

## Developing Taijiquan Training Program to Improve Physical Fitness of Elderly in Jiaozuo City

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### Abstract

**Background and Aims:** Age-related decline in physical fitness, particularly balance, flexibility, and lower-limb strength, significantly affects the health and quality of life of older adults in Jiaozuo City. Although Taijiquan is recognized for its fitness benefits, structured and progression-based programs tailored to local elderly populations are lacking. This study developed and evaluated an 8-week Chen-style Taijiquan program aimed at improving these physical fitness components.

**Methodology:** A quasi-experimental design was employed with 48 older adults (age 60–70; 75% male) recruited from a Taijiquan activity center in Jiaozuo. Participants were allocated into experimental (n=24) and control (n=24) groups using sex-stratified block randomization. The experimental group underwent a supervised Taijiquan program (5 days/week, 90 min/session) for 8 weeks, while the control group maintained their usual daily activities. The program was developed through expert interviews (n=5), a focus group (n=10), and connoisseurship validation (n=7). Primary outcomes included static/dynamic balance, flexibility (Chair Sit and Reach Test), and lower-limb strength (5-Time and 30-Second Sit-Stand Tests). Data were analyzed using repeated-measures ANOVA, independent t-tests, and ANCOVA, adjusting for baseline, with effect sizes and 95% confidence intervals reported.

**Results:** 1. The post-tests of the experimental group on balance force, flexibility, and lower limb muscle strength were significantly better than the pretests, while the differences in the control group were not significant. 2. The post-test comparison between the experimental group and the control group showed that the balance force, flexibility, and lower limb muscle strength tests of the experimental group were significantly better than those of the control group. 3. The confirmation of the taijiquan training program was regarded by experts as scientific and practical.

**Conclusion:** The taijiquan training program for the elderly was tested by experts for quality and considered to be scientific and practical in the experiment. The experimental results showed improvement and had statistically significant differences.

**Keywords:** Taijiquan Training Program; Physical Fitness; Elderly

## Introduction

The Healthy China 2030 Plan (Outline) issued by the State Council clearly points out that it is necessary to pay attention to the health problems of the elderly population (Bulletin of the State Council, 2021). The physical fitness and quality of life of the elderly are the direct embodiment of a country's success in promoting healthy aging, so the current public health goal is to improve the physical fitness and quality of life of the elderly.

As people age, multiple physiological functions begin to decline, of which muscle strength, balance ability, flexibility, and cardiopulmonary function decline the most. In particular, the lower limb muscle strength is reduced in the elderly, gait stability is decreased, and the risk of falling accidents is increased (Zhao et al., 2024). The “14th Five-Year Sports Development Plan” has put forward proposals such as the gradual promotion of fitness guidance programs, the optimization of sport-prescription databases, and the establishment of a scientific, authoritative health-exercise system. Therefore, based on promoting health through exercise, exercise intervention programs for the elderly should be scientifically and quantifiably designed to meet the needs of the elderly.

Chen-style Taijiquan has a strong health-promoting effect, and much literature has verified the health-promoting effect of Taijiquan. In a cross-sectional study by Li et al., Taijiquan delayed the occurrence of diseases and improved the motor function and quality of life (Li et al., 2003). The regular long-term training of Taijiquan has been found to slow down the decline in skeletal muscle mass and lower limb muscle strength in the elderly (Jiang & Li, 2024). Taijiquan can effectively improve the muscular strength of the lower limbs, balance ability, coordination, and daily functional ability of the elderly and has an ideal application effect in the health-promoting activity for the physical fitness and exercise ability of the elderly (Zhao et al., 2024). Long-term Taijiquan training can also promote the nervous system, enhance joint mobility, and further improve the balance of the elderly by increasing lower-limb muscle strength (Yang & Gong, 2013). However, in Jiaozuo, there is no Taijiquan program tailored to the health needs of older adults in terms of balance, flexibility, and lower-limb muscle strength, nor is there a Taijiquan program suitable for the Taijiquan training level of older adults. Therefore, this study innovatively designed a progressive Taijiquan program for the elderly and set up an 8-week Taijiquan intervention, observing the improvement effect on balance, flexibility, and lower-limb muscle strength in the elderly in Jiaozuo. It was expected that the intervention group would have significantly better improvement in balance, flexibility, and lower-limb muscle strength compared with the control group.

## Objectives

To develop a taijiquan training program to improve the physical fitness of the elderly in Jiaozuo City.

## Literature Review

### 1. Taijiquan

Taijiquan is a kind of traditional Chinese martial art that strengthens the body and balances emotions. Taijiquan originated from ancient guiding and breathing, integrated the meridian theory, collateral theory, yin-yang theory, and other traditional Chinese theories, and formed its own action characteristics (Xu et al., 2022). Taijiquan has strong adaptability in coordination and balance of the whole body, and has a good guiding role based on traditional medical theory. In particular, the softness and slowness of Taijiquan movements, as well as their variability, make it possible to adjust Taijiquan practice based on people's actual physical conditions, providing a very flexible and accessible form of exercise for older adults to meet the requirements of health promotion such as improving martial arts skills, increasing functional fitness, and health and longevity (Sun & Wang, 2024). Systematic and scientific Taijiquan practice can improve body balance, flexibility, lower limb muscle strength, and other dimensions of physical fitness.

### 2. Physical Fitness of the Elderly

From the collected statistics, we can see that the chronic disease prevalence rate in Jiaozuo City among people aged 60 and over is 59.8%. The chronic disease prevalence rate in Jiaozuo City among people aged 60 and over is 82.89%, and the ADL impairment rate is 12.08% (Zhu et al., 1999). The above information reminds us that it is necessary to focus on the older population in the future to maintain their ability to carry out activities and reduce their health risks.

### 3. Taijiquan Training Program

A Taijiquan training program is a program or exercise course designed according to scientific fitness principles and a training system to improve the physical fitness of the elderly. Taijiquan training programs have certain specific Taijiquan movements, standardized Taijiquan instruction content, and specific Taijiquan training time, frequency, and training environment. The Taijiquan training program is designed according to scientific fitness principles, and the program design can fully play the advantages of Taijiquan to improve the older population's physical fitness (Gjinovci et al., 2017). For the elderly, they are targeted and specific to improve physical fitness in certain functional dimensions to help them achieve a healthier old age.

The Taijiquan training program not only has a good regulatory effect on the age-related decline in various physiological functions in older people but also helps reduce the incidence of osteoporosis (Huang et al., 2010). Taijiquan interventions are potentially effective in the prevention and treatment of chronic diseases such as diabetes, hypertension, and other metabolic disorders.

### 4. Summary

Taijiquan absorbs the traditional medicine meridian, qi, and blood theory, in line with medical theory, with fitness. Practicing taijiquan can help improve physical fitness, including strengthening muscle strength, balance ability, and cardiovascular health. Through an extensive literature search, it was found that specific taijiquan training interventions have shown better

training effects on balance force, skeletal muscle, lower limb muscle strength, chronic disease, cognitive function, and other aspects of the elderly. For example, adhering to taijiquan exercise for more than 12 weeks and maintaining a single training time of more than 40 minutes can effectively control blood pressure. Taijiquan exercise can effectively delay the decline of skeletal muscle content and lower limb muscle strength in the elderly, but the effect is not obvious in the upper limb grip strength. So, it is recommended that the elderly increase the resistance training of small and medium intensity during exercise. Therefore, this research aims to develop a taijiquan training program to improve the physical fitness of the elderly. Through the experimental process, to study and develop a taijiquan training program.

### Conceptual Framework

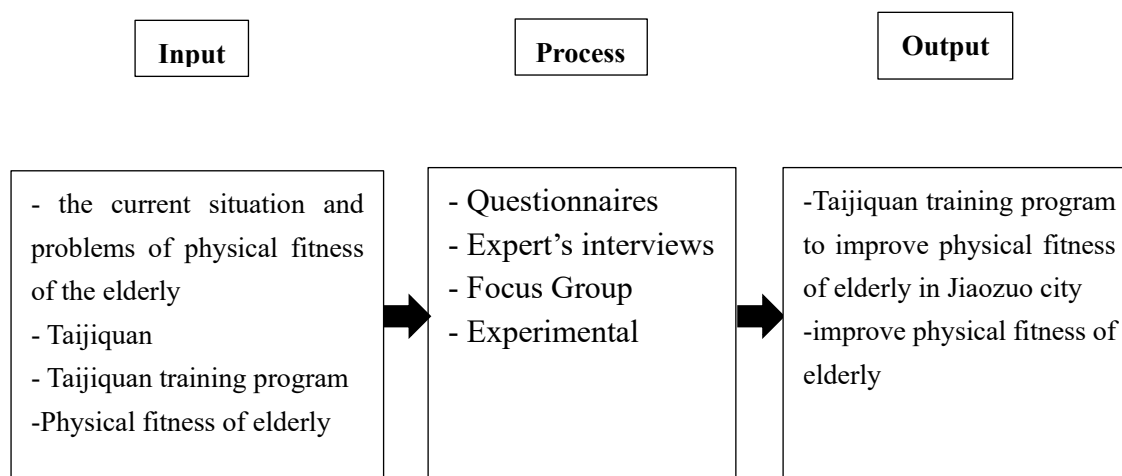


Figure 1 Conceptual Framework

### Methodology

#### Population

The population of this study comprised 128 elderly individuals and 15 taijiquan instructors from 5 taijiquan activity centers in Jiaozuo City.

#### Sample

Using purposive sampling, 48 elderly people from taijiquan activity centers at Jiaozuo People's Square were selected as the sample group for this study. Among these elderly people, there were 36 males (accounting for 75%) and 12 females (accounting for 25%), aged between 60 and 70 years old. Randomization method.

#### Randomization method

All 48 elderly people took part in the balance test, and their test results were recorded. The scores were then ranked separately for males and females, with 36 males ranked from highest to lowest and 12 females ranked from highest to lowest. Using a systematic sampling method, the males were divided into two groups of 18 each, and the females into two groups

of 6 each. A lottery method was then used to randomly pair the groups. From this process, 24 elderly participants were assigned to the experimental group (18 males and 6 females), and 24 elderly participants to the control group (18 males and 6 females) for this experiment.

### Research Participants

1. 3 professional taijiquan instructors with master's degrees and more than 10 years of practice were selected to evaluate the questions in the geriatric questionnaire and expert interview form using the project-objective consistency (IOC) indicator.

2. 5 experts, including 2 taijiquan teachers and 3 taijiquan instructors with more than 10 years of practical experience, all have master's degrees, and conducted face-to-face interviews. Through expert interviews, a focus group questioning framework was constructed, focusing on the main contents of formulating a taijiquan training program to improve the physical fitness of the elderly.

3. 10 experts, including 3 taijiquan teachers, 3 taijiquan instructors, and 4 taijiquan researchers with more than 10 years of practical experience, participated in the focus group discussion, all of whom have master's degrees. The focus group members developed a taijiquan training program for the elderly, aiming to improve the physical fitness of the elderly in Jiaozuo City.

4. 7 experts, including 3 professional taijiquan coaches, 2 taijiquan teachers, and 2 taijiquan instructors, constructed a connoisseurship discussion, who have more than 10 years of practical experience and hold associate professor or higher academic titles, for the purpose of confirming the taijiquan training program to improve the physical fitness of the elderly in Jiaozuo City.

### Research Instrument

1. Questionnaires for the elderly and instructors: Distribute Questionnaires to the elderly and instructors at the taijiquan activity center to form interview questions and establish a framework for the taijiquan training program. Subsequently, 3 experts conducted a review to ensure that the questions were consistent with the research objective.

2. Interview questionnaire: Design an interview questionnaire and conduct expert interviews. The interview questionnaire was reviewed by 3 experts, who assessed the alignment of the questions with the research objectives using the index of Item-Objective Congruence (IOC).

3. Focus group outline: This outline is mainly designed to include some open-ended questions to assist focus group experts in formulating a taijiquan training program.

4. Connoisseurship outline: A connoisseurship outline was constructed to guide the discussion. The purpose of this outline was to confirm the taijiquan training program to improve the physical fitness of the elderly in Jiaozuo City.

5. Taijiquan training program: The Taijiquan training program was developed and

designed to last 8 weeks, with sessions held 5 days a week, 90 minutes a day.

#### 6. Physical fitness test

Balance force was evaluated by using the static test and the dynamic test. The static test of balance force was tested by the methods described in Guo (2023). The dynamic test of balance force was tested by the methods proposed in Lu (2017).

Flexibility was measured by using the Chair Sit-and-Reach (CSR) Test introduced by Jones and colleagues, as was used in our previous research (Hou et al., 2004). The CSR Test is one of the most used tests for measuring the flexibility of hip joints and hamstrings in the elderly.

The lower-limb muscle strength was tested by using two methods due to the safety and accuracy for older adults: the 5-Time Sit-to-Stand Test (Xue, 2021) and the 30-Second Sit-to-Stand Test (Tang, 2023).

#### Data Collection

1. Questionnaires were distributed to 128 elderly people and 15 instructors from 5 taijiquan activity centers in Jiaozuo City through on-site distribution.

2. 5 experts were interviewed through face-to-face interviews. Through expert interviews, the question framework for the focus group was constructed, focusing on components for developing a taijiquan training program to improve the physical fitness of the elderly.

3. 10 experts participated in the focus group discussion. The purpose of the focus group discussion was to develop a taijiquan training program for the elderly, aiming to improve the physical fitness of the elderly in Jiaozuo City.

4. 7 experts participated in a connoisseurship discussion for the purpose of confirming the taijiquan training program to improve the physical fitness of the elderly in Jiaozuo City.

5. The experiment was conducted for 8 weeks, comprising pre-test, 4-week test, and 8-week test stages, including balance force test, flexibility test, and lower limb muscle strength test to evaluate the effects of the taijiquan training program.

#### Data Analysis

1. The data collected from the questionnaire were analyzed by descriptive statistical techniques, such as calculating the mean ( $\bar{x}$ ) and standard deviation (S.D.).

2. Expert interviews, focus group discussion, and connoisseurship discussion results were using content analysis to analyze the data.

3. Objective consistency index (IOC) was used to evaluate the content validity of the questionnaires and expert interview questionnaire, with an IOC value = 0.60-1.00.

4. An independent t-test was used to analyze the test results of pre-test and post-test (after 8 weeks of training) between the experimental group and the control group.

5. The results of the pre-test, mid-test (after 4 weeks of training), and post-test (after 8 weeks of training) of the experimental group were analyzed using one-way repeated measures ANOVA to determine significant changes in physical fitness over time.

6. Post-hoc comparisons were conducted to further examine significant differences found in the repeated measures ANOVA to identify specific changes over time.

7. In this study, the significance level was set as  $p \leq 0.05$  indicates a significant difference

8. In this study, a Likert scale was utilized to assess the data collected from the elderly questionnaire. The mean score for each item was calculated based on the respondents' evaluations and feedback.

## Results

**Investigate the current situation and problems of physical fitness of the elderly in Jiaozuo City.**

To explore the current physical condition of the elderly in Jiaozuo City and identify potential problems that affect the improvement of their physical condition. Firstly, the questionnaires using a five-point Likert scale were distributed to 128 elderly and 15 instructors from five taijiquan activity centers. After distributing the questionnaires to 128 elderly and 15 instructors, all the responses from the elderly participants were successfully collected.

**Draft taijiquan training program to improve the physical fitness of the elderly in Jiaozuo city.**

After the expert interviews, the researchers invited ten experts to conduct a focus group discussion, consisting of 10 experts (3 taijiquan teachers, 3 taijiquan instructors, and 4 taijiquan researchers), to develop a taijiquan training program suitable for the physical fitness of the elderly. After a discussion by 10 experts in a focus group discussion, the taijiquan training program was formulated. This program lasts for 8 weeks, with 5 days arranged each week and 90 minutes each day. Each training session consists of 15 minutes of warm-up, 60 minutes of main training (divided into routine and specialized training), and 15 minutes of cool-down. The training outline is as follows (Table 1).

**Table 1** Outline of the 8-Week Taijiquan Training Program.

| Program Structure by Phase               |                                                                                |
|------------------------------------------|--------------------------------------------------------------------------------|
| <b>Basic Taijiquan Exercises</b>         |                                                                                |
| <b>Week 1-2:</b><br>Adaptation stage     | -Focus: Breathing techniques, basic steps, and hand shapes of Taijiquan        |
|                                          | -Specialized Practice:                                                         |
|                                          | 1) Balance training (standing on one foot in coordination with breathing)      |
|                                          | 2) Lower limb strength (half squat, horse stance endurance)                    |
| <b>Week 3-4:</b><br>Consolidation of the | 3) Flexibility training (flexibility of the waist, legs, and shoulders)        |
|                                          | <b>Basic exercises integrated into taijiquan movements</b>                     |
|                                          | -Focus: Shift the center of gravity, coordinate body movements and techniques. |

### Program Structure by Phase

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| foundation                                        | -Specialized Practice: <ol style="list-style-type: none"> <li>1) Balance training (standing on one foot in coordination with breathing)</li> <li>2) Lower limb strength (half squat, horse stance endurance)</li> <li>3) Flexibility training (flexibility of the waist, legs, and shoulders)</li> </ol>                                                                                                                                                   |
| <b>Week 5-7:</b><br>Connect the movement routines | <b>Balance force and flexibility</b><br>-Focus: Complete the learning of the action routine.<br>-Specialized Practice: <ol style="list-style-type: none"> <li>1) Balance training (standing on one foot in coordination with breathing)</li> <li>2) Lower limb strength (half squat, horse stance endurance)</li> <li>3) Flexibility training (flexibility of the waist, legs, and shoulders)</li> </ol>                                                   |
| <b>Week 8:</b><br>Consolidation and improvement   | <b>Comprehensively consolidate the movements of taijiquan</b><br>-Focus: Proficiency in movement routines and physical and mental health care.<br>-Specialized Practice: <ol style="list-style-type: none"> <li>1) Balance training (standing on one foot in coordination with breathing)</li> <li>2) Lower limb strength (half squat, horse stance endurance)</li> <li>3) Flexibility training (flexibility of the waist, legs, and shoulders)</li> </ol> |

### The experimental results

In this step, the researcher would summarize the experimental results analysis. Data analysis was conducted using mean, standard deviation, one-way repeated measures analysis of variance, Bonferroni post hoc test, and independent t-test.

**Table 2** Mean and standard deviation of the results of the static balance force test of the experimental group.

| Variables                                       | Experimental Group |      |           |      |           |      |
|-------------------------------------------------|--------------------|------|-----------|------|-----------|------|
|                                                 | Pre-test           |      | Mid-test  |      | Post-test |      |
|                                                 | $\bar{x}$          | SD   | $\bar{x}$ | SD   | $\bar{x}$ | SD   |
| Standing on the left foot with eyes closed (s)  | 6.12               | 1.22 | 6.73      | 1.34 | 6.89      | 1.32 |
| Standing on the right foot with eyes closed (s) | 6.13               | 0.77 | 6.18      | 0.95 | 7.00      | 0.97 |

As can be seen from Table 2, the static balance force test results of the experimental group are as follows: 1) Standing on the left foot with eyes closed was pre-test  $\bar{x}$  =6.12 and SD =1.22; mid-test  $\bar{x}$  = 6.73 and SD = 1.34; Post-test  $\bar{x}$  = 6.89 and SD = 1.32. 2) Standing on the right foot with eyes closed was pre-test  $\bar{x}$  =6.13 and SD =0.77; mid-test  $\bar{x}$  = 6.18 and SD = 0.95; Post-test  $\bar{x}$  = 7.00 and SD = 0.97.

**Table 3** Mean and standard deviation of the results of the static balance force test of the control group.

| Variables                                       | Control Group |      |           |      |           |      |
|-------------------------------------------------|---------------|------|-----------|------|-----------|------|
|                                                 | Pre-test      |      | Mid-test  |      | Post-test |      |
|                                                 | $\bar{x}$     | SD   | $\bar{x}$ | SD   | $\bar{x}$ | SD   |
| Standing on the left foot with eyes closed (s)  | 6.15          | 1.25 | 5.73      | 1.34 | 5.69      | 1.45 |
| Standing on the right foot with eyes closed (s) | 6.15          | 0.78 | 6.14      | 1.02 | 6.13      | 1.06 |

As can be seen from Table 3, the static balance force test results of the control group are as follows: 1) Standing on the left foot with eyes closed was pre-test  $\bar{x}$  =6.15 and SD =1.25; mid-test  $\bar{x}$  = 5.73 and SD = 1.34; Post-test  $\bar{x}$  = 5.69 and SD = 1.45. 2) Standing on the right foot with eyes closed was pre-test  $\bar{x}$  =6.15 and SD =0.78; mid-test  $\bar{x}$  = 6.14 and SD = 1.02; Post-test  $\bar{x}$  = 6.13 and SD = 1.06.

**Table 4** The comparison between the experiment and control groups with the pre-test results of static balance force, by independent t-test.

| Variables                                       | Exp. G    |      | Cont. G   |      | t     | p    |
|-------------------------------------------------|-----------|------|-----------|------|-------|------|
|                                                 | $\bar{x}$ | SD   | $\bar{x}$ | SD   |       |      |
| Standing on the left foot with eyes closed (s)  | 6.12      | 1.22 | 6.15      | 1.25 | -0.08 | 0.94 |
| Standing on the right foot with eyes closed (s) | 6.13      | 0.77 | 6.15      | 0.78 | 0.08  | 0.93 |

\*P<0.05

Table 4 showed that the pre-test results of Standing on the left foot with eyes closed and Standing on the right foot with eyes closed were not significantly different.

**Table 5** The comparison between the experiment and control groups with the post-test results of static balance force, by independent t-test.

| Variables                                       | Exp. G    |      | Cont. G   |      | t    | p     |
|-------------------------------------------------|-----------|------|-----------|------|------|-------|
|                                                 | $\bar{x}$ | SD   | $\bar{x}$ | SD   |      |       |
| Standing on the left foot with eyes closed (s)  | 6.89      | 1.32 | 5.69      | 1.45 | 2.47 | 0.02* |
| Standing on the right foot with eyes closed (s) | 7.00      | 0.97 | 6.13      | 1.06 | 2.71 | 0.01* |

\*P<0.05

**Table 6** The comparison of the test results of standing on the left foot with eyes closed within the experimental group by using one-way ANOVA repeated measurement.

| Source of Variance (Sov) | df | SS     | MS   | F    | p       |
|--------------------------|----|--------|------|------|---------|
| Time                     | 2  | 16.72  | 8.36 | 4.99 | < 0.01* |
| Error                    | 46 | 115.61 | 1.68 |      |         |
| Total                    | 71 | 132.33 |      |      |         |

\*P<0.05

Table 6 showed that the test results of standing on the left foot with eyes closed in the experimental group had a significant difference,  $p < 0.05$ , between pre-test, mid-test, and post-test.

**Table 7** The comparison of the test results of standing on the left foot with eyes closed within the experimental group by using the Bonferroni post hoc.

| Dependent | Mean | Pre-test | Mid-test | Post-test |
|-----------|------|----------|----------|-----------|
|           |      | 6.12     | 6.73     | 6.89      |
| Pre-test  | 6.12 |          | -0.61    | -0.77*    |
| Mid-test  | 6.73 |          |          | -0.16*    |
| Post-test | 6.89 |          |          |           |

\*P<0.05

Table 7 showed that the test results of standing on the left foot with eyes closed in the experimental group had a significant difference,  $p < 0.05$ , between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

**Table 8** The comparison of the test results of standing on the right foot with eyes closed within the experimental group by using one-way ANOVA repeated measurement.

| Source of Variance (Sov) | df | SS    | MS   | F    | p       |
|--------------------------|----|-------|------|------|---------|
| Time                     | 2  | 11.46 | 5.73 | 7.07 | < 0.01* |
| Error                    | 46 | 56.03 | 0.81 |      |         |

| Source of Variance (Sov) | df | SS    | MS | F | p |
|--------------------------|----|-------|----|---|---|
| Total                    | 71 | 67.49 |    |   |   |

\*P<0.05

Table 8 showed that the test results of standing on the right foot with eyes closed in the experimental group had a significant difference,  $p<0.05$ , between pre-test, mid-test, and post-test.

**Table 9** The comparison of the test results of standing on the right foot with eyes closed within the experimental group by using the Bonferroni post hoc.

| Dependent | Mean | Pre-test | Mid-test | Post-test |
|-----------|------|----------|----------|-----------|
|           |      | 6.13     | 6.18     | 7.00      |
| Pre-test  | 6.13 |          | -0.05    | -0.87*    |
| Mid-test  | 6.18 |          |          | -0.82*    |
| Post-test | 7.00 |          |          |           |

\*P<0.05

Table 9 showed that the test results of standing on the right foot with eyes closed in the experimental group had a significant difference,  $p<0.05$ , between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

**Table 10** Mean and standard deviation of the results of the dynamic balance force test of the experimental group.

| Variables                                   | Experimental Group |      |           |      |           |      |
|---------------------------------------------|--------------------|------|-----------|------|-----------|------|
|                                             | Pre-test           |      | Mid-test  |      | Post-test |      |
|                                             | $\bar{x}$          | SD   | $\bar{x}$ | SD   | $\bar{x}$ | SD   |
| Crossing obstacles while walking (score)    | 2.61               | 0.10 | 2.83      | 0.42 | 2.95      | 0.68 |
| Walking on a narrow support surface (score) | 1.88               | 0.36 | 2.36      | 0.45 | 2.56      | 0.69 |

As can be seen from Table 10, the dynamic balance force test results of the experimental group are as follows: 1) Crossing obstacles while walking was pre-test  $\bar{x}$  = 2.61 and SD = 0.10; mid-test  $\bar{x}$  = 2.83 and SD = 0.42; Post-test  $\bar{x}$  = 2.95 and SD = 0.68. 2) Walking on a narrow support surface was pre-test  $\bar{x}$  = 1.88 and SD = 0.36; mid-test  $\bar{x}$  = 2.36 and SD = 0.45; Post-test  $\bar{x}$  = 2.56 and SD = 0.69.

**Table 11** Mean and standard deviation of the results of the dynamic balance force test of the control group.

| Variables                                   | Control Group |      |           |      |           |      |
|---------------------------------------------|---------------|------|-----------|------|-----------|------|
|                                             | Pre-test      |      | Mid-test  |      | Post-test |      |
|                                             | $\bar{x}$     | SD   | $\bar{x}$ | SD   | $\bar{x}$ | SD   |
| Crossing obstacles while walking (score)    | 2.62          | 0.10 | 2.64      | 0.12 | 2.66      | 0.12 |
| Walking on a narrow support surface (score) | 1.85          | 0.37 | 1.87      | 0.45 | 1.89      | 0.46 |

As can be seen from Table 11, the dynamic balance force test results of the control group are as follows: 1) Crossing obstacles while walking was pre-test  $\bar{x}$  = 2.62 and SD = 0.10; mid-test  $\bar{x}$  = 2.64 and SD = 0.12; Post-test  $\bar{x}$  = 2.66 and SD = 0.12. 2) Walking on a narrow support surface was pre-test  $\bar{x}$  = 1.85 and SD = 0.37; mid-test  $\bar{x}$  = 1.87 and SD = 0.45; Post-test  $\bar{x}$  = 1.89 and SD = 0.46.

**Table 12** The comparison between the experiment and control groups with the pre-test results of dynamic balance force, by independent t-test.

| Variables                                   | Exp. G    |      | Cont. G   |      | t     | p    |
|---------------------------------------------|-----------|------|-----------|------|-------|------|
|                                             | $\bar{x}$ | SD   | $\bar{x}$ | SD   |       |      |
| Crossing obstacles while walking (score)    | 2.61      | 0.10 | 2.62      | 0.10 | -0.31 | 0.76 |
| Walking on a narrow support surface (score) | 1.88      | 0.36 | 1.85      | 0.37 | 0.27  | 0.79 |

\*P<0.05

Table 12 showed that the pre-test results of crossing obstacles while walking and walking on a narrow support surface were not significantly different.

**Table 13** The comparison between the experiment and control groups with the post-test results of dynamic balance force, by independent t-test.

| Variables                                   | Exp. G    |      | Cont. G   |      | t    | p     |
|---------------------------------------------|-----------|------|-----------|------|------|-------|
|                                             | $\bar{x}$ | SD   | $\bar{x}$ | SD   |      |       |
| Crossing obstacles while walking (score)    | 2.95      | 0.68 | 2.66      | 0.12 | 2.87 | 0.00* |
| Walking on a narrow support surface (score) | 2.56      | 0.69 | 1.89      | 0.46 | 5.36 | 0.00* |

\*P<0.05

Table 13 showed that the post-test results of crossing obstacles while walking and walking on a narrow support surface were significantly different, p<0.05.

**Table 14** The comparison of the test results of crossing obstacles while walking within the experimental group by using one-way ANOVA repeated measurement.

| Source of Variance (Sov) | df | SS   | MS   | F    | p     |
|--------------------------|----|------|------|------|-------|
| Time                     | 2  | 5.58 | 0.24 |      |       |
| Error                    | 46 | 2.34 | 1.17 | 8.73 | 0.00* |
| Total                    | 71 | 7.92 |      |      |       |

\*P<0.05

Table 14 showed that the test results of crossing obstacles while walking in the experimental group had a significant difference, p<0.05, between pre-test, mid-test, and post-test.

**Table 15** The comparison of the test results of crossing obstacles while walking within the experimental group by using Bonferroni post hoc.

| Dependent | Mean | Pre-test | Mid-test | Post-test |
|-----------|------|----------|----------|-----------|
|           |      | 2.61     | 2.83     | 2.95      |
| Pre-test  | 2.61 |          | 0.22*    | 0.34*     |
| Mid-test  | 2.83 |          |          | 0.12*     |

| Dependent | Mean | Pre-test | Mid-test | Post-test |
|-----------|------|----------|----------|-----------|
|           |      | 2.61     | 2.83     | 2.95      |
| Post-test | 2.95 |          |          |           |

\*P<0.05

Table 15 showed that the test results of crossing obstacles while walking in the experimental group had a significant difference,  $p<0.05$ , between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

**Table 16** The comparison of the test results of walking on a narrow support surface within the experimental group by using one-way ANOVA repeated measurement.

| Source of Variance (Sov) | df | SS    | MS   | F     | p     |
|--------------------------|----|-------|------|-------|-------|
| Time                     | 2  | 8.42  | 0.37 |       |       |
| Error                    | 46 | 4.63  | 2.32 | 12.45 | 0.00* |
| Total                    | 71 | 13.05 |      |       |       |

\*P<0.05

Table 16 showed that the test results of walking on a narrow support surface in the experimental group had a significant difference,  $p<0.05$ , between pre-test, mid-test, and post-test.

**Table 17** The comparison of the test results of walking on a narrow support surface within the experimental group by using the Bonferroni post hoc.

| Dependent | Mean | Pre-test | Mid-test | Post-test |
|-----------|------|----------|----------|-----------|
|           |      | 1.88     | 2.36     | 2.56      |
| Pre-test  | 1.88 |          | 0.48*    | 0.68*     |
| Mid-test  | 2.36 |          |          | 0.20*     |
| Post-test | 2.56 |          |          |           |

\*P<0.05

Table 17 showed that the test results of walking on a narrow support surface in the experimental group had a significant difference,  $p < 0.05$ , between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

**Summary:** The core issue addressed in this study is the physical health of the elderly in Jiaozuo City, which is manifested in weakened balance ability, reduced flexibility of the lower limbs, and a decline in lower limb muscle strength.

The taijiquan training was conducted for eight weeks. The elderly in the experimental group used a taijiquan training program, while the elderly in the control group continued to use a traditional training program. The results showed that the elderly in the experimental group had significant improvements in all indicators. The mean score of the test results of balance force, flexibility, and lower limb muscle strength of the elderly in the experimental group showed a significant difference  $p < 0.05$  between pre-test, mid-test, and post-test. Additionally, the post-test results of balance force, flexibility, and lower limb muscle strength between the experimental group and the control group showed a significant difference,  $p < 0.05$ . This indicates that the developed taijiquan training program was more effective in improving the physical fitness of the elderly.

## Discussion

The results of this study showed that an 8-week Chen-style Taijiquan training program significantly enhanced the balance, flexibility, and lower-limb strength of older adults in Jiaozuo, China. This is a clinically significant finding, for instance, because the improvement in single-leg stance time was about 0.8 s, which typically represents a clinically important reduction in fall risk for older adults. The possible mechanisms may be related to Taijiquan's emphasis on continuous weight-shifting, low postures, and multi-directional movements that increase proprioception, neuromuscular coordination, and eccentric strength in the lower limbs. On the contrary, the 24 older adults in the control group maintained their original living habits and had little change in physical fitness over 8 weeks. In short, the 8-week Taijiquan training program significantly and effectively improved balance force (static balance, dynamic balance), flexibility (Chair Sit-and-Reach Test), and lower-limb muscle strength (5-Time Sit-to-Stand Test, 30-Second Continuous Sit-to-Stand Test).

First, in terms of balance and flexibility, the postural control of the body and lower-limb flexibility are important indicators of the physical fitness of the elderly. After 8 weeks of intervention, the experimental group had greater improvements in balance force and flexibility than the control group, and the between-group difference was statistically significant ( $p < .05$ ). These data suggest that Taijiquan training properly prescribed can effectively improve balance and flexibility in older adults. These results are also consistent with the experimental results of Sun (2017). In terms of Taijiquan movement, whether the upper limb, lower limb, or trunk moves, the

trajectory is mostly arc-shaped. The movement of the upper limb is mainly the movement from the shoulders to the elbows to the fingers, and the forward and backward movements can be changed in turn. The movement of the lower limb includes lifting step, following step, lunge, and other movements, which repeatedly bend and extend the hip joint, coordinated with the knee joint and ankle joint movement. Meanwhile, the upper and lower limb movement is promoted by the waist rotating and twisting. In this way, the rotation of the joint can reach the maximum, and the extension of the muscle fiber can reach the maximum; that is, at the moment of the most violent twist and the most violent stretch, the upper limb, lower limb, and trunk are all in the state of active extension. This generates the beneficial effects of Taijiquan practice on balance and flexibility among older adults (Sun, 2017).

Second, in terms of lower-limb muscle strength, the reason for the effectiveness and practicability of the Taijiquan training program may be that it was based on the specificity and individuality of the exercise prescription. On the one hand, the training incorporated representative Chen-style forms such as Six Steals and Four Closing, Single Whip, Cloud Hands, and Ground-Hacking Dragon while focusing on balance, flexibility, and lower-limb strength training. On the other hand, and more importantly, each older adult received a unique, individualized training plan that matched his or her particular physical characteristics and capacities. As a result, not only were the balance and flexibility of the older adults trained by Taijiquan improved, but their lower-limb muscle strength was also significantly increased. The above findings are in line with the findings of Zhao and Tan (2024), who found that Taijiquan can increase lower-limb muscle strength, stimulate intramuscular receptors, and improve lower-limb motor function.

Based on the above results, the Taijiquan training of older adults in this study can be further optimized in terms of a personalized and precise exercise prescription that is specific to the individual's health condition, sex, and functional ability of older adults. In future programs, the training intensity and duration should be more quantified, and the optimal combination of the two for maximizing health gains in the elderly should be further explored.

## Recommendation

### Recommendation for this research

1. It is recommended to extend the training period and conduct a follow-up assessment 4 weeks after the training to evaluate the long-term effect and the retention of training results.
2. It is suggested to enhance the publicity and promotion of its fitness benefits, and correctly guide more elderly people to participate in taijiquan.
3. It is suggested to expand the sample size to ensure broader representativeness and enhance the universality of the research results.

### Recommendation for further research

1. It may explore the application of taijiquan training programs to a broader range of people.



2. It is suggested that future research explore the long-term effects of a taijiquan training program over extended periods (1 year to 2 years) to assess sustained improvements in performance and injury prevention.

3. It is suggested that targeted exploration be carried out for specific movements to provide more guidance directions for the elderly when choosing taijiquan as an exercise project, which will be of great significance.

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