TAI CHI INFLUENCE ON CARDIOPULMONARY FUNCTION IN THE ELDERLY

INFLUÊNCIA DO TAI CHI NA FUNÇÃO CARDIOPULMONAR DE IDOSOS

INFLUENCIA DEL TAI CHI EN LA FUNCIÓN CARDIOPULMONAR DE LAS PERSONAS MAYORES

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ABSTRACT

Introduction: Cardiopulmonary function testing is a fundamental component of the physical examination and an elementary indicator for measuring physical fitness. With advancing age, the cardiopulmonary system will undergo a series of aging changes in morphology and function. Objective: Explore the effect of Tai Chi exercise on cardiopulmonary function in middle-aged and elderly people. Methods: A total of 73 50-75 years old from 5 areas in our city were recruited. A total of 63 healthy subjects were selected, 37 in the exercise group and 26 in the non-exercise group. The heart rate, lung capacity, and 6-min walking distance of each subject were measured in a calm state during the recovery time after walking 10 min after recovery. Results: In a calm state, Tai Chi practitioners had better lung capacity and a lower heart rate than non-practitioners (p0.05). In the immediate recovery time after walking, Tai Chi exercise elevated lung capacity more than non-exercisers (p0.01). Conclusion: Tai Chi exercise can improve the adaptability of cardiopulmonary function in middle-aged and elderly people after exercise. ***Level of Evidence: Therapeutic Studies - Outcome Investigation.***

Keywords: Tai Ji; Middle Aged; Elderly; Testing, Cardiopulmonary Exercise.

RESUMO

Introdução: O teste de função cardiopulmonar é um elemento fundamental no exame físico, e também um indicador elementar corrente para medir a aptidão física. Com o avanço da idade, o sistema cardiopulmonar passará por uma série de mudanças de envelhecimento na morfologia e função. Objetivo: Explorar o efeito do exercício de Tai Chi sobre a função cardiopulmonar de pessoas de meia-idade e idosas. Métodos: Um total de 73, 50-75 anos de idade de 5 áreas em nossa cidade foram recrutados. Foram selecionados 63 sujeitos saudáveis, 37 no grupo de exercícios e 26 no grupo de não-exercício. O ritmo cardíaco, a capacidade pulmonar e a distância de caminhada de 6 minutos de cada sujeito foram medidas em um estado calmo, durante o tempo de recuperação após a caminhada, e 10 minutos após o período de recuperação. Resultados: Em um estado calmo, os praticantes de Tai Chi apresentam uma melhor capacidade pulmonar e uma frequência cardíaca menor do que os não praticantes (p0,05). No tempo de recuperação imediata após a caminhada, o exercício de Tai Chi elevou a capacidade pulmonar mais do que os não-exercitantes (p0,01). Conclusão: O exercício de Tai Chi pode melhorar a adaptabilidade da função cardiopulmonar em pessoas de meia-idade e idosos após o exercício. ***Nível de evidência: Estudos Terapêuticos - Investigação dos Resultados.***

***Descritores*:** *Tai Chi Chuan; Pessoa de Meia-Idade; Idoso; Teste de Esforço Cardiopulmonar.*

RESUMEN

Introducción: La prueba de función cardiopulmonar es un elemento fundamental en el examen físico, y también un indicador elemental actual para medir la aptitud física. Con el avance de la edad, el sistema cardiopulmonar sufrirá una serie de cambios de envejecimiento en su morfología y función. Objetivo: Explorar el efecto del ejercicio de Tai Chi sobre la función cardiopulmonar en personas de mediana y avanzada edad. Métodos: Se reclutó a un total de 73 personas de 50 a 75 años de edad de 5 zonas de nuestra ciudad. Se seleccionó un total de 63 sujetos sanos, 37 en el grupo de ejercicio y 26 en el grupo de no ejercicio. Se midieron la frecuencia cardíaca, la capacidad pulmonar y la distancia recorrida en 6 minutos de cada sujeto en estado de calma, durante el tiempo de recuperación tras la marcha y 10 minutos después del periodo de recuperación. Resultados: En un estado de calma, los practicantes de Tai Chi tenían una mejor capacidad pulmonar y una menor frecuencia cardíaca que los no practicantes (p0,05). En el tiempo de recuperación inmediata tras la marcha, el ejercicio de Tai Chi aumentó la capacidad pulmonar más que los no practicantes (p0,01). Conclusión: El ejercicio de Tai Chi puede mejorar la adaptabilidad de la función cardiopulmonar en personas de mediana y avanzada edad después del ejercicio. ***Nivel de evidencia: Estudios terapéuticos - Investigación de resultados.***

***Descriptores*:** *Taichi Chuan; Persona de Mediana Edad; Anciano; Prueba de Esfuerzo Cardiopulmonar.*

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INTRODUCTION

According to the results of the seventh census, China's population aged 60 and above has exceeded 260 million, accounting for 18.70% of the national population. The absolute number of elderly people aged 65 and over exceeds 190 million, accounting for 13.50% of the country's total population.[1] It is estimated that by 2050, the proportion of the elderly population in my country will rise to 31.2%.[2] Obviously, our country has begun to enter an aging country, and the related problems of the elderly have increasingly become a major social problem in our country that needs to be solved urgently. The cardiopulmonary function test is a standard part of a physical exam and a measure of fitness. The cardiopulmonary system ages through hardening of the arterial vascular wall, decreasing elasticity of blood vessels, increasing peripheral resistance, and raising blood pressure. Exercise can greatly decrease the deterioration of heart function, especially in the elderly and middle-aged.[4] Tai Chi mixes boxing, daoyin, and breathing. During exercise, thinking, breathing, and movement must be closely integrated to build the body and prolong life.[5]

OBJECTS AND METHODS

Research Object

Source of research subjects

The research objects are middle-aged and elderly people recruited from five community cultural centers in our city.

Inclusion criteria are as follows: ①Age: middle-aged and elderly people aged 50-75; ②Tai Chi exercise group: In addition to daily physical activities, exercise no less than 3 times a week, each exercise time is no less than 30 minutes, and last for more than 1 year (including 1 year) regular Tai Chi exercise; No exercise group: Not participating in Tai Chi exercise or other irregular and unsustainable physical exercise in addition to daily physical activity in the past year. ③ No major cardiovascular, pulmonary, or metabolic disorders; no exercise contraindications, excluding long-term medication therapy, cognitive impairment, or severe musculoskeletal disease.

Research Methods

Literature review method

In the CNKI database, 464 papers about Tai Chi and cardiopulmonary function were found. Retrieval took years. In Web of Science and Pubmed, 74 and 72 literatures were searched with the subject words "shadowboxing exercise" or "shadow boxing" and "cardiopulmonary function" Read the literature to develop a theoretical basis for research content and techniques.

Questionnaire method

AHA issued the/ACSM screening questionnaire before health/fitness exercises, tai chi exercise situation questionnaire, a questionnaire to understand the purpose of the subjects' personal basic information, and to further screen and evaluate the subjects, selected test high-risk groups, and assess the safety of the subjects to participate in the test.

Experimentation

1. Test venue: five community cultural centers
2. Test time: October 2021-December 2021, each test time is 13:00-16:30.
3. Main test indicators and methods
①Height
Test instrument: Portable height measuring instrument
②Weight, BMI, body fat percentage
Test instrument: Omron HBF-701 Electronic Weight Scale
③Heart rate
Test instrument: Omron HEM-7137 Upper Arm Electronic Blood Pressure Monitor
④Lung capacity
Test instrument: WQS-8888 Electronic Spiro metric Tester
⑤Borg Dyspnea Score
Test instrument: Borg Dyspnea Rating Scale
4. 6-minute walk test method and steps
①Site preparation

Choose a corridor that is 30m long, make a mark every 3m, and place conical road signs (marker buckets with colors) at the turnaround points, marking the departure line with a bright color bar, representing the starting point and the end point of one round trip.

⑤Precautions

If the patient has adverse reactions during the test, such as chest pain, intolerable dyspnea, profuse sweating, paleness or cramps in the lower extremities, or shaking when walking, it should be considered to stop the test.

Mathematical Statistics

All data were processed and analyzed by SPSS 22.0 statistical software and Excel 2007 software, and the results were expressed as mean ± standard deviation (X ± SD).Independent sample T test and chi-square test were used to compare the differences of basic indexes between groups; The differences in heart rate variability and cardiopulmonary function indicators between groups at the same time were compared by analysis of covariance (adjusted for baseline measurements);2×3 (2 groups×3 time points) ANOVA repeated measures analysis of variance was used to analyze the changes of HRV and cardiopulmonary function between the two groups before the test, the immediate recovery period and the 10-min recovery period; The significance level was $p<0.05$, and the very significant level was $p<0.01$.

Note: Author says research followed Helsinki principles. Participants signed free and informed consent (EHIC). Author confirms all participants' publication consent.

RESULTS

Basic information of the research object

73 and 50-75-year-olds from 5 neighborhoods in our city signed informed consent forms. The questionnaire survey excluded people with hypertension, heart disease, severe lung disease, and movement disorders. After the relevant medical examination, 3 people's blood pressure did not meet the index requirements, 6 people quit halfway, and 1 person's data was unavailable. Finally, 63 people were included, 37 in the Tai Chi exercise group and 26 in the non-exercise group.[6,7] Subject basics Table 3 details the subjects' Tai Chi exercises; all 63 subjects did the 6MWT. Table 1 demonstrates a significant difference in height between the Tai Chi training group and the non-exercise group ($p=0.006$), but no difference in gender, age, weight, BMI, or body fat percentage ($p=0.054$,$p=0.261$,$p=0.785$,$p=0.087$,$p=0.059$).

Cardiopulmonary function characteristics of middle-aged and elderly people in resting state

In a quiet state, the heart rate (HR) of the Tai Chi exercise group was lower than that of the non-exercise group, and the difference between the two groups was statistically significant ($p=0.031$); Secondly, the vital capacity (VC) of the Tai Chi exercise group was significantly greater than that of the non-exercise group ($p=0.021$). The heart rate of Tai Chi exercise group (n=37) and No exercise group (n=26) were 75.22±7.76 times/min and 79.85±6.73 times/min, respectively.

Table 1. Basic information of subjects (X±SD).

	n	Gender Male/Female	Year	Height (cm)	Weight (kg)	BMI (kg/m^2)	Body fat (%)
Overall	63	51/12	65.86±26.26	159.30±6.29	63.11±9.17	24.48±4.66	34.46±5.93
Tai Chi exercise group	37	27/10	65.11±5.54	161.08±6.23	62.85±8.24	23.60±5.09	33.57±6.64
No exercise group	26	24/2[a]	66.92±7.15	156.76±5.55**	63.50±10.53	25.64±3.74	36.03±4.38

Note:*represents P<0.05, **represents P<0.01, compared with the Tai Chi exercise group; a represents the difference between the two groups by chi-square test.

Table 2. The basics of Tai Chi exercise.

	Tai Chi exercise	Number of people (n)
Exercise frequency	1-2 times	6
	3-4 times	11
	≥5 times	29
Exercise time	<30 times	4
	30-45 minutes (excluding 45)	13
	45>60 minutes	9
	>60 minutes	20
Exercise years	<1 year	5
	1-3 years (excluding 3)	2
	≥3years	39
Never participate	/	17

Cardiopulmonary function characteristics of middle-aged and elderly people in the immediate recovery period after 6-minute walking

The heart rate (HR) of the non-exercise group in the immediate recovery period after 6-minute walking was higher than that of the Tai Chi exercise group, and the difference between the two groups was not statistically significant (p=0.194); The vital capacity (VC) and walking distance of the Tai Chi exercise group were significantly greater than those of the non-exercise group (p=0.006, p<0.001). The heart rate (HR) of Tai Chi exercise group (n=37) and No exercise group (n=26) after 6 minutes walking were 110.27±9.31 times/min and 113.08±7.72 times/min, respectively.[6-8]

Cardiopulmonary function characteristics of middle-aged and elderly people in the 10-minute recovery period after 6-minute walking

During the recovery period, the vital capacity (VC) of the Tai Chi exercise group for 10 minutes was significantly greater than that of the non-exercise group (p<0.001); The HR of the Tai Chi exercise group was lower than that of the non-exercise group, and the difference between the two groups was statistically significant (p=0.006). The heart rate (HR) of Tai Chi exercise group (n=37) and No exercise group (n=26) in the recovery period were 77.11±10.03 times/min and 91.23±10.33 times/min, respectively.

The characteristics of cardiopulmonary function changes in middle-aged and elderly people at different time periods

Changes in heart rate indicators

The Tai Chi exercise group and the non-exercise group had significantly different heart rates in a calm condition, immediately after walking, and in the 10-min recovery period (the main impact of time was p=0.537, and the between-group effect was p0.537). (Table 3); During the trial, both groups' heart rates increased and subsequently decreased. The Tai Chi group had a lower heart rate after walking than the quiet group (p0.001). The non-exercise group's heart rate was substantially different from resting immediately after walking and 10 min during recovery, and it did not return to resting 10 min after the conclusion of walking (both p0.001). (Figure 1).[8,9]

Table 3. Heart rate (HR) index change characteristics (X±SD).

	Tai Chi exercise group (n=37)	No exercise group (n=26)
When quiet	75.22±7.76	79.85±6.73
Immediately after walking	110.27±9.31	113.08±7.72
Recovery period 10min	77.11±10.03	91.23±10.33

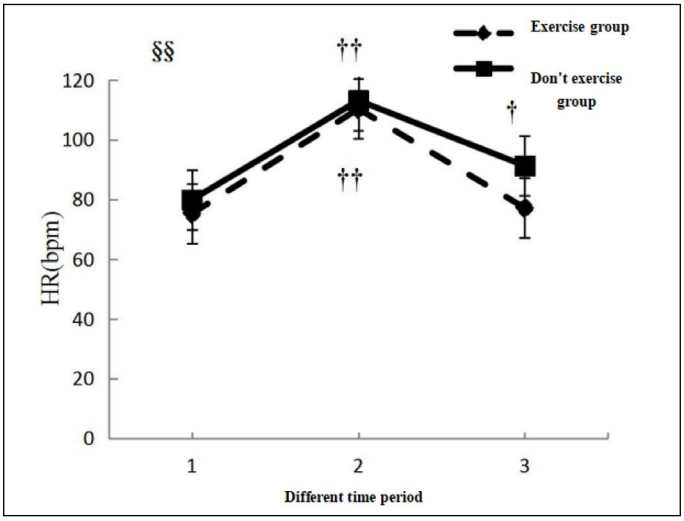

Figure 1. Changes of central lung indexes during the experiment of Tai Chi exercise combination and no exercise group.

The characteristics of changes in vital capacity indicators

Analysis of the vital capacity index showed no significant difference between the Tai Chi exercise group and the non-exercise group in the quiet state, the immediate recovery period after walking, and the 10-min recovery period (main effect of time, p=0.544, group between effect p=0.004 and interaction effect p=0.860) (Table 4); During the experiment, the Tai Chi group's lung capacity declined and then regained, while the non-exercise group's lung capacity continued to fall. There was a significant difference in vital capacity between the two groups in the early recovery period and at rest (p=0.004, p=0.013), while the Tai Chi exercise group's lung capacity progressively recovered 10 minutes after the conclusion of walking, with no significant difference from rest (p=0.161). The non-exercise group's 10-min recovery period was significantly different from resting (p=0.009), and walking did not return to resting after 10 min. (Figure 2).

DISCUSSION

This study examines the effect of Tai Chi on the cardiopulmonary function of middle-aged and older persons by comparing their short-term recovery (5-10 min) following a 6-minute walking test while doing Tai Chi versus not exercising. Influence middle-aged and elderly persons to exercise scientifically. During the experiment, the Tai Chi exercise group had superior cardiopulmonary function than the non-exercise group, and lung capacity was the most different. Both groups' HRV indicators eventually returned to resting levels after 10 minutes of recuperation, although the non-exercise group's heart rate and vital capacity recovered more slowly. Tai Chi improves middle-aged and older people's cardiopulmonary function.[8-10]

Table 4. The characteristics of changes in vital capacity indicators (X±SD).

	Tai Chi exercise group (n=37)	No exercise group (n=26)
When quiet	2523.69±646.28	2080.27±543.27
Immediately after walking	2272.43±529.27	1839.81±565.25
Recovery period 10min	2395.27±621.33	1832.23±597.97

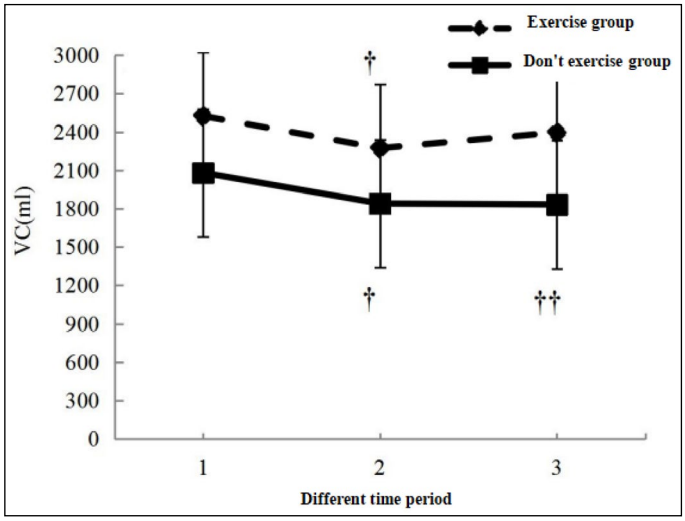

Figure 2. Changes of central lung indexes during the experiment of Tai Chi exercise combination and no exercise group.

Cardiopulmonary function characteristics in resting state

Recent studies correlate a high resting heart rate to hypertension, coronary heart disease, hyperglycemia, and obesity-related death. Regardless of all-cause and CVD mortality. Li Bo et al. separated 106 senior hypertensives into groups A (80 beats/min) and B (>80 beats/min) based on resting heart rate to study heart rate variability and blood pressure. Group B had lower SDNN, RMSSD, PNN50, and blood pressure than group A. According to the research, increased resting heart rate reduces heart rate variability in elderly hypertension patients. An increased resting heart rate triggers sympathetic nerve overactivation and catechol elevation. Tai Chi practice helps improve middle-aged and elderly people's lung capacity and respiratory function.[7,8]

Change characteristics of central pulmonary function during the experiment

Heart Rate Indicator Features

Early research reveals that there is no significant difference between the heart rate in the 10s following exercise and the heart rate during activity. The Tai Chi and non-exercise groups' heart rates were considerably greater after exercise than in a quiet condition. During exercise, sympathetic nerve tone predominates, and adrenaline output increases. This increases myocardial glycogenolysis and energy use. Both groups' hearts race. HRR after exercise depends on sympathetic and vagus nerve balance. Recovering from exercise improves health. Delayed heart rate recovery is used to detect cardiovascular disease risk. Tai Chi improves CNS integration, vagus and sympathetic nerve co-regulation, and heart function during exercise.[9,10]

Characteristics of vital capacity and walking distance indicators

Tai Chi exercisers had a higher vital capacity in a calm state, shortly after exercise, and after recovery. Immediately after exercise, the two groups' vital capacity fell dramatically compared to before exercise. This may be related to the weariness of enormous lung tissue mobilization and the regulation of the neurological system that governs lung muscle contraction after acute exercise. Exercise raises the body's oxygen requirement and oxygen-carrying blood flow. Catecholamines and hormones raise heart rate and cardiac output. Workouts improve breathing. Burden stimulates the CNS and cardiovascular system, reducing lung capacity. Tai Chi group's lung capacity returned to pre-exercise level 10 minutes after exercise. Non-exercise group lung capacity fell considerably below pre-exercise level, showing Tai Chi functioned better. Tai Chi group walked 552.92 m in 6 minutes, non-exercise group 468.15 m. The Tai Chi exercise group has considerably larger walking distance than the non-exercise group, confirming that Tai Chi can improve middle-aged and older people's cardiovascular function.[10-12]

Analysis of Influencing Factors of Heart Rate Variability

Middle-aged and elderly people's heart rate variability is influenced by exercise time and years. The sympathetic nerve regulates heart rate during exercise. Long-term Tai Chi gradually adjusts the heart to the exercise load, raises vagus nerve tension, and lowers heart rate. Tai Chi helps the heart adapt and protect itself. Different exercise years affect middle-aged and older people's HRV. Long-term Tai Chi practice can strengthen the elderly's vagus nerve modulation since the power of SDNN, TP, LF, and HF is much higher than in novices.[8-10]

CONCLUSIONS

Under extreme fatigue, long-term training years had a superior sympathetic-vagal nerve balance than training years. The authors feel that the more years an athlete trains, the better their body adapts to fatigued exercise. Few studies have examined how exercise duration and years affect HRV. Future study should focus on providing a scientific basis for middle-aged and older persons to exercise.

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