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Effect of Tai Chi versus Aerobic Training on Improving Hand Grip Strength, Fatigue, and Functional Performance in Older Adults Post-COVID-19: a randomized controlled trial

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ABSTRACT

Background: The recent pandemic of COVID-19 has left a wide range of after-effects on the health of older adults. The effects of the pandemic have been particularly felt in the areas of physical strength, fatigue, and functional performance.

Material and methods: Fifty-four participants were allocated into three groups: Tai Chi (TC) attended 4 sessions of 60-min TC training per week for consecutive 12 weeks, Aerobic Training (AT) attended 4 sessions of 60-min aerobic training per week for 12 weeks, and Control (CON) instructed to maintain a daily routine. Hand grip strength (HGS) and Fatigue Severity Scale (FSS) were used to evaluate the participants. Functional performance outcomes were determined The functional performance outcome was determined by The 30-second Chair Stand Test (CST), The 30-second Arm Curl Test (ACT), The 8-feet Up-and-Go test (TUG), and The 2 min steps. Pre-post comparisons of all outcomes in each group and comparisons between groups were analyzed using the ANOVA test with SPSS software.

Results: After the intervention, TC and AT groups both experienced significant improvements in HGS, fatigue levels, CST, ACT, TUG, and 2-minute steps compared to baseline (all $P < 0.001$). The Tai Chi group also experienced significantly improved hand grip strength ($p = 0.0435$, mean difference of - 2.5), and ACT ($p = 0.0235$, mean difference of 1) compared to the AT group.

Conclusions: Tai Chi is an integrated rehabilitation program that had a positive effect on hand grip strength, fatigue levels, and functional performance compared to aerobic training in the elderly post-COVID-19.

Keywords: *Tai Chi, Aerobic, Grip strength, Fatigue, Covid-19*

INTRODUCTION

The world is rapidly changing due to the current pandemic, and many people are facing new physical challenges due to the effects of coronavirus disease (COVID-19). The current extended state of COVID-19 could affect many features of people's lives, older adults are a particularly vulnerable population, as they may be more susceptible to the effects of the virus, as well as its effects on physical performance.1 It has become increasingly clear that infected patients have symptoms not only in the acute phase, approximately 10%-20% of people experience a variety of mid- and long-term effects after they recover from their initial infection.2 The elderly are more likely to develop chronic diseases which can limit their functioning and lead to disability. This disability can cause early inability to work and loss of independence, as well as decreased psychophysical capabilities which can lead to reduced social participation.3

The evidence confirmed that the total physical activity time in the elderly reduced above 35% after the COVID-19 pandemic. Regular physical exercise and/or activity play a significant role in preventing contrary health consequences.4,5 Close monitoring and rehabilitation intervention are necessary to ensure the well-being of older adults affected by COVID-19, elderly are highly recommended to exercise after COVID-19 recovery.6

Hand grip strength (HGS) is a significant indicator of health status and overall muscular strength. Research has shown a strong correlation between HGS and the strength of other muscle actions of both healthy individuals and adults with pathology.7

Low HGS readings were recorded among elderly survivors post-COVID-19 with longer hospital stays. This recommends the need for evaluation and delivery of rehabilitation modalities to the elderly affected by COVID-19 infection. The deterioration of HGS post covid-19 suggested the possibility of chronic damage to skeletal muscles by COVID-19.8

Fatigue is a common long-term symptom of COVID-19 infection, particularly among elderly patients, with 64% of them reporting fatigue as the most prevalent symptom post-COVID-19.9,10

The movements of TC are circular, flowing movements, and simple low impact for anyone to learn. Each movement is meant to be done slowly, using steady, controlled movements that are often combined with deep breathing and meditation. This makes it a great exercise for elderly people who may not be able to do more strenuous forms of exercise without putting a strain on their joints or muscles. It helps to improve balance, posture, flexibility, and strength while increasing the range of motion and circulation.11 TC involves a series of simple, continuous movements that promote strength, flexibility, improved posture, coordination, balance, and spatial acuity. It also promotes relaxation and reduces stress.12

Research suggests that physical activity can help prevent and treat COVID-19, improve physical function, reduce post-acute infection by COVID-19 syndrome, and improve psychological well-being. It is suggested to develop exercise program prescriptions for different survivors.13

The Fatigue Severity Scale (FSS) is a tool used to evaluate the impact of fatigue on physical and social functioning. It consists of nine questions that measure the patient's perception of how fatigue affects their daily activities.14

The Senior Fitness Test (SFT) is a physical performance test commonly used in geriatric and rehabilitative care, consisting of six functional tests of strength, endurance, balance, agility, and flexibility. Each test is scored separately on different scales, and there is no overall score.15,16

In our study, a randomized controlled clinical trial was conducted to understand the impact of TC versus AT on HGS, fatigue, and functional performance in the elderly post-COVID-19.

MATERIALS AND METHODS

The study followed a randomized controlled trial. The study was performed between September 2022 and January 2023 and registered on the clinicaltrials.gov website with identification number: NCT05501067. All participants were informed about all procedures and signed informed consent. The research related to human use has complied with all the relevant national regulations, and institutional policies have followed the Declaration of Helsinki's tenets. The authors' institutional review board has approved them by the Ethical Committee of the Faculty of Medicine, Beni-Suef University, with approval number FMBSUREC/04012023/Saeed.

Participants

The study recruited 54 participants from Beni-Suef University Hospital. The Arabic version of the 36-Item Short Form (SF-36) was performed to exclude any physical or mental problems. None of the participants enrolled in this study received any previous training program post-discharge.

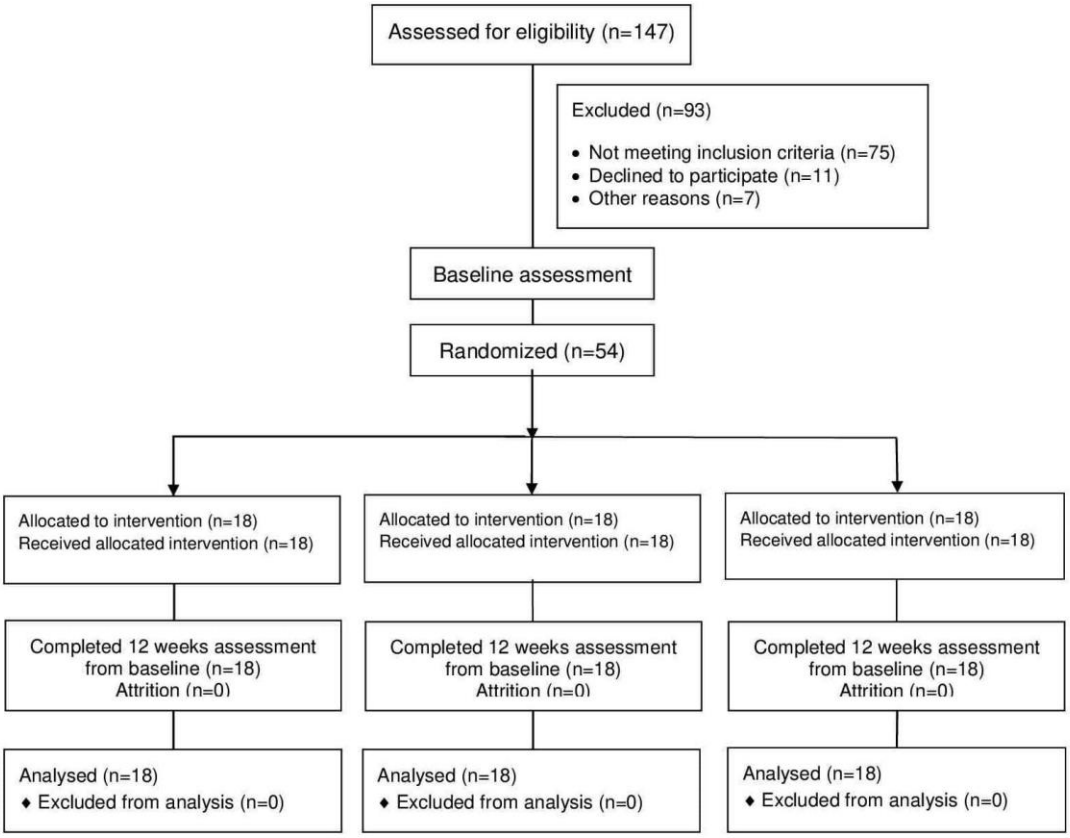

FIG. 1: The participants' flowchart

Inclusion criteria

Participants will be included if they were ≥ 60 years old, both sex, infected with COVID-19 with mild-to-moderate symptoms according to the Post-COVID-19 Functional Status scale (PCFS),18 at least 3 months post-recovery (negative swab results since 3 to 4 months).

Exclusion criteria

Participants who had COVID-19 with severe symptoms, DM type I, Unstable medical status, orthopedics disorders, neurological impairments visual impairments, vestibular disorders, those who were unable to provide informed consent for study participation, or follow instructions.

Intervention

Each participant received a thorough explanation of the study's objectives, as well as a demonstration of equipment and procedures.

Both TC and AT groups received an active intervention for 12 weeks. The participants in the TC group received four 60-minute sessions of Tai Chi exercises weekly, consisting of 10 min warm-up, 40 min TC exercise program, and 10 min relaxation exercises. Each TC exercise movement is five repetitions with a mild-moderate intensity of 50 to 70% maximal heart rate, or 4-6 of the modified borg scale to improve balance, postural alignment, and concentration. The protocol consisted of seven TC movements designed to challenge cardiovascular fitness, balance, and gait. It included controlled weight shifting, ankle sways, and anterior-posterior and lateral stepping. Normal breathing pattern was also combined into the training routine:19,20

Carrying a ball, stepping sideways, and alternating left and right

Stepping diagonally forward, and alternating left and right

Stepping sideways and alternating left and right

Stepping sideways, elevate upper limbs and wave-like clouds, and alternating left and right

Step diagonally backward, and alternating left and right

Brush Knees, stepping diagonally forward and alternating left and right

Stands with one leg (Golden pheasant)

Participants allocated to the AT group received four supervised 60-minute aerobic training sessions weekly for 12 weeks. The participant trained at moderate intensity activities, at 40–60% max heart rate or 4–6 Borg Scale.21 Each training session consisted of:

10 min of warm-up static stretching exercises targeting the trunk and limbs muscle groups (neck side-bending, anterior cross-arm stretch, behind-the-neck triceps stretch, standing quadricep stretch with chair assist, toe touch stretch from sitting, calf stretch on the wall) 20 min of upper and lower limbs muscle-strengthening using a 0.5 kg weight.

Treadmill walking, 15:20 minutes, with a moderate effort of 1.2–2.6 km/h.22

10 min of stretching exercises (cool-down targeting the trunk and limb muscle groups).

The CON group was informed to maintain their usual ADLs, and not to participate in any new placebo and other interventions. All participants in the TC, AT, and CON groups had their HGS, fatigue, and physical performance by the SFT evaluated at baseline, and twelve weeks after the intervention.

HGS was measured by using a digital hand dynamometer (Jamar® Smart, Model:21434). After a practice trial, each participant performed at least three maximal contractions were conducted with the dominant hand until no further improvement occurred, rest for about 30 s between trials. The greatest test result was used in the analyses, and the score was expressed in kilograms.

To evaluate fatigue levels we used the Fatigue Severity Scale (FSS), It is scored on a Likert scale, and scoring is done by calculating the mean response to the questions with a score of four or superior representing severe fatigue.14

The physical performance assessment was conducted using four tests from the SFT: 30-second arm curls to assess upper extremity function, 30-second chair stands to assess lower

extremity function, 8-Foot up and go exercise test to assess balance, and 2-minute step test to assess cardiopulmonary function.23

Data analysis

Two-way analyses of variance (ANOVA) were used to compare pre-and post-training effects, and ANOVA tests were used to compare outcomes between groups. The effect size was expressed as Cohen's d, and the within-group effect size was calculated by subtracting the mean at baseline from the mean at the end of the intervention and dividing it by the pooled standard deviation of the two-time points. The data were statistically processed using IBM SPSS Statistics version 25.0 for Windows (IBM Corp., Armonk, NY).

RESULTS

As shown in Table 1, the demographics and clinical measurement comparison of the TC, AT, and CON groups haven't significant variances in age, sex, body mass index (BMI), months post-COVID-19, and SF-36, which suggested that they were comparable in base information. After baseline assessment, 54 eligible participants were equally randomized to one of the groups with an allocation of 1:1:1, through a permuted block randomization as shown in (Fig. 1).

TABLE 1: Baseline characteristics of the participants

Variables	TC	AT	CON	P between group
Participants n	18	18	18	-
Age mean±SD	65.7±3.6	66.2±3.8	66.3±4	0.0948
Sex N (% Male)	12 (67%)	11 (61%)	12 (67%)	0.0558
BMI	27.4±1.9 kg/m²	28.7±1.3 kg/m²	28.1±1.8 kg/m²	0.1370
Months post COVID-19	7.1±2.3	7.2±1.8	7.6±2.2	0.7600
SF-36	63.6±1.66	62.8±1.7	64.7±1.74	0.0606

Notes: TC: Tai Chi group, CON: Control group, BMI: Body Mass Index, N: Number, SD: Standard Deviation, SF-36: Short Form 36 (SF-36)

TABLE 2: Changes in HGS, FSS, and functional performance in the TC, AT, and CON groups

Group	Variables	HGS (kg)	FSS	CST (reps)	ACT (reps)	TUG (s.ms)	2 min steps (n. of steps)
TC	Baseline (SD)	24.2±4.8	51.3±2.9	12.6±1.5	15.2±1.1	6.3±0.4	85.7±4.3
	Outcome (SD)	29.6±4.6	44.9±3.8	16.9±0.9	20.1±1.6	4.7±0.7	95.4±6.5
	Within group p	.001	.0001	.0001	.0001	.0001	.0001
	d	5.4	6.4	4.3	4.9	1.6	9.7
AT	Baseline (SD)	23.7±5.7	51.6±4.2	13.1±1.2	15.1±1.1	6.1±0.7	86.5±3.7
	Outcome (SD)	27.1±2.1	43.7±2.1	17.3±1.6	21.1±0.8	4.8±0.4	94.1±3.8
	Within group p	0.0274	.0001	.001	.0001	.0001	.0001
	d	3.4	7.9	4.2	6	1.3	7.6
CON	Baseline (SD)	23.6±2.1	50.6±4.4	12.4±1.2	14.9±1.3	6.3±0.5	86.5±3.7
	Outcome (SD)	23.9±2.3	49.7±4.6	12.9±1.2	15.6±1.2	5.9±0.7	87.7±3.8
	Within group p	0.6853	0.5526	0.2198	0.1024	0.0567	0.3439
	d	0.3	0.9	0.5	0.7	0.4	1.2

Notes: TC: Tai Chi group, AT: Aerobic Training group, CON: Control group, SE: Standerd Erorr, HGS: Hand Grip Strength, FSS: Fatigue Severity Scale, CST: The 30-Second arm curl test, ACT: The 30-Second arm curl test, TUG:The 8-Foot up-and-go exercise test, SD: Standard Deviation, Kg: kilogram, Reps: Repetitions, N: Number.

The TC group showed that HGS increased significantly with values of P = 0.001, d = 5.4. The fatigue levels (FSS) showed a significant change with values of P = 0.0001, d = 6.4. The 30-second chair stand (reps) increased significantly with values of P = 0.000, d = 4.3. The 30-Second arm curl test (reps) increased significantly with values of P = 0.0001, d = 4.9. The 8-Foot up-and-go exercise test (s.ms) showed a significant change with values of P = 0.0001, d = 4.3. The 2 min steps (n. of steps) increased significantly with values of P = 0.0001, d =9.7. The AT group showed that HGS increased significantly with values of P = 0.0274, d =3.4. The fatigue levels (FSS) showed a significant change with values of P = 0.0001, d = 7.9. The 30-second chair stand (reps) increased significantly with values of p = 0.0001, d = 4.2. The 30-Second arm curl test (reps) increased significantly with values of P = 0.0001, d = 6. The 8-Foot up-and-go exercise test [s.ms] showed a significant change with values of P = 0.0001, d =1.3. The 2 min steps [n. of steps] increased significantly with values of P = 0.0001, d = 7.6. There were no significant differences in any of the variables in the control group. As shown in table 3, the results also revealed that the group that practiced Tai Chi experienced significantly improved hand grip strength (P =0.0435, mean difference of - 2.5), and 30-Second arm curl test (P =0.0235, mean difference of 1) compared to the group that practiced aerobic training.

DISCUSSION

Post-COVID-19 elderly are the most susceptible to suffering a rapid decline in physical function due to sedentariness or low activity levels; this decline can, in turn, cause a loss of independence and an increased number of falls. Exercise and physical activity are effective measures for maintaining and improving general health status and for preventing a wide range of complications.24

TABLE 3: Differences Between groups post-intervention in HGS, FSS, and physical performance.

	Groups	Between groups post-intervention		
		Mean difference (SE)	P value	Cohen's d
HGS (kg)	TC vs. CON	- 5.7 (1.2)	0.0001	1.6
	AT vs. CON	- 3.2 (0.7)	0.0001	1.453
	TC vs. AT	- 2.5 (1.2)	0.0435	0.6992
FSS	TC vs. CON	4.8 (1.4)	0.001	1.1
	AT vs. CON	6 (1.2)	0.0001	1.678
	TC vs. AT	- 1.2 (1)	0.2491	0.3909
CTS (reps)	TC vs. CON	- 4 (0.4)	0.0001	3.8
	AT vs. CON	- 4.4 (0.5)	0.0001	3.111
	TC vs. AT	0.4 (0.4)	0.3618	0.308148
ACT (reps)	TC vs. CON	- 4.3 (0.5)	0.0001	3
	AT vs. CON	- 5.3 (0.3)	0.0001	5.1971
	TC vs. AT	1 (0.4)	0.0235	0.7906
TUG (s.ms)	TC vs. CON	1.1 (0.2)	0.0001	1.6
	AT vs. CON	1 (0.2)	0.0001	1.7541
	TC vs. AT	0.1 (0.2)	0.6021	0.1754
2 min steps (n. of steps)	TC vs. CON	- 7.8 (1.8)	0.0001	1.4
	AT vs. CON	- 6.4 (1.3)	0.0001	1.6842
	TC vs. AT	- 1.3 (1.8)	0.4689	0.2442

Notes: TC: Tai Chi group, AT: Aerobic Training group, CON: Control group, HGS: Hand Grip Strength, FSS: Fatigue Severity Scale, CST: The 30-Second arm curl test, ACT: The 30-Second arm curl test, TUG:The 8-Foot up-and-go exercise test, SD: Standard Deviation, Kg: kilogram, Reps: Repetitions, N: Number.

The results of the study showed that both Tai Chi and aerobic training were effective in improving HGS, fatigue levels, and functional performance in older adults compared to baseline.

All participants in the TC and AT showed improvements in the HGS. The results in the TC group are supported by smooth movements of the muscles of the upper limbs, training the arms to move with more force and power. A longer duration of TC practice is associated with improved forearm strength as measured by the handgrip dynamometer.25,26 Also, the AT group demonstrated improvement in HGS score post-intervention due to improve markers of bone metabolism, muscle strength, and dexterity of the hand post treadmill training.27,28

Previous studies emphasized the potential benefits of TC exercise for people with Chronic Fatigue Syndrome (CFS) and Cancer-Related Fatigue (CRF). Previous studies have suggested that TC could be an effective complementary or alternative intervention to existing therapies. The findings of these studies promote our understanding of Tai Chi's value in treating fatigue. Additionally, improved breathing and cardiovascular fitness are essential for post-COVID-19 recovery, and a recent study found that patients post-COVID-19 demonstrated improvement in fatigue after 8 weeks of training including aerobic training.29,30

In our study, the improvement of fatigue levels in the TC group may be attributed to improving slow movement and continuity gradually increasing the body’s metabolism. Improved breathing post-COVID-19 is essential for carrying oxygen and nutrients throughout the body and improving cardiovascular fitness.31 The findings in our study are in line with the statement that good cardiorespiratory fitness causes an increase in the ability to work with high intensity for a long time to achieve fatigue.32 In the AT group, the improvement in fatigue levels is supported by a recent study that found that patients post covid-19 demonstrated improvement in fatigue after 8 weeks of the training program including aerobic training.33

About 50% of human steps during walking and ADLs activities are redirected, older adults may have difficulty with walking safely and performing ADLs due to a reduction in executive and cognitive control.34 Individuals with a history of mild-to-moderate COVID-19 showed more asymmetrical gait patterns than individuals without a disease history.35,36

Studies have shown that TC exercises can improve gait velocity, stride length, and stride balance, as well as lower extremity neuromuscular patterns. These improvements can help older adults with walking safely and performing activities of daily living.37 In our study the improvement in the physical performance in the TC group might be recognized by improving the spine flexibility through tai chi movements seems to be a factor in the improvement of postural control during walking and the performance of ADLs.11

The improvement in the physical performance in the TC group is supported by many studies that emphasized the benefits of TC training exercises for middle-aged and elderly people. Studies have shown that it can slow aging-related functional decline, increase strength in the lower limbs, and improve dynamic balance, leg strength, upper body physical function, fine motor control, and strength. Additionally, it has been suggested that Tai Chi can improve body balance and cognitive function in older people.38,39,40

CONCLUSIONS

Tai Chi is an integrated rehabilitation program that had a positive effect on hand grip strength, fatigue levels, and functional performance compared to aerobic training in the elderly post-COVID-19. All the movement of the TC is combined with controlled breathing and concentration which maintains a good cardiorespiratory function and high physical performance. TC program promotes the strengthening and flexibility movements of the upper and lower extremities and the spine with postural balance and high concentration.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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