

## Original Article

# Influence of Tai Chi exercise cycle on the senile respiratory and cardiovascular circulatory function

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**Abstract:** Objective: Observe the improvement effect of different cycles of Tai Chi exercise on the senile respiratory and cardiovascular circulatory function. Methods: Select 180 elderly men who don't usually do the fitness exercise and then ask them to do Tai Chi exercise. Test their related indicators respectively prior to exercise and upon exercise for 3 months, 6 months and 12 months. ① The cardiac pump function indicator: "Stroke Volume", "Ejection Fraction" and "Heart Rate"; ② Rheoencephalogram (REG) indicator: "Inflow time", "Wave Amplitude"; ③ Pulmonary ventilation indicator: "Vital Capacity" (VC), "Maximum Minute Ventilation" (MMV). Results: ① Compared with the indicators before exercise, each indicator has no significant difference after 3 months of exercise and a part of indicators are improved after 6 months of exercise, but most indicators have no significant differences; ② After 12 months of the exercise, compared with those indicators before exercise, the tested indicators are obviously improved. Specific data indicates that stroke volume (mL) is increased to  $71.82 \pm 10.93$  from  $66.21 \pm 11.35$  and the ejection fraction (%) is improved to  $67.89 \pm 4.94$  from  $60.54 \pm 5.02$ , but the heart rate (times/min) is reduced to  $67.15 \pm 8.39$  from  $76.62 \pm 8.40$ , mean  $P < 0.05$ ; inflow time (s) is shortened to  $0.13 \pm 0.04$  from  $0.17 \pm 0.05$ ; the amplitude ( $\Omega$ ) is increased to  $1.19 \pm 0.23$  from  $0.97 \pm 0.21$  before exercise and mean  $P < 0.05$ ; the vital capacity (L) is increased to  $3.57 \pm 1.39$  from  $2.84 \pm 0.32$ ; maximum minute ventilation (L/min) is improved to  $117.25 \pm 14.86$  from  $97.26 \pm 14.71$ , mean  $P < 0.05$ . Conclusion: The short-term Tai Chi exercise that is less than six months the following 6 months has no significant effect on the senile respiratory and cardiovascular circulatory function, however, with the longer exercise duration, after 12 months' exercise, it can significantly improve the effect.

**Keywords:** Tai Chi, old people, exercise cycle, health, effect

## Introduction

As old people grow older, their various body functions obviously decline. In particular, muscle atrophy, declined coordination capability and hypofunctions in breathing and circulatory systems caused by the lack of exercise pose a big threat to the health of old people [1, 2]. Besides, restricted by their athletic ability, old people, especially the elderly, are usually unable to participate in many sports and in fact, many sports or exercise modes are unfit for old people [3]. Tai Chi, as a softer exercise mode, emphasizes on unity of form and spirit, syncretism of inside and outside, relaxation and nature, stillness in motion and kindness with security. It serves as an appropriate long-term exercise mode for old people [4]. Profile

indicates that Tai Chi helps to improve human blood circulation, ease high blood pressure, strengthen cardio-pulmonary function, and plays an important role in maintaining mental happiness and health [5, 6]. This study discusses different exercise cycles for Tai Chi and their effect on the breathing, heart and brain blood circulation, as well as provides practical evidence for old people to formulate their fitness routine.

## Material and method

### Study object

From June, 2012 to September, 2013, 180 old men from five communities of Jiaozuo city, the home of Tai Chi, were selected as the study

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**Table 1.** Comparison of cardiac pump function indicators before and after Tai Chi exercise ( $\bar{x} \pm s$ , n = 180)

Indicators	Before exercise	Three months after exercise	Six months after exercise	12 months after exercise
Stroke volume (mL)	66.21 ± 11.35	67.18 ± 11.29	67.85 ± 12.50	71.82 ± 10.93*
Ejection fraction (%)	60.54 ± 5.02	61.22 ± 5.21	62.83 ± 5.29	67.89 ± 4.94*
Heart rate (times/min)	76.62 ± 8.40	74.56 ± 8.51	70.97 ± 8.37*	67.15 ± 8.39*

Note: Compared with that before exercise, \* $P < 0.05$ .

**Table 2.** Comparison of brain impedance rheography indicators before and after Tai Chi exercise ( $\bar{x} \pm s$ , n = 180)

Indicators	Before exercise	Three months after exercise	Six months after exercise	12 months after exercise
Inflow time (s)	0.171 ± 0.054	0.160 ± 0.052	0.153 ± 0.056	0.130 ± 0.049*
Amplitude ( $\Omega$ )	0.975 ± 0.210	0.984 ± 0.217	1.023 ± 0.206	1.194 ± 0.231*

Note: Compared with that before exercise, \* $P < 0.05$ .

object. They are 60 to 70 years old on average, generally in good health and seldom take exercise. Inclusion criteria: 60 years old or older; free from diagnosed cardiovascular and cerebrovascular diseases or diabetes; free from medicines to treat cardiovascular and cerebrovascular diseases; with basic seeing, hearing, comprehension and expression ability; voluntary to participate in the experiment and suitable to take Tai Chi. The selected men are informed of this study and agree.

### Exercise method

Prior to exercise, professional instructors are invited to train the selected men to help them understand the exercise method, intensity, amount, and relevant notes so that they can take part in the study with good form and positive attitude. The 150 selected men take Chen-style Tai Chi for about 60 minutes every morning and evening and the experiment lasts for 12 months.

### Index detection

Prior to exercise, three, six and 12 months after exercise respectively: the Japan-made Aloka-SSD701 "cardiac ultrasound device" is used to test "stroke volume" (mL), "ejection fraction" (%) and "heart rate" (times/min); the Italy-made Pony "pulmonary function device" is used to test "lung capacity" (L) and "maximum minute ventilation" (L/min); the RG-2B "brain impedance rheograph" made by Shanghai Medical

Electronic Instruments Plant is used to test "amplitude" ( $\Omega$ ) and "Inflow time" (s). Compare the data before and after the experiment and observe the changes in the "cardiac pump function", "pulmonary ventilation function" and "brain blood flow resistance".

### Statistical analysis

The SPSS12.0 software package is adopted to conduct statistics and analysis on the experimental data, which is symbolized by ( $\bar{x} \pm s$ ). The t is used to test the measurement data and when  $P < 0.05$ , the discrepancy has statistical significance.

### Result

#### *Changes in the cardiac pump function of old people before and after Tai Chi exercise*

After taking Tai Chi for six months, "heart rate" of the selected men slows down to some degree ( $P < 0.05$ ) and other indicators of the cardiac pump function show no obvious improvement ( $P > 0.05$ ). After taking Tai Chi for 12 months, indicators of the cardiac pump function of the selected men improve a lot ( $P < 0.05$ ). The discrepancy has statistical significance. See **Table 1**.

#### *Changes in brain impedance rheography before and after Tai Chi exercise*

After taking Tai Chi for 12 month, the "Inflow time (s)", which reflects cerebral blood flow

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**Table 3.** Comparison of pulmonary ventilation function indicators before and after Tai Chi exercise ( $\bar{x} \pm s$ , n = 180)

Indicators	Before exercise	Three months after exercise	Six months after exercise	12 months after exercise
Lung capacity (L)	2.84 ± 0.32	2.90 ± 0.31	3.15 ± 1.41	3.57 ± 1.39*
Maximum minute ventilation (L/min)	97.26 ± 14.71	99.53 ± 14.93	110.58 ± 15.34*	117.25 ± 14.86*

Note: Compared with that before exercise, \* $P < 0.05$ .

resistance, decreases from  $0.171 \pm 0.054$  to  $0.130 \pm 0.049$ ; the “amplitude ( $\Omega$ )”, which reflects cerebral blood flow, increases from  $0.975 \pm 0.210$  to  $1.194 \pm 0.231$ . Both discrepancies have statistical significance ( $P < 0.05$ ). After taking Tai Chi for three months, the testing indicators show no obvious changes; after taking Tai Chi for six months, an improving tendency emerges but there are still no obvious discrepancies. According to the study, short-time exercise within six months doesn't bring about obvious effects and as time goes on, the effect becomes more notable. The study proves that taking Tai Chi regularly on a long term basis can effectively reduce the “Inflow time” of the rheoencephalogram and the cerebral blood flow resistance, and increase “amplitude” and cerebral blood flow to remarkably improve the blood supply to the brain. See **Table 2**.

### *Changes in pulmonary ventilation function of the selected men before and after Tai Chi exercise*

After taking Tai Chi for 12 month, pulmonary ventilation function of the selected men improves obviously, with “lung capacity” increasing from  $2.84 \pm 0.32$  to  $3.57 \pm 1.39$  ( $P < 0.05$ ). The “maximum minute ventilation (L/min)” also improves greatly after taking Tai Chi for six and 12 months, from  $97.26 \pm 14.74$  to  $110.58 \pm 15.34$  and  $117.25 \pm 14.86$  respectively ( $P < 0.05$ ). See **Table 3**.

### Discussion

Taking exercise can help old people improve body functions and physical fitness, and meanwhile ease their negative emotions such as tension, suppression and anxiety. Therefore, it is an effective way to promote health of old people [7, 8]. Tai Chi, simple, tender, economical, and free from time and place limitations, is a suitable exercise mode for old people [9]. This study, focusing on the physical and mental characteristics of old people, probes into the

effect of Tai Chi on the breathing, heart and brain blood circulation of old people by experimental research.

As is known, stroke volume of the heart is affected by cardiac preload, afterload and myocardial contractility and when the first two factors remain unchanged, myocardial contractility prevails. As an internal functional characteristic of cardiac muscles, myocardial contractility is closely related to energy metabolism of these muscles and the aerobic metabolism generating energy proceeds in mitochondria. The study proves that moderate and regular Tai Chi exercise can improve the activity of compound enzymes on the oxidative respiratory chain in mitochondria, elevate the macrofunction of mitochondria and further guarantee abundant supply of energy for cardiac muscles to pump blood [10, 11]; besides, relevant research proves that Tai Chi exercise thickens the compensation of cardiac muscle cells, strengthens their contractility, and enlarges “stroke volume” and “ejection fraction” [12]; decreased heart rate indicates an increase in heart rate storage [13], which can effectively improve pump function of the heart. Data of **Table 1** show that after taking Tai Chi for 12 months, the “stroke volume” and “ejection fraction” of the selected men improve greatly ( $P < 0.05$ ) and “heart rate” slows down obviously ( $P < 0.05$ ); while when the exercise period is less than six months, the effect is not evident.

As a method to examine vascular function and blood supply of the head, “brain impedance rheography” can indicate the change in blood of the brain tissue during the cardiac cycle. “Amplitude” is in positive correlation to cerebral blood flow and “Inflow time” is in positive correlation to cerebral blood flow resistance [14-16]. Data of **Table 2** indicate that after taking Tai Chi for 12 months, “Inflow time” of the “brain impedance rheography” of the selected men shortens obviously ( $P < 0.05$ ), which means Tai Chi can reduce brain vessel resistance,

relieve cerebral angiospasm and guarantee soundness of autonomic nervous functions; “amplitude” increases obviously ( $P<0.05$ ), which means Tai Chi can improve metabolism of brain tissues and enhance cerebral blood flow in adjusting expansion of blood vessels so as to increase cerebral blood flow. On the contrary, taking Tai Chi for three months brings about no obvious changes and taking Tai Chi for six months shows a tendency of improvement but makes no obvious difference ( $P>0.05$ ).

Data of **Table 3** show that “pulmonary ventilation function” of the selected men begins to improve obviously from the sixth month and after taking Tai Chi for 12 months, “lung capacity” and “maximum minute ventilation” both improve greatly ( $P<0.05$ ). When taking Tai Chi, abdominal and thoracic respiration coordinates to improve respiratory movement [17]; abdominal respiration can increase the intensity of diaphragm relaxation and shrinkage so as to enlarge the amplitude of its elevation and decline and constantly change abdominal and thoracic pressure. Thus, respiratory organs can get adequate blood supply [18], and the pulmonary ventilation function can be improved.

To sum up, taking Tai Chi for within three months has no obvious effect on the breathing, heart and brain blood circulation of old people, but as time goes on, the effect becomes more notable. After six months, some test indicators improve obviously and after 12 months, all the indicators improve greatly ( $P<0.05$ ) and the discrepancy has statistical significance. Hence, according to the study: ① Tai Chi is an economical, safe and simple exercise mode suitable for old people; ② The effect of Tai Chi lies in a long term exercise. Tai Chi exercise within six months has a limited effect on the breathing, heart and brain blood circulation of old people, but as time goes on, obvious effect will emerge after 12 months.

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### Disclosure of conflict of interest

None.

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