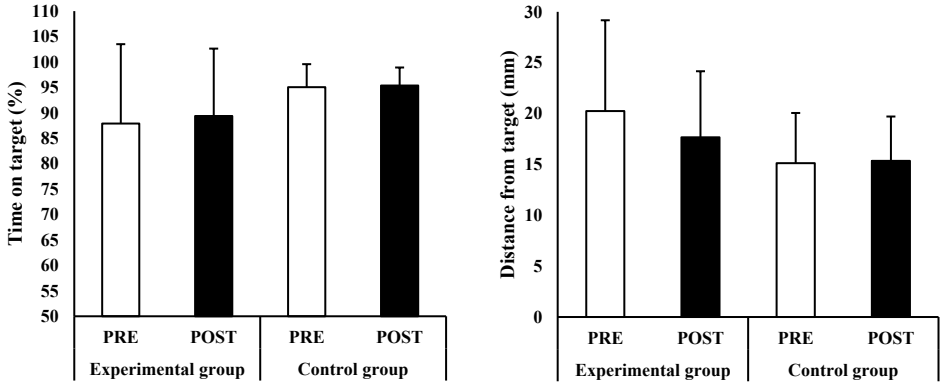
Figure 3. **Changes in grip strength**

Endurance. As Figure 4 shows, no significant differences were observed in relative VO_2peak results in the experimental and control groups.



Note. Data are presented as mean ± standard deviation.

Figure 4. **Endurance parameters**



Note. Data are presented as mean ± standard deviation.
*$p < 0.05$, compared with values before.

Figure 5. **Changes in pursuit tracking task parameters**

Psychomotor coordination. As Figure 5 shows, no significant differences were observed ($p > 0.05$) in time on target results in both groups. However, in the speed-accuracy motor task, the average distance from target significantly decreased ($p = 0.0439$) in the experimental group. Results in the control group did not induce any change in tracking performance.

DISCUSSION

The aim of the present study was to determine the 10-week regular yoga practice effects on physical fitness and psychomotor coordination in older adults. Yoga improved grip strength and flexibility, whereas cardiovascular endurance was not affected by it. In addition, improvement in psychomotor coordination was observed.

According to F. M. Luskin et al. (2000), through the progression of a sequence of static physical postures, yoga causes stretching to improve joint flexibility. Thus, as expected, our results concur with the previous findings (Chen et al., 2010; Gothe, McAuley, 2016), where researchers have found improvements in flexibility measures following yoga practice in older adults.

It is important to mention that greater grip strength is associated with significantly lower risk of all causes of cardiovascular mortality (Celis-Morales et al., 2018). In accordance with our expectations we have observed that yoga improved grip strength. A previous study of E. J. Groessl et al. (2018) also observed that 10-week yoga improves grip strength in older adults. It is believed that the benefit may be mediated by some yoga postures (Lau et al., 2015), however yoga postures incorporate wrist, but not grip movements. It is well established that yoga improves brain functioning (Gothe et al., 2015), thus it may be expected, that changes were conveyed by improved corticomotor drive to the spinal motoneurons as a key determinant of grip strength (Gomes-Osman et al., 2017). Nevertheless, the mechanisms by which yoga provides beneficial effects on grip strength still need to be determined.

In contrast to our expectations, yoga had no impact on cardiovascular endurance in older adults. However, previous studies observed that yoga could improve endurance in younger population (Chen et al., 2010; Tran et al., 2001). Differences between studies may be explained by different postures included in yoga programs and the duration of specific postures exceeding sufficient intensity to improve cardiovascular endurance (Hagins et al., 2007).

As expected, yoga improved psychomotor coordination in older adults. This finding is in line with previous research findings in young adults (Manjunath, Telles,1999). It can be expected that yoga improved accuracy in performance of

pursuit tracking task due to improved physical fitness (Spirduso et al., 1980) or motivation (Manjunath, Telles, 1999).

Our study has several limitations worth noting. Firstly, the subjects were healthy and volunteers. It still remains to be established whether similar adherence to yoga program and improvements in functional outcomes would be observed in older adults with lower levels of functioning or poor health. Secondly, there is the absence of a follow-up to examine long-term adherence and effects of yoga practice on the measured outcomes.

CONCLUSIONS

Regular 10-week yoga practice had no effect on the cardiovascular endurance, but it produced beneficial changes in muscular strength, flexibility and accuracy-task performance for older adults. Given the high adherence and attendance rates as well as the observed improvements in some aspects of physical fitness and psychomotor coordination, yoga may be a promising alternative form of exercise for older adults.

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JOGOS PRAKTIKA PAGERINA VYRESNIOJO AMŽIAUS ASMENŲ FIZINES SAVYBES IR PSICHOMOTORINĘ KOORDINACIJĄ

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SANTRAUKA

Tyrimo pagrindimas. Tyrimai rodo, kad jogos praktika gali pagerinti širdies ir kraujagyslių ištvermę, o fiziškai aktyvūs asmenys geriau veikia psichomotoriškai, tačiau vis dar neaišku, koks jogos poveikis vyresniojo, nuo 60 metų, amžiaus asmenims.

Tyrimo tikslas buvo patikrinti hipotezę, kad 10 savaičių jogos praktika pagerins vyresniojo amžiaus asmenų fizinę būklę ir psichomotorinę koordinaciją.

Metodai. Trisdešimt trys vyresni asmenys, kurių amžius 66.9 ± 6.0 m., atsitiktine tvarka buvo suskirstyti į kontrolinę grupę ir eksperimentinę grupę, kurios tiriamieji atliko dešimties savaičių jogos praktiką, du kartus per savaitę, 90 minučių per vieną užsiėmimą. Jogos praktikos metu buvo žymimas tiriamųjų lankomumas, įvertinta širdies ir kraujagyslių ištvermė, lankstumas, plaštakos griebimo jėga ir psichomotorinė koordinacija.

Rezultatai. Eksperimentinės grupės tiriamųjų jogos praktikos lankomumas sudarė 96,4 ± 4,1%. Jogos praktika padidino ($p < 0.05$) plaštakos griebimo jėga, pagerino stuburo lankstumą ir lankstumą per klubus, šlaunis, sutrumpėjo ($p < 0.05$) atstumas nuo taikinio atliekant psichomotorinę užduotį. Tuo tarpu didžiausio deguonies suvartojimo pokyčių nenustatyta.

Išvada. Reguliari dešimties savaičių jogos praktika neturėjo įtakos širdies ir kraujagyslių ištvermei, tačiau pagerino vyresniojo amžiaus asmenų raumenų jėgą, lankstumą ir psichomotorinę koordinaciją.

Raktažodžiai: senėjimas, širdies ir kraujagyslių ištvermė, raumenų jėga, lankstumas, pratimai.

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