

How Does 12-weeks of Taekwondo Training Effect Older Persons' Functional Fitness: A Preliminary Study

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| Abstract |

PURPOSE: This pre-post intervention study aimed to examine the effects of a 12-week supervised modified Taekwondo exercise program on the functional fitness of community-dwelling older adults.

METHODS: 10 participants (mean age: 72.3 ± 4.6 years) completed the program over a 12-week period. The intervention consisted of Taekwondo-based exercises modified for older persons. Changes to functional fitness were measured using the finger-to-nose test, functional reach test, timed up and go test, 30-second sit-to-stand test, 30-second arm curl test, Chester step test, chair sit-and-reach test, and back scratch test. Participants were assessed prior to the training and after the final training session, changes were measured using descriptive statistics and

paired sample 't' tests.

RESULTS: Effect sizes ranged from small to large (Cohen's $d = .22$ to 1.23). The exercise program was well-tolerated by participants, with a high level of engagement and no attrition for the duration of the program. Results showed significant improvements in most measures of functional fitness ($p < .05$) except for the back scratch test ($p = .051$).

CONCLUSION: These findings suggest a well-designed, supervised, modified Taekwondo exercise program can significantly improve functional fitness in older adults.

Key Words: Balance, Hard martial arts, Older Adult, Taekwondo

I. Introduction

Functional fitness represents the physiological parameters associated with the ability to carry out daily physical tasks, encompassing essential physical abilities such as strength, endurance, agility, and flexibility. These physical capabilities ensure that individuals can perform

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both basic and advanced activities of daily living independently, without undue fatigue [1,2,3]. A decline in functional fitness and associated loss of muscle mass has been shown to be a strong predictor of adverse health outcomes and a diminished quality of life [4,5]. Therefore, to mitigate the decline in functional fitness, it is important for older adults to maintain an active lifestyle throughout their lifespan, emphasizing physical activities that maintain or improve functional fitness. While the positive impacts of cardiovascular and strength exercises on functional fitness in older adults have been well-established [6,7], conventional exercise frequently suffers from poor participant adherence and high attrition rates, particularly among the elderly [8,9].

Recent studies have highlighted these challenges. For instance, Viken et al. [10] reported a 15% dropout rate in a cohort of older adults over three years. Similarly, a resistance training program completed by Bårdstu and colleagues [11] reported a 44% dropout rate despite participants exercising only twice weekly. These findings underscore the need for alternative physical activity modalities that can not only enhance functional fitness but also sustain the engagement of older adults.

Tai Chi, a gentler martial art, has gained popularity among older adults. It has been shown to significantly improve various functional fitness components, including reaction time, balance, mobility, flexibility, and strength [12,13,14]. Encouragingly, some Tai Chi studies have reported dropout rates as low as 23% [15]. However, Tai Chi's slow-paced exercises might not resonate with all older adults. This has led to growing interest in harder martial arts like Taekwondo and Karate as potential alternatives to Tai Chi. These hard martial arts, while incorporating elements from Tai Chi such as breath control and mindfulness, are executed at a brisker pace and involve more physically demanding exercises such as punching kicking and blocking [16,17,18]. Consequently, Taekwondo training might offer a comprehensive exercise regimen that

challenges multiple physiological systems, potentially countering many age-related impairments.

In light of this, Linhares et al. [19] conducted a systematic review exploring the efficacy of Taekwondo as an exercise intervention for community-dwelling older adults. Their review, spanning studies from 2002, identified only seven relevant papers, involving fewer than 160 participants. The findings from this review emphasizes a clear gap in the literature and the need for additional contemporary research on the potential benefits of Taekwondo on functional fitness for older adults.

This study aimed to conduct a preliminary investigation into the effects of a 12-week supervised and modified Taekwondo training program on the functional fitness of older adults. We hypothesized participants in the modified Taekwondo training would demonstrate improvements in functional fitness compared to their baseline measurements.

II. Methods

1. Participants

This preliminary study examined community-dwelling ambulatory adults aged over 64 years, assessing the impact of a 12-week supervised, modified Taekwondo training program on selected outcome measures of functional fitness. Ethical approval for the research was obtained from the Human Research Ethics Committee at Southern Cross University (approval number: 2019/575). All participants provided written, informed consent prior to any testing or involvement.

A convenience sample of ten older adults (see Table 1) were recruited for this study, comprising four women and six men aged between 64 to 84 ($M = 76.6 \pm 7.4$ years). None of the participants had prior experience with Taekwondo or any other martial arts and were not engaged in other forms of exercise. The study employed a pre-post intervention design, with participants undergoing fitness

Table 1. Participant demographics

Variable	Intervention Group (n =10)
Male/Female	6/4
Age (years)	76.6 ± 7.4
Mass (kg)	89.1 ± 15.1
Height (cm)	167.3 ± 8.0
Body mass index (kg/m ²)	31.9 ± 4.9

Note: values are mean ± standard deviation

assessments before and after the 12-week Taekwondo training program.

To ensure participant safety, a pre-exercise screening was conducted, verifying that participants had no existing cardiovascular, metabolic, musculoskeletal, or respiratory diseases, and exhibited no signs or symptoms of these conditions that would preclude their participation in this study [18]. All participants were free from severe medical conditions that might compromise their safe participation in the Taekwondo exercises. While two participants occasionally used assistive devices, they did not need these devices during testing procedures.

2. Outcome Measures & Procedures

1) Dependent Variables: Functional Fitness Assessments

Identical measures were chosen to evaluate functional fitness pre and post-intervention based upon their proven validity for functional fitness assessment and established validity in older adults [20,21,22]. The following tests were conducted in the order of appearance below:

Timed Finger to Nose Test: This test, which assesses upper limb coordination and speed, has been widely reported in studies of motor function among older adults [23]. Previous research has reported good test-retest reliability and validity when compared to other measures of upper limb function [24,25].

Functional Reach Test: To evaluate dynamic balance and reach capability, we utilized the functional reach test

[27]. This test has demonstrated good reliability and validity with other balance assessments [26].

Timed Up and Go Test (TUG): The TUG test is a well-established measure of mobility and fall risk among older adults. It has shown excellent test-retest reliability and concurrent validity with various functional assessments [27].

Sit-to-Stand Test: We employed the sit-to-stand test to evaluate lower limb strength and endurance. This test has been found to have good reliability and validity in assessing lower body function in older populations [20].

Arm Curl Test: The arm curl test is a valid and reliable measure of upper body strength in older adults. Previous studies have demonstrated its test-retest reliability and concurrent validity with other strength assessments [20]. The bicep curl test used a 2-kg or 4-kg hand weight based upon the participants' gender. These adaptations were made to make the testing repeatable and more precise.

Modified Sit and Reach Test: To assess lower back and hamstring flexibility, we used the modified sit and reach test. This test has been widely used in flexibility assessments and has shown good test-retest reliability and concurrent validity with other flexibility measures [20].

Back Scratch Test: The back scratch test, which evaluates upper body flexibility, has demonstrated good reliability and concurrent validity in previous research on older adults [20].

Chester Step Test (CST): To assess cardiorespiratory fitness, we conducted the Chester Step Test, a well-established measure of aerobic fitness. This test has shown excellent test-retest reliability and concurrent validity with other cardiorespiratory fitness assessments [28,29].

3. Intervention

1) Independent Variables: Modified Taekwondo Procedure

The modified Taekwondo classes were scheduled for ninety minutes twice weekly for 12 weeks, adhering to

the frequency component of the FITT principle [30]. The intensity of the classes was modulated by a 1st-degree black belt Taekwondo instructor who had the training to deliver this modified form of Taekwondo in a safe and effective manner.

All Taekwondo classes started with a short warm-up of joint mobility exercises and gentle stretches for the torso and upper and lower limbs for five minutes, followed by coordination and reaction time exercises for a further five minutes.

Modified Taekwondo exercises began with singular blocking, striking, and kicking movements while standing in place. These exercises were progressed to include directional changes and stepping movements in which the participants must turn before executing a block, strike or kick. The time spent on these exercises varied based upon each participant's ability and comfort level.

In addition to the modified kicking and punching strikes on foam sticks and kick shields, the participants also practiced Chon-Ji Poomsae. This traditional pattern in Taekwondo consists of a sequence of structured movements designed to improve overall body control, balance, and focus. The Chon Ji Poomsae is typically taught in the early stages of Taekwondo training and emphasizes the basic blocks, strikes, and kicks fundamental to martial arts. By incorporating this pattern into the modified Taekwondo classes, the participants could further develop their coordination, balance, and technique while improving their overall physical fitness.

Classes concluded with a further series of gentle stretches for five minutes. Standardised testing procedures were used, with detailed descriptions provided for each test.

4. Data Analyses

In this pre-post-intervention study, statistical analysis was conducted using descriptive statistics. Results are presented as mean \pm standard deviation (SD) for each of the dependent measures. To examine within-group

effects, paired t-tests were used to compare the mean scores for each dependent measure pre versus post-intervention. The statistical analyses were assessed at the alpha equals .05 level of significance, and all data were analysed using the Statistical Package for Social Sciences (SPSS) (Version 25.0, SPSS., Armonk, NY). Effect sizes (Cohen's *d*) were also calculated, threshold values for minor, moderate and significant effects were set at .2, .5, and .8, respectively [31].

III. Results

1. Attendance and Participant Safety

Over the 24 classes, participants attended an average of 20.4 ± 3.2 classes, with an average attendance rate of 85% (62-100%). Importantly, there were no dropouts from the program, and no adverse events occurred during the 12-week training period or testing sessions.

2. Significant Improvements in Functional Fitness

Table 2 presents the results of the various functional fitness assessments. We observed statistically significant improvements ($p < .05$) in the following dependent variables:

- **Finger-to-Nose Test (FTNT):** Participants showed a significant enhancement in upper limb coordination and speed ($p < .05$), with a large effect size (Cohen's $d > .8$).
- **30-Second Arm Curl Test (30ACT):** There were substantial improvements in upper body strength ($p < .05$), also indicated by a large effect size (Cohen's $d > .8$).
- **Chester Step Test (CST):** Cardiorespiratory fitness significantly improved ($p < .05$) following the 12-week modified Taekwondo program, with a large effect size (Cohen's $d > .8$).

Table 2. Mean \pm Standard deviations for functional fitness measures

Test	Pre to Post Measures					
	Pre	Post	p-value	Absolute	% Δ	Cohen's d
FTNT (number)	4.51 \pm .50	3.68 \pm .80	.003*	.83 \pm .80	-18.40%	1.220
FRT (cm)	30.60 \pm 7.10	35.45 \pm 10.30	.055	4.85 \pm 7.50	15.80%	.680
TUG (number)	6.02 \pm .80	5.87 \pm .50	.160	.15 \pm .80	-2.50%	.490
30S2ST (number)	12.80 \pm 3.70	13.70 \pm 1.70	.200	.90 \pm 3.10	7.00%	.440
30ACT (number)	16.60 \pm 3.60	19.10 \pm 4.80	.038*	2.50 \pm 3.80	15.10%	.760
CST (seconds)	254.70 \pm 80.30	320.80 \pm 139.30	.036*	66.10 \pm 121.60	25.90%	.770
CSRT (cm)	-16.10 \pm 15.40	-12.10 \pm 15.60	.190	4.00 \pm 10.40	24.80%	.460
BST (cm)	-14.00 \pm 10.90	-11.90 \pm 9.50	.330	2.10 \pm 9.90	15.00%	1.220

Acronym Key FTNT: Finger to Nose Test, FRT: Functional Reach Test, TUG: Timed Up and Go Test, 30S2ST: 30 Second Sit to Stand Test, 30ACT: 30 Second Arm Curl Test, CST: Chester Step Test, CSRT: Chair Sit and Reach Test, BST: Back Scratch Test.

1) Trend Toward Significance

The Functional Reach Test (FRT) displayed a noteworthy trend towards significance ($p = .055$), indicating enhanced dynamic balance. The effect size for this measure was moderate (Cohen's $d > = .68$).

3. Limited Changes in Other Dependent Measures

In contrast, the remaining dependent measures did not exhibit statistically significant changes ($p > .05$) following the 12-week training period. Additionally, these outcome measures displayed smaller effect sizes (Cohen's $d < .5$).

4. Summary of Findings

In summary, our paired t-test analysis revealed significant improvements in some, but not all, dependent measures following the 12 weeks of modified Taekwondo training. Specifically, substantial enhancements were observed in the Finger-to-Nose Test, 30-Second Arm Curl Test, and Chester Step Test, with moderate changes in the Functional Reach Test. However, the other dependent measures did not show significant changes over the 12-week training period.

IV. Discussion

This preliminary study aimed to investigate the effects of 12-weeks of supervised and modified Taekwondo exercise intervention on functional fitness in older adults. The subjects who participated in this program trained for 90 minutes twice weekly over 12 weeks, which is similar to the duration and frequency recommended by Miller [32] in order to realize changes to functional fitness. These results showed significant improvements in most of the dependent variable measures. Specifically, the functional reach test which is a measure of dynamic balance, indicated a 15.8% improvement from baseline, highlighting enhanced dynamic balance. Similarly, the 30-Second Arm Curl Test demonstrated a 15.1% improvement, suggesting an increase in upper body strength.

This study's findings resonate with the growing body of literature on hard martial arts training and its effectiveness on balance and mobility in older adults. For instance, Kim et al. [36] found substantial improvements in balance, mobility, and lower body strength after a 12-week Taekwondo training program with older adults.

Table 3. Modified taekwondo training program

Component	Weeks 1-2	Weeks 3-4	Weeks 5-6	Weeks 7-8	Weeks 9-10	Weeks 11-12
warm-up – 5 minutes	Dynamic stretching of the major muscle groups.	Dynamic stretching of the major muscle groups.	Dynamic stretching of the major muscle groups.	Dynamic stretching of the major muscle groups.	Dynamic stretching of the major muscle groups.	Dynamic stretching of the major muscle groups.
Reaction ball – Neuromotor component #1 – 15 minutes	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.	2 x 1-minute rounds with 30-second rest. Aim: as many strikes on the ball as possible, stationary.
Stance isometric stick exercises – strength component – 5-minutes	Stationary partner drill 1. H/S hands chest height stick 1x pushes 1x isometric hold 1x 10x 5s hold. 2. F/S hold the stick in one hand and pulls back to the hip as the other hand punches.	Stationary partner drill 1. H/S hands chest height hold stick 1x pushes 1x isometric hold 1x 10x 5s hold. 2. F/S hold a stick in one hand and pulls back to the hip as the other hand punches.	Stationary partner drill 1. H/S hands chest height hold stick 1x pushes 1x isometric hold 1x 10x 5s hold. 2. F/S hold stick one hand pull back to hip as other hand punches (provide resistances) 3. H/S hands chest height isometric hold partner taps stick diff directions to move stick. 1 min	Stationary partner drill 1. H/S hands chest height hold stick 1x pushes 1x isometric hold 5s hold x 10 2. F/S hold the stick in one hand and pulls back to the hip as the other hand punches. (provide resistances) 1 min 3. H/S hands chest height isometric hold partner taps stick diff directions to move stick. 1 min	Stationary partner drill 1. H/S hands chest height hold stick 1x pushes 1x isometric hold 5s hold 1 min 2. F/S hold the stick in one hand and pulls it back to the hip as the other punches. (provide resistances) 1min each side 3. H/S hands chest height isometric hold partner taps stick diff directions to move stick. 1 min each	Stationary partner drill 1. H/S hands chest height stick 1x pushes 1x isometric 5s hold 1 min 2. F/S hold stick one hand pull back to hip as other hand punches provide resistance 1 min each side 3. H/S hands chest height isometric hold partner taps stick diff directions to move stick. 1 min each
Taekwondo techniques - blocking, punching & kicking aerobic neuromotor component #2 – 20 minutes	Stationary Techniques 1 set x 10 repetitions • Horse stance forward punching - Kihap last punch. • F/S L/F FWD R/H and reverse punching • F/S R/F FWD L/H reverse punches • Rising block in L-stance (L/R sides) • Downward block L-stance (L/R side) • Front Kick L/S (L/R side) • Side kick 90° L/S (L/R side)	Stationary Techniques 1 set x 12 repetitions: • H/S forward 3-level punching - Kihap last punch. • F/S L/F FWD R/H and reverse punching • F/S R/F FWD L/H reverse punches • Rising block in L-stance (L/R sides) • Downward block L/S (L/R side) • Front Kick L/S (L/R side) • Side kicks 90° L/S (L/R side) • Back kick L/S (L/R sides)	Stationary + forward - stepping Techniques 1 set x 12 repetitions: • H/S forward 3-level punching - Kihap last punch. • Forward punching Backward stepping Rising block in L-stance (L/R side) • Downward block L-stance (L/R side/stepping forwards & backwards • Front Kick (L/R side/stepping f/wds/bwds) • Side kicks 90° stationary L/R side • Back kick L/R side stationary	Stationary + forward - stepping Techniques 1 set x 15 repetitions: • H/S forward 3-level punching - Kihap last punch • L/S Rising block L/R • L/S L/R downward block • L/S front kick step f/wds /b/wds • L/R sidekick stationary	Stationary + forward - stepping Techniques 1 set x 20 repetitions • H/S forward 3-level punching - Kihap last punch • L/S Rising block L/R • L/S L/R downward block • L/S inner arm blocks • L/S hold chair combination + side kicks • L/S L/R back kick stationary • L/S L/R downward block • L/S front kick step f/wds /b/wds • L/R sidekick stationary	Stationary + forward - stepping Techniques 1 set x 20 repetitions H/S forward 3-level punching - Kihap last punch 14 punches each level • H/S forward 3-level punching - Kihap last punch • L/S Rising block L/R • L/S L/R downward block • L/S inner arm blocks • L/S hold chair combination + side kicks • L/S L/R back kick stationary • L/S L/R downward block • L/S front kick step f/wds /b/wds • L/R sidekick stationary • L/S front kick step f/wds/bwds • L/R sidekick stationary FWD

Component	Weeks 1-2	Weeks 3-4	Weeks 5-6	Weeks 7-8	Weeks 9-10	Weeks 11-12
Fitness – punching and kicking techniques on the foam paddles and kick shield. – aerobic training component - 20 minutes	<p>Stationary Techniques on foam paddles/kick shield Paddles 1x1min rounds</p> <ul style="list-style-type: none"> • Left/Right punching on paddles. • Left /Right punch and duck • Squat l/kick squat r/kick 	<p>Stationary Techniques on foam paddles/kick shield/Paddles 1x1min rounds</p> <ul style="list-style-type: none"> • Left/Right punching • Left/right punch and duck • Squat L/kick squat R/kick 	<p>Stationary Techniques on foam paddles/kick shield paddles 2x1 min rounds</p> <ul style="list-style-type: none"> • Left/Right cross punch L/R downward blocks • L/R punches • Left/right punch and duck on foam paddles • Squat L kick squat r kick on paddles 	<p>Stationary Techniques on foam paddles/kick shield paddles 2x1 min rounds</p> <ul style="list-style-type: none"> • Left/Right cross punch L/R rising block • L/R cross L/R downward blocks • Left/right punch and duck on foam paddles • Squat L/R groin kick on paddles 	<p>Stationary Techniques on foam paddles/kick shield paddles 2x1 min rounds</p> <ul style="list-style-type: none"> • Left/Right cross punch L/R Rising block • L/R cross L/R downward blocks • Left/right punch and duck on foam paddles • Squat R/front kick squat L/front groin Kicks on paddles 	<p>Stationary Techniques on foam paddles/kick shield paddles 2x1 min rounds</p> <ul style="list-style-type: none"> • Left/Right cross punch rising blocks • L/R cross L/R downward blocks • L/R cross punch and duck • Squat R/front kick squat L/front groin Kicks on paddles
Poomsae – neuromotor fitness component #3 –20 minutes	Chon Ji Poomsae	Chon Ji Poomsae	Chon Ji Poomsae	Chon Ji Poomsae	Chon Ji Poomsae	Chon Ji Poomsae
Cool down – static stretching & deep breathing exercises – flexibility component – 15 Minutes	Static Stretching & Deep Breathing Exercises	Static Stretching & Deep Breathing Exercises	Static Stretching & Deep Breathing Exercises	Static Stretching & Deep Breathing Exercises	Static Stretching & Deep Breathing Exercises	Static Stretching & Deep Breathing Exercises
	Moderate Intensity – Borg scale 9/6-20	Moderate Intensity – Borg scale 10/6-20	Moderate Intensity Borg Scale 11/6-20	Moderate Intensity Borg Scale 12/6-20	Hard Intensity Borg Scale 15/6-20	Hard Intensity Borg Scale 16/20
	50-59%	60-69%	70%-79%	75%	80%	85%
	90-minutes	90 minutes	90 minutes	90-minutes	90-minutes	90 minutes
	L/S = L-stance; H/S = horse stance; F/S = forward stance; L/R = left and right sides; fwds = forward; bwds=backwards; kihap = sharp, forceful exhale; S2S = sit-to-stand motion					

Similarly, Cromwell et al. [17] noted improvements in balance and mobility following an 11-week Taekwondo training program as measured by the timed up and go test and other outcome measures.

As injuries sustained by persons from falling increase as they age, primarily due to decreased strength and poor balance. These findings suggest participation in Taekwondo or similar martial arts may have a role to play in ameliorating these effects. Therefore, reducing injuries, and resulting in fewer hospitalisations and ultimately reducing the burden of disease on societies from aging populations.

The findings of this study also demonstrated improvements in hand-eye coordination, as evidenced by the finger-to-nose test results. However, this contrasts with the findings of Del Vecchio et al. [35], who observed a non-significant improvement in hand-eye coordination after a six-week modified Taekwondo training regimen for older adults. These variations in outcomes could arise from several factors, including differences in the specific type of martial art exercises, the duration of the interventions, and the reliability of results.

For instance, the findings from Ma et al. [37] demonstrated that a specific Chinese martial art did not yield significant improvements in balance for older adults. In contrast, the results from our study suggest that modified Taekwondo enhances balance. This highlights the importance of considering the specific type of martial art, training intensity, and characteristics of the study population when designing studies.

The physical changes participants experienced in this study may have a correlation with the low attrition rate when compared to attrition rates in other forms of exercise. Other authors [16] investigating Taekwondo intervention in older persons have noted similar attendance trends. For example, Bauman et al. [33] suggested that adults who participate in exercise are primarily motivated by perceived changes to their physical health status, which is subsequently linked to increased self-efficacy [34].

Taekwondo training was selected as the intervention in this study because of its potential to address multiple aspects of functional fitness, including balance, strength, coordination, and flexibility. The modified Taekwondo program followed a standardized curriculum designed specifically for older adults, which included exercises and movements tailored to the needs of older adults. These modifications aimed to enhance dynamic balance, hand-eye coordination, leg strength, and flexibility, all of which are crucial components of functional fitness for older individuals. The inclusion of the Chon Ji Poomsae, further contributed to improving overall body control, balance, and technique.

This study had several limitations. Firstly, the sample size was small, which limited statistical power and generalizability of the results. Additionally, while this study spanned 12 weeks, a longer duration may have demonstrated a stronger relationship between the variables. The absence of a control group is another limitation, which prevented causality from being established; therefore, these results only describe a trend. As the purpose of this study was preliminary, the authors will address these limitations when designing future research.

V. Conclusion

In conclusion, this study contributes to the expanding evidence on the benefits of Taekwondo training for older adults. These findings suggest an opportunity for the inclusion of modified Taekwondo exercises in programs that promote functional fitness aimed at mitigating age-related declines among older adults. With high compliance, an absence of adverse outcomes, and low dropout rates, this novel intervention presents a promising exercise modality for future exploration. Building on these findings, we suggest conducting more in-depth studies with an emphasis on larger sample sizes, longer intervention

periods, and the particular adjustments and adaptations that make Taekwondo training advantageous and accessible for older adults. Further investigation into these subtleties will aid in improving the recommended course of adapted Taekwondo instruction for this particular population.

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