

# Tai Chi can prevent cardiovascular disease and improve cardiopulmonary function of adults with obesity aged 50 years and older

## A long-term follow-up study

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### Abstract

To research the possible role of Tai Chi in preventing cardiovascular disease and improving cardiopulmonary function in adults with obesity aged 50 years and older.

Between 2007 and 2012, 120 adults with obesity, aged 50 years and older, were divided into a Tai Chi group and a control group, with 60 participants in each group. The 2 groups were evaluated for weight, waist circumference, hip circumference, blood pressure (BP), body mass index, and incidence of chronic disease during follow-up monitoring.

Two- and 6-year follow-up showed that the average BP in the Tai Chi group along with either the systolic or diastolic pressure decreased significantly compared to those in the control group ( $P < .001$ ). Waist and hip circumference, weight, and body mass index in the Tai Chi group were significantly reduced compared to those in the control group ( $P < .001$ ). The cardiopulmonary function of the control group and the Tai Chi group changed, with the cardiac index significantly higher in the Tai Chi group than in the control group ( $P < .05$ ). The Tai Chi group had significantly higher levels of lung function, including vital capacity, maximal oxygen uptake, and total expiratory time, than the control group. The total incidence of complications and mortality in the Tai Chi group were much lower than those in the control group ( $P < .001$ ). The incidence of cardiovascular and cerebrovascular disease in the Tai Chi group (16.67%) was lower than that in the control group (38.33%).

Tai Chi is not only a suitable exercise for elderly people with obesity, but it can also help to regulate BP, improve heart and lung function in these individuals, as well as reduce the incidence of cardiovascular disease and other chronic diseases, helping to improve their quality of life.

**Abbreviations:** BMI = body mass index, BP = blood pressure, CI = cardiac index, WHO = World Health Organization.

**Keywords:** cardiopulmonary function, cardiovascular disease, obese elderly, Tai Chi

## 1. Introduction

According to a World Health Organization (WHO) study, among all factors that cause death worldwide, the top 3 are hypertension, smoking, and hypercholesterolemia.<sup>[1]</sup> In the

middle-aged population, the primary cardiovascular and cerebrovascular diseases are hypertension, coronary heart disease, and stroke. For the elderly, blood viscosity increases, vascular elasticity reduces, the degree of arteriosclerosis increases, and the incidence of cardiovascular disease continues to increase, which seriously threatens the health of the elderly.<sup>[2,3]</sup> Obesity is a risk factor for cardiovascular disease, which can increase the incidence of type 2 diabetes, hypertension, coronary heart disease, and other diseases.<sup>[4-6]</sup> With the development of science and technology, people gradually realized the importance of sport for enhancing their health and preventing disease. Tai Chi, a type of psychophysiological exercise, is a traditional physical and mental training that can be of light to medium intensity, depending on the training style, posture, and duration.<sup>[7-9]</sup> Tai Chi, as a Chinese national art, is a combination of fitness, health, and exercise; the action is lively, continuous, oscillating, and consistent with the psychological and physiological characteristics of the elderly.<sup>[10]</sup> Some studies have found that Tai Chi has many positive effects on the health of the elderly and is an exercise that is very suitable for the elderly.<sup>[8,11-13]</sup> However, there are few long-term follow-up studies on the effects of Tai Chi on the prevention and treatment of cardiovascular diseases and cardiopulmonary function in elderly people with obesity. This study aimed to explore the positive effects of Tai Chi exercise on preventing and treating cardiovascular diseases and improving cardiopulmonary function in elderly people with obesity through long-term follow-up.

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## 2. Materials and methods

### 2.1. Population and covariates

Between 2007 and 2012, 120 adults with obesity, aged 50 years and older, who participated in physical exercise in an elderly activity center were included in the study. Clinical data were collected prospectively and analyzed retrospectively. The series included 68 men and 52 women, mean age  $65.8 \pm 9.6$  years, with a mean weight of  $94.1 \pm 3.1$  kg. All study participants reported a negative history of stroke, tumor, hypertension, diabetes, heart failure, liver and kidney dysfunction, rheumatism, trauma, acute and chronic infection, ischemic heart disease, and other diseases. Clinical data were collected prospectively and analyzed retrospectively. The Institutional Review Board of Fujian Medical University approved the study (approval number: 20120131).

Systematic health education and detailed data registration were completed for all participants including age, sex, height, weight, waist circumference, hip circumference, blood pressure (BP), body mass index (BMI), and the incidence of chronic diseases. The 2 groups participated in health education on time, and their diet and nutrition status were basically the same, with both groups having no regular exercise program prior to clinical observation. The participants' diet and lifestyle were not changed during the observation period.

### 2.2. Intervention

Regular health education was provided for all participants. In addition to the regular education, the activities of daily living and lifestyle remained the same for participants in the control group. For the Tai Chi group: All participants in this group received regular Tai Chi basic training and instruction on exercise precautions. Tai Chi training begins with stretching, walking, and standing exercises and other relaxing preparations. In the first month of the test, the basic posture and routine of Tai Chi with 24 specific exercises, basic movements, and technical routes were practiced; beginning with the second month, planned Taijiquan routines were implemented. The early stage was mainly for posture training with a high level of difficulty, and the practice time was not less than 3 times per week, with each practice session spanning 30 to 40 minutes.

### 2.3. Evaluation criteria

The outcomes of this study, such as BP, weight, height, waist circumference, and hip circumference, were measured by the same group of trained nurses, while the lung index (forced vital capacity, maximal oxygen uptake, and total expiratory time) and the cardiac index (CI) were measured by the same group of

trained physicians through pulmonary function tests and cardiac color doppler ultrasonography, respectively. CI is a hemodynamic parameter that relates the cardiac output from the left ventricle in one minute to body surface area, thus relating heart performance to the size of the individual.<sup>[14]</sup> All participants visited every 3 to 6 months; and all the participants continued with follow-up evaluation for 6 years.

### 2.4. Statistical analysis

All data were processed using SPSS software (version 19.0; IBM Corp., Armonk, NY). Data are presented as the mean  $\pm$  standard deviation for continuous variables and as a number for categorical variables. The measurement data before and after the intervention were compared by paired *t* tests. The data between groups were compared by independent sample *t* tests. The incidence of chronic disease in each group was evaluated using  $\chi^2$  tests.  $P < .05$  was set as the level of significance.

## 3. Results

### 3.1. General characteristics

The 120 elderly participants were divided into the Tai Chi group and the control group, with 60 participants in each group. The average age of the Tai Chi group was  $66.4 \pm 10.0$  years, and the average age of the control group was  $65.2 \pm 9.2$  years. There were 36 men and 24 women in the Tai Chi group, and 32 men and 28 women in the control group. There were no significant differences between the participants of the 2 groups regarding the general characteristics before treatment ( $P > .05$ ).

### 3.2. BP

For BP: 2- and 6-year follow-up showed that the average BP in the Tai Chi group along with either their systolic pressure or diastolic pressure decreased significantly compared with those in the control group ( $P < .001$ ) (Table 1). Additionally, 2- and 6-year follow-up found that both waist circumference and hip circumference in the Tai Chi group were significantly reduced compared with those in the control group ( $P < .05$ ) (Table 2).

### 3.3. Body weight

Weight and BMI: 2 years after the exercise, compared with the control group, the Tai Chi group had significantly decreased weight and BMI ( $P < .05$ ). The 6-year follow-up also showed that BMI and weight in the Tai Chi group had decreased significantly ( $P < .001$ ) (Table 3).

**Table 1**

Changes of systolic and diastolic blood pressure and average blood pressure between the control group and the Tai Chi group.

Group	n	SBP (mmHg)			DBP (mmHg)			The average of blood Pressure (mmHg)		
		Before treatment	2 yr later	6 yr later	Before treatment	2 yr later	6 years later	Before treatment	2 yr later	6 yr later
Control group	60	115 $\pm$ 14	130 $\pm$ 13	150 $\pm$ 14	75 $\pm$ 6	84 $\pm$ 8	94 $\pm$ 10	101 $\pm$ 11	115 $\pm$ 8	131 $\pm$ 6
Tai Chi group	60	118 $\pm$ 18	122 $\pm$ 16	125 $\pm$ 11	74 $\pm$ 10	75 $\pm$ 8	80 $\pm$ 9	105 $\pm$ 13	107 $\pm$ 12	110 $\pm$ 9
<i>T</i>		1.019	3.006	10.876	0.664	6.162	2.879	1.815	4.296	15.038
<i>P</i>		.310	.003	<.001	.507	<.001	<.001	.071	<.001	<.001

DBP = diastolic blood pressure, SBP = systolic blood pressure.

**Table 2****Changes of waist circumference, hip circumference, and height between the control group and the Tai Chi group.**

Group	n	WC (cm)			HC (cm)		
		Before Treatment	2 yr later	6 yr later	Before Treatment	2 yr later	6 yr later
Control group	60	93.9±9.3	91.9±9.5	90.5±8.6	100.6±8.4	99.3±7.5	98.7±9.6
Tai Chi group	60	90.9±7.6	87.9±8.1	85.6±7.9	100.5±5.8	95.7±5.5	95.0±4.4
<i>T</i>		1.934	2.481	3.250	0.075	2.998	2.714
<i>P</i>		.055	.014	.001	.939	.003	.007

HC=hip circumference, WC=waist circumference.

**Table 3****Changes of weight and body mass index between the control group and the Tai Chi group.**

Group	n	Weight (Kg)			BMI (kg/m <sup>2</sup> )		
		Before Treatment	2 yr later	6 yr later	Before Treatment	2 yr later	6 yr later
Control group	60	94.2±3.2	92.4±2.2	89.4±2.0	37.6±5.3	37.0±7.2	35.6±5.2
Tai Chi group	60	94.0±3.0	88.1±1.8	75.9±2.2	38.1±3.6	34.5±4.3	29.4±6.4
<i>T</i>		0.353	11.717	35.17	0.604	2.31	5.82
<i>P</i>		.724	<.001	<.001	.547	.023	<.001

### 3.4. Cardiopulmonary function

In the total of 6 years of follow-up, the control group and the Tai Chi group experienced cardiopulmonary function changes, with the CI of the Tai Chi group trending significantly better than that of the control group ( $P < .05$ ) (Table 4). The Tai Chi group was also significantly better than the control group with respect to lung function, including vital capacity, maximal oxygen uptake, and total expiratory time ( $P < .05$ ) (Table 5).

### 3.5. The incidence of complication and mortality

During 6 years of follow-up, in the control group, 2 participants died due to myocardial infarction and stroke, respectively, and in the Tai Chi group 1 participant died due to pulmonary infection after depression. The study data from 6 years of follow-up show that the total incidence of complication and mortality in the Tai Chi group were much lower than those in the control group

( $P < .001$ ). The incidence of cardiovascular and cerebrovascular disease in the Tai Chi group (16.67%) was significantly lower than that in the control group (38.33%) ( $P = .008$ ) (Table 6).

## 4. Discussion

Aging is a physiological developmental process. With increasing age, the physiological functions of the elderly gradually degenerate, heart function changes from strong to weak, myocardial cells degenerate or shrink, making the myocardial cells no longer fully and effectively using oxygen, manifested as contractility decreased, cardiac output reduced, heart rate slowed, and cardiac morphology change.<sup>[15]</sup> As the blood vessel elasticity disappears, calcium deposits in the vessel wall and hyperplasia of gelatinous fibers, vascular expansion slips, arteriosclerosis progresses, increasing peripheral resistance, increasing BP, overloading the left ventricle, causing left cardiac

**Table 4****Changes of the cardiac index between the control group and the Tai Chi group.**

Group	n	Cardiac index		
		Before treatment	2 yr later	6 yr later
Control group	60	3.32±0.71	3.08±0.99	2.91±0.78
Tai Chi group	60	3.22±0.81	3.50±0.63	3.51±0.78
<i>T</i>		0.719	2.772	4.915
<i>P</i>		.473	.006	<.001

**Table 5****Changes of lung function between the control group and the Tai Chi group.**

Group	n	VC (mmHg)		Maximal oxygen uptake (L/min)		The total expiratory time (s)	
		Before treatment	6 yr later	Before treatment	6 yr later	Before treatment	6 yr later
Control group	60	2.02±0.5	1.84±0.47	2.45±0.31	2.03±0.38	2.48±0.28	2.10±0.27
Tai Chi group	60	2.12±0.4	2.24±0.39	2.55±0.23	2.30±0.43	2.58±0.36	2.45±0.54
<i>T</i>		1.210	5.073	2.007	3.645	1.698	4.491
<i>P</i>		.228	<.001	.047	<.001	.092	<.001

VC=Vital capacity.

**Table 6**  
**The incidence of complication and mortality in the control group and the Tai Chi group [n (%)].**

Group	n	Complication					Death	Cardiovascular diseases
		Stroke	Hypertension	Diabetes	CHD	Tumor		
Control group	60	3	15	10	12	2	2	23 (38.33%)
Tai Chi group	60	1	8	4	6	1	1	10 (16.67%)
$\chi^2$				16.21				7.06
P				<.001				.008

CHD = Coronary Heart Disease.

insufficiency and many cardiovascular diseases. New research from WHO shows that cardiovascular disease kills 1250 million lives each year and has become the biggest killer of human life.<sup>[16,17]</sup> Hypertension, heart disease, cerebral thrombosis, atherosclerosis, and other cardiovascular diseases, with long-term threats to global health in the elderly. This attack seriously affects the well-being of middle-aged and elderly people, and especially in today's aging society, this will give families and society a great burden. Obesity is a risk factor of various cardiovascular diseases. Though there are now drugs and even surgical approaches to treating obesity, they are generally unsuitable for the elderly population. Therefore, looking for a suitable method to reduce the weight of the elderly population and effectively reduce the incidence of disease and complication is a problem which needs to be addressed. Tai Chi is a small and medium intensity aerobic exercise. In addition to an emphasis on slow movement and fine and even rhythmic deep breathing, but also stressing that "intention" and "calm" are good results of a relaxing spirit, regulating neural activity status, and slowing down the aging process of the autonomic nervous system.<sup>[18]</sup> Tai Chi with its soft, gentle, uniform consistency, natural, smooth, and sleek coordination features is incredibly popular. It cannot only prolong life, improve health and fitness, but also prevent chronic diseases, and has drawn the attention of scholars from all over the world. Related studies show that Tai Chi has played an important role on the human body's balance of metabolism and energy consumption of gas and on body sculpting and fitness.<sup>[19–21]</sup> Moderate exercise and physical activity can increase energy consumption and burn fat, if combined with diet control, it can play a role in good weight loss results. Even if not able to reduce the weight to healthy levels, properly losing weight (such as the weight loss of 5%–10%) can significantly reduce the risk of obesity-related diseases.<sup>[22–24]</sup> In addition, with age, people's appetites tend to decrease, but if they reduce physical activity or employ no exercise, even if they lose weight, the waist circumference will increase, which is not conducive to the prevention and treatment of cardiovascular disease. In this study, after 6 years of follow-up, the data show that the weight of the 2 groups had significantly decreased, and the hip and waist circumferences of the Tai Chi group were significantly decreased compared with those before starting the exercise regimen. This study also confirmed that Tai Chi is important for elderly people with obesity as the results show that there was a significant difference between the Tai Chi group and the control group regarding BMI change, with long-term Tai Chi exercise reducing the BMI in elderly with obesity.

At present, the burden of disease caused by chronic diseases has exceeded infectious diseases and the number of deaths accounted for 80% of all deaths in China.<sup>[25]</sup> Cardiovascular and cerebrovascular disease, diabetes, respiratory disease, tumor, and other chronic diseases have become a public health problem which seriously threatens residents' health. Elderly people with

obesity are at high-risk for cerebrovascular disease. From 6 years of follow-up, we found that the blood-brain disease incidence of the Tai Chi group was 16.67%, while the incidence in the control group was 38.33%, which shows that long-term Tai Chi exercise for reducing the incidence of cardiovascular disease is fruitful. The Tai Chi process requires breathing deep, long, uniform, slowly, from beginning to end to maintain aerobic metabolism and improve lung function.<sup>[11]</sup> Tai Chi exercise requires uniform motion gently, at peace inside, the mind silent of concentration, thus reducing the exerciser's autonomic nerve centers of the brain stress positions, reducing nerve ending activation releases norepinephrine, promoting the myocardium secretes statins, thus stabilizing the cardiovascular motor nerves, improving the elasticity of the cardiovascular smooth muscle, reducing the total peripheral resistance, and increasing the diastolic ability of cardiovascular reactivity. Related studies have shown that Tai Chi exercise on cardiovascular function and lung function in the elderly demonstrate a positive correlation effect.<sup>[10]</sup> This study also shows that Tai Chi can improve elderly blood conditions and arterial BP, improve endothelial diastolic function, reduce atherosclerosis, promote the flow of breath easier, improve lung function, and improve the cardiac function index. Therefore, the value of Tai Chi in old-age care is prominent and worthy of promotion.

This study has some limitations. First, individuals with a history of stroke, tumor, hypertension, diabetes, heart failure, liver and kidney dysfunction, rheumatism, trauma, acute and chronic infection, ischemic heart disease, and other diseases were excluded, which led to potential selection bias of this study. Second, although this study found that Tai Chi can improve cardiopulmonary function in adults with obesity aged 50 years and older, it is not a randomized controlled clinical study and still requires multicenter randomized controlled clinical studies to confirm the findings. Finally, this study is based on research exclusively on a Chinese population, and further research is needed to extend it to other ethnic groups.

In summary, Tai Chi is not only a suitable exercise for elderly people with obesity, but it can also help to regulate BP, support weight loss, and improve the heart and lung function in these individuals, as well as reduce the incidence of cardiovascular disease and other chronic diseases, helping to improve their quality of life.

### Author contributions

**Data curation:** Lei Sun.

**Project administration:** Wei-Feng Wu.

**Resources:** Wei-Feng Wu.

**Supervision:** Wei-Feng Wu.

**Writing – original draft:** Lei Sun.

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