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# Therapeutic effects of Tai Chi on cardiovascular conditions: An overview of existing systematic reviews

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#### Abstract

**Objectives:** Tai Chi, a mind-body exercise, has the potential to improve cardiovascular status, psychological well-being, and quality of life. We aim to assess the effects of Tai Chi on these realms. **Data sources and methods:** the database PubMed was searched for systematic reviews of Randomized Controlled Trials focused on the therapeutic effects in the realms of cardiovascular and psychological well-being.

**Results:** Thirty systematic reviews were considered, thirteen focused on the cardiovascular area and fourteen on mental health. All the reviews assessed the strength of the results and the quality of the evidence.

**Conclusions:** There is substantial evidence that Tai Chi improves physical aspects, cardiovascular-specific aspects and mental health aspects in people with cardiovascular disease or with its risk factors, like hypertension. Tai Chi also improves mental health in elderly subjects, with or without dementia or depression. Its usefulness for mental health improvements was also proved for health care workers, adolescents, people with physical mobility impairment and the general population suffering from depression.

Keywords: Tai Chi, Cardiovascular, Mental health, Mind-Body

# Introduction

Tai Chi is a body-mind practice, meaning that the connection of the practitioner's consciousness with the state, movement, and sensations of the body is of essential importance. Several principles must be considered for the practice to be considered Tai Chi, distinguishing it from the mere execution of body movements.

The posture of the head should be upright and the spirit infused into it to the top. One should not use force, because it makes the back of the neck stiff, preventing the free circulation of Qi and blood. The intention must be "empty and alive (or free)". One should shrink the chest slightly inward so that the Qi sinks into the DanTian (abdomen). The chest should not be inflated, because in this way the Qi is blocked in the chest area. By enjoying the flow of support between the legs, rotational movements become light, agile, and almost effortless. The shoulders should be relaxed, open, and droop.

The practice of this exercise is not based on strength, but on intention. If the body moves with rigid force, the meridians are blocked, the Qi and blood are blocked, and the movements loses agility. If you use intention instead of force, where intention goes, Qi also goes, and the body follows.

It is important to synchronize the upper and lower body: when the hands move, the waist and legs move, and the gaze moves along with them. In the same way, it is necessary to harmonize the Interior and the Exterior.

The practice must be continuous and without interruption. It is necessary to seek the stillness within the movement: the slower, the better. By moving slowly, the breath becomes deep and long, the Qi sinks into the Dantian, the eyes and ears become clear, and the mind calms down.

# **Materials and Methods**

A search was made on PubMed for systematic reviews published in the last 5 years, that is in the period 2019-2023, containing the terms 'Tai Chi' or 'Tai Ji' in the title or abstract. 106

Corresponding Author: Rui Aguiar Escola de Medicina Tradicional Chinesa, Lisboa, Portugal articles were found. Only the reviews related to cardiovascular or mental health were selected, yielding 27 articles. Only free open text papers were considered. Eleven papers were excluded for not being freely available. Since all the articles considered were systematic reviews, they will be from now on referred simply as 'reviews'.

#### Results

All the reviews evaluated the strength and quality of the evidence of the underlying trials, using tools like Risk of Bias in Systematic reviews (ROBIS), the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Grades of Recommendations, Assessment, Development and Evaluation (GRADE), among others. All of them report at least some limitations in the methodological quality, reporting quality, and risk of bias of the included trials. Some critical issues include the lack of protocols or registration, inadequate reporting of the list of excluded studies, and insufficient details on the computational aspects of the meta-analysis. Additionally, many trials have small sample sizes and low methodological quality. For that reason, there is a unanimous call for highquality, well-designed RCTs with large groups to provide more comprehensive insights into the relationship between Tai Chi and therapeutic effects.

Many of the reviews have considered the level of evidence in the underlying trials low, and with a high risk of performance and detection bias. However, taking in consideration that Tai Chi is a mind-body exercise, in which the intention of the practitioner is a component of the practice itself, this criticism seems somewhat misplaced. If the pilar of what is considered scientific evidence is an underlying vision of the human being as a helpless machine in some way, there will be some limitations in the understanding of human health issues. One can question whether the risk of bias is high or if these criteria revel a bias in the appraisal of evidence that expunges the therapeutic actions of mind-body interactions from the world of science.

The reported therapeutic benefits of Tai Chi related with cardiovascular conditions can be classified in three dimensions:

First, they span mental health aspects, physical aspects, and cardiovascular-specific aspects. In the mental health realm, reduced depression, anxiety and stress levels were confirmed in several of the systematic reviews. In the physical aspect, decrease of bodily pain and improvements in walking ability, exercise capability, dynamic balance, and activities of daily living were also confirmed. The cardiac parameters improved include left ventricular ejection fraction and B-type natriuretic peptide/N-terminal fragment of pro-BNP, with positive results in Peak oxygen uptake only in one of the reviews.

Second, they include the cardiovascular disease and its risk factors. Tai Chi improves the general and cardiovascular-specific health status of stroke survivors, myocardial infarction survivors and people suffering from chronic heart failure, while also ameliorating risk factors for CV disease like systolic and diastolic blood pressure, cholesterol, triglycerides, and low-density lipoprotein levels in people with hypertension.

Third, benefits were seen in the broad QoL aspect, which includes physical functioning, role-physical, general health, bodily pain, vitality, social functioning, role-emotional, and mental health.

Tai Chi practice, with its low costs, multiple physical benefits, and minimal equipment requirements, emerge as a promising rehabilitation therapy. It can be considered either as an adjunct to routine pharmacotherapies or as an alternative to conventional exercises, especially in homebased settings.

More research is needed to determine whether these practices are most effective as supplements to rehabilitation, as standalone alternatives, or as maintenance strategies. Additionally, exploring different schools of Tai Chi, considering detailed subtypes and stages for each of the conditions could help optimize the results and provide a more comprehensive understanding of their benefits.

Table 1: Overview of systematic reviews of literature on therapeutic effects of Tai Chi on cardiovascular conditions

Disease or condition (Ref)	# RCTs (# total subjects)	Analysis results
Stroke survivors [1]	11 (723)	Tai Chi may lead to greater improvement in depression scores compared to conventional rehabilitation therapy
Stroke survivors [2]	27 (1919)	<ul> <li>Notable Improvement in walking ability, dynamic balance, and activities of daily living, in both short-term and long-term programs</li> <li>Benefits remained consistent when compared with both active controls and no treatment groups</li> </ul>
Stroke patients [3]	12 (966)	<ul> <li>Significant improvements in balance function by the Berg Balance Scale</li> <li>Positive outcomes in the Fugl-Meyer Motor Assessment and Simple Test of Extremity Function</li> <li>Improved walking ability in the Time-Up and Go Test</li> <li>Improvement in Activities of daily living by the Modified Barthel Index</li> </ul>
Myocardial infarction patients [4]	7 (615)	<ul> <li>Significant effects on the 6-minute walk and left ventricular ejection fraction compared to no or low-density exercise.</li> <li>Positive impacts on quality of life, pro-B type natriuretic peptide levels, and MOS item short-form health survey</li> <li>No significant effect on activities of daily living scale ADL, sense of coherence scale SCO-13, and N-terminal pro B type natriuretic peptide</li> </ul>
Heart failure [5]	6 (229)	<ul> <li>Significantly better exercise capacity, improved quality of life, reduced depression, and decreased b-type natriuretic peptide expression</li> </ul>
Chronic Heart Failure	15 (1236)	<ul> <li>Notable improvements in health status tests: score reductions in the Minnesota Living with Heart Failure Questionnaire, the Hamilton Depression Rating Scale, and the Pittsburgh Sleep Quality Index</li> </ul>

Chronic Heart Failure		<ul> <li>Positive effects in physical function and exercise capacity: significant improvements in the 6-minute walk test and the timed up-and-go test</li> <li>Improvement in cardiac parameters: left ventricular ejection fraction and B-type natriuretic peptide/N-terminal fragment of pro-BNP</li> <li>Reduced risk of heart failure hospitalization</li> <li>No significant difference in peak oxygen uptake</li> <li>Inconclusive evaluation of all-cause mortality or cardiovascular death</li> <li>Tai Chi and Qigong combined with resistance exercises: improvements in VO2peak, 6MWD (6-minute walk distance), and MLHFQ (Minnesota Living with Heart Failure Questionnaire)</li> </ul>
[7]		<ul> <li>Superior improvements when compared to general exercise (particularly significant in MLHFQ)</li> <li>Safety and high adherence</li> </ul>
Cardiovascular disease [7]	15 (1853)	<ul> <li>Significantly better general QOL, mental health QOL, and physical health QOL</li> <li>Reduced levels of depression and psychological distress</li> </ul>
People with cardiovascular disease or CV risk factors [9]	37 (3525)	<ul> <li>Tai Chi may have positive effects on stress, self-efficacy, and mood.</li> <li>Tai Chi combined with usual care: reductions in anxiety and depression and improvements in mental health and bodily pain domains of the 36-Item Short Form Survey</li> </ul>
Hypertension [10]	24	<ul> <li>Significant improvements in systolic and diastolic blood pressure and QoL (physical functioning, role-physical, general health, bodily pain, vitality, social functioning, role-emotional, and mental health) compared to the control group</li> <li>No significant improvements in BMI compared to control</li> </ul>
Hypertension []11	13	<ul> <li>Significant reduction in both SBP and DBP</li> <li>24-movement or Yang-style Tai Chi was effective in reducing both systolic and diastolic blood pressure, whether intervention period was &gt; or ≤ 12 weeks. Other styles did not show significant reductions in blood pressure when the duration was ≤ 12 weeks</li> </ul>
Hypertension [12]	28 (2937)	<ul> <li>Statistically significant difference in reducing both systolic and diastolic blood pressure when compared with health education/no treatment, other forms of exercise, or antihypertensive drugs: high quality of evidence</li> </ul>
Hypertension [13]	Several sub- analysis	<ul> <li>More effective in reducing both systolic and diastolic blood pressure over a cycle of more than 12 weeks</li> <li>Longer-term Tai Chi practice associated with increased levels of nitric oxide (NO)</li> <li>Reductions in total cholesterol, triglycerides, and low-density lipoprotein after more than 12 weeks of practice</li> <li>Enhancement of high-density lipoprotein cholesterol more pronounced with practice under 12 weeks</li> </ul>

Four of the reviews focused on trials with people who had suffered stroke or myocardial infarction. Four other reviews focused on trials with people with cardiovascular disease. And five reviews on cardiovascular disease risks, like hypertension.

# Discussion

# On stroke or myocardial infarction survivors

In the first review, 11 randomized controlled trials involving 723 stroke survivors who received conventional rehabilitation therapy or Tai Chi training found that Tai Chi may lead to greater improvement in depression scores compared to conventional rehabilitation therapy. The methodological quality of the included studies varied, with one assessed as "low," eight as "moderate," and two as "high", while the overall quality of evidence for the outcomes was generally low or very low according to the Grading of Recommendations Assessment, Development, and Evaluation (GRADE). The review suggests that Tai Chi could be a promising intervention for improving depression in stroke survivors, but further high-quality research is needed to strengthen the evidence base [1].

In the second review, a meta-analysis was conducted on 27 randomized trials involving 1,919 stroke survivors, with 18 trials focused on Tai Chi and 9 on Qigong. None of the studies were considered high risk of bias, with around 70% having some concerns and 30% being deemed low risk. The results, analyzed using random-effects models, showed that both Tai Chi and Qigong were effective in improving mobility among stroke survivors, particularly in walking

ability (Hedges' g = 0.81), dynamic balance (Hedges' g = 1.04), and activities of daily living (ADL) (Hedges' g = 0.43). These positive effects were observed in both short-term and long-term programs (Hedges' g 0.91 vs. 0.75) and were consistent when compared with both active controls and no treatment groups (Hedges' g 0.81 vs. 0.73). The conclusion was that practicing Tai Chi and Qigong for 12 weeks or less can effectively improve the mobility of stroke survivors [2].

In the third review focusing on stroke patients, 12 eligible randomized controlled trials were included, involving 966 subjects. The meta-analysis results indicated significant improvements in balance function assessed using the Berg Balance Scale (MD=4.87, p<0.001, I2=90, 95% CI=4.46– 5.28). Motor function assessments, using the Fugl-Meyer Motor Assessment (SMD=1.11, p<0.001, I2=94, 95% CI=0.94-1.28) and Simple Test of Extremity Function (MD=10.28, p<0.001, I2=0, 95% CI=7.89–12.68), showed positive outcomes. Improved walking ability was observed through the Time-Up and Go Test (MD=-3.22, p<0.001, I2=83, 95% CI=-3.71-2.73). Activities of daily living, measured by the Modified Barthel Index, also exhibited improvement (MD=4.61, p<0.001, I2=81, 95% CI=3.61-5.61). This supports the idea that Tai Chi Yunshou training can enhance the balance and motor function of stroke survivors. Furthermore, it may contribute to improved walking ability and daily living skills, potentially surpassing the effects of conventional rehabilitation training [3].

One review focused on myocardial infarction patients and took in seven RCTs, comprising a total of 615 patients, with

the Tai Chi group consisting of 294 patients and the control group containing 261 patients. The results demonstrated that Tai Chi had significant effects on the outcomes of the 6minute walk (SMD=1.30, 95% CI: 0.50 to 2.11) and left ventricular ejection fraction (SMD=1, 95% CI: 0.43 to 1.57) when compared to no or low-density exercise. Additionally, Tai Chi positively impacted the quality of life, pro-B type natriuretic 90 peptide levels, and MOS item short-form health survey. However, Tai Chi did not show a significant effect on activities of daily living scale ADL (P=0.060), sense of coherence scale SCO-13 (P=0.057), and N 89 terminal pro B type natriuretic peptide (NT-proBNP) levels (P=0.081). There was a moderate to high level of heterogeneity observed across all comparisons. In conclusion, Tai Chi can be considered as an effective exercise option for cardiac rehabilitation [4].

# On cardiovascular disease and cardiac failure

Analyzing six studies with a total of 229 participants, the first review found that Tai Chi can be beneficial for individuals with heart failure. Compared to control groups, those practicing Tai Chi showed significantly better exercise capacity, improved quality of life, reduced depression, and decreased b-type natriuretic peptide expression [5].

Another analysis of 15 trials, involving a total of 1,236 participants, also focused on individuals with chronic heart failure. When Tai Chi was combined with usual care and compared to usual care alone, significant improvements were observed across various health parameters. These improvements encompassed health status tests, such as the Minnesota Living with Heart Failure Questionnaire (MLHFQ) (MD = -8.51), the Hamilton Depression Rating Scale (MD = -2.89), and the Pittsburgh Sleep Quality Index (MD = -2.25). Additionally, Tai Chi demonstrated positive effects on physical function and exercise capacity, including a significant improvement in the 6-minute walk test (MD = 43.47) and the timed up-and-go test (MD = -1.34). Cardiac parameters, such as left ventricular ejection fraction (MD = 6.07) and B-type natriuretic peptide/N-terminal fragment of pro-BNP (SMD = -1.12), also showed significant improvement. Furthermore, Tai Chi was associated with a reduced risk of heart failure hospitalization (RR = 0.47). However, there was no significant difference in peak oxygen uptake, and the evaluation of all-cause mortality or cardiovascular death was inconclusive due to insufficient data. Tai Chi appears to be safe and beneficial for patients with chronic heart failure, improving health status, physical function, and cardiac parameters. The certainty of evidence was rated from very low to moderate due to various factors, including the risk of bias, inconsistency, imprecision, and publication bias, which points out the need for more highquality and long-term studies [6].

A review with the same subject included RCTs compared the addition of Tai Chi to routine managements (RMs) against RMs alone or compared Tai Chi to general exercise, with RMs as a consistent cointervention in both groups. The systematic review comprised 33 RCTs with 2,465 patients. Tai Chi plus RMs, compared to RMs alone, demonstrated improvements in VO2peak, 6MWD, and MLHFQ. When compared to general exercise, the Tai Chi group exhibited superior improvements, particularly significant in MLHFQ. Evidence also indicated the safety and high adherence of Tai Chi practice [7].

The benefits of Tai Chi exercise for psychological wellbeing among adults with cardiovascular disease were analyzed by looking at 15 RCTs, involving 1853 participants (mean age = 66 years old, 44% women). The assessed outcomes included quality of life (OOL), stress, anxiety, depression, and psychological distress. When comparing Tai Chi with control groups, the results showed significantly better general QoL (Hedges' g 0.96; p=0.02, I2=94.99%), mental health QoL (Hedges' g=0.20; p=0.01, I2=15.93%), and physical health QoL (Hedges' g=0.40; p=0.00, I2=0%). Additionally, Tai Chi was associated with reduced levels of depression (Hedges' g=0.69; p=0.00, I2=86.64%) and psychological distress (Hedges' g=0.58; p=0.00, I2=0%). The findings suggest positive effects, being needed further research with more robust study designs, appropriate Tai Chi exercise doses, and carefully selected outcome measures that evaluate both the mechanisms and effects of Tai Chi [8].

# On cardiovascular disease risk factors

Psychological risk factors have been recognized as potential, modifiable risk factors in the development and progression of cardiovascular disease. A broad review of 37 RCTs (involving 3525 participants total) evaluating Tai Chi for psychological well-being and quality of life in people with cardiovascular disease or risk factors found that Tai Chi may have positive effects on stress, self-efficacy, and mood. Meta-analyses indicated that Tai Chi, when combined with usual care, led to reductions in anxiety and depression and improvements in mental health and bodily pain domains of the 36-Item Short Form Survey. The study suggests that Tai Chi is beneficial in managing anxiety, depression, and quality of life in individuals with cardiovascular disease and/or cardiovascular risk factors [9].

Hypertension is one of the major risk factors for CV disease. Four reviews analyzed the existing literature to extract evidence of the benefits of Tai Chi on patients with this condition. The first one focused on blood pressure, body mass index (BMI), and quality of life (QoL) in individuals with hypertension, analyzed 24 studies and revealed that the intervention group exhibited significant improvements in SBP (SMD -1.05, 95% CI -1.44 to -0.67, P  $\leq 0.001$ ; I2 = 93.7%), DBP (SMD -0.91, 95% CI -1.24 to -0.58, P  $\leq$ 0.001; I2 = 91.9%), and OoL, encompassing various aspects such as physical functioning, role-physical, general health, bodily pain, vitality, social functioning, role-emotional, and mental health, compared to the control group. However, no significant improvements were observed in BMI for the intervention group (SMD -0.08, 95% CI -0.35 to -0.19, P = 0.554; I2 = 69.4%) in comparison to the control group. In conclusion, Tai Chi proves to be an effective intervention for enhancing SBP and DBP in individuals with essential hypertension [10].

In another review, thirteen eligible trials were analyzed, revealing that Tai Chi has a significant impact on treating essential hypertension compared to control interventions. After practicing Tai Chi, there was a notable difference between the intervention and control groups in terms of the change in systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically, Tai Chi resulted in a significant reduction in both SBP (WMD = -6.58) and DBP (SMD = -0.57). Subgroup analyses further highlighted that the 24-movement or yang-style Tai Chi was particularly effective in reducing both systolic and diastolic blood

pressure, whether the intervention period was  $\leq 12$  weeks or > 12 weeks. However, other styles of Tai Chi did not show significant reductions in blood pressure when the duration of practice was  $\leq 12$  weeks <sup>[11]</sup>.

Another review that filtered 28 randomized controlled trials (RCTs) encompassing 2,937 participants revealed that, when compared with health education/no treatment, other forms of exercise, or antihypertensive drugs (AHD), Tai Chi had a statistically significant difference in reducing both SBP and DBP. The trial sequential analysis indicated that the evidence in this meta-analysis was reliable and conclusive. Subgroup analyses specifically comparing Tai Chi to AHD showed that Tai Chi had a greater impact on reducing SBP and DBP in hypertension patients under 50 years old. Additionally, interventions lasting between 12 to 24 weeks were associated with a significant reduction in both SBP and DBP. Among the 28 included RCTs, two reported no adverse events. The quality of evidence for blood pressure outcomes was deemed moderate or high, while the quality of evidence for other outcome indicators was considered low or very low [12].

Finally, a review focusing on program duration concluded that Tai Chi exercise conducted over a cycle of more than 12 weeks appears to be more effective in reducing SBP [MD = -11.72, 95% CI (-15.52, -7.91)] and DBP [MD = -4.68, 95% CI (-7.23, -2.12)], as well as increasing the levels of nitric oxide (NO) [MD = 0.99, 95% CI (0.69, 1.28)]. Furthermore, improvements in blood lipid metabolism are evident after more than 12 weeks of Tai Chi exercise, with reductions in total cholesterol (TC) [SMD = -0.68, 95% CI (-0.89, -0.46)], triglycerides (TG) [SMD = -0.84, 95% CI (-1.25, -0.43)], and low-density lipoprotein cholesterol (LDL-C) [SMD = -1.58, 95% CI (-2.29, -0.86)]. However, the enhancement of high-density lipoprotein cholesterol (HDL-C) [SMD = 0.54, 95% CI (0.28, 0.79)] was more pronounced with exercise cycles lasting less than 12 weeks. A subgroup analysis focusing on exercise frequency and duration indicates that, for individuals with hypertension, an exercise frequency of more than or equal to 5 times per week is preferable while, for those with hypertension and hyperlipidemia, a frequency of less than 5 times per week coupled with exercise durations under 60 minutes per session may yield more benefits [13].

# Conclusion

Systematic reviews consistently report a wide range of benefits of Tai Chi for cardiovascular health. Evidence spans improvements in mental health (reduced anxiety, depression, and stress), physical function (pain reduction, balance, mobility, and exercise capacity), cardiovascular-specific outcomes (better left ventricular ejection fraction, BNP/NT-proBNP levels, and, in some cases, peak oxygen uptake). Tai Chi also supports recovery in stroke, myocardial infarction, and chronic heart failure patients, while lowering risk factors such as blood pressure, cholesterol, and triglycerides. Broader quality of life domains-including vitality, social functioning, and emotional wellbeing-also improve. Given its low cost, minimal equipment needs, and adaptability to home-based practice, Tai Chi emerges as a promising rehabilitation and preventive strategy. Still, more high-quality RCTs are needed to clarify its role as a supplement, alternative, or maintenance therapy, as well as to assess the effectiveness of different Tai Chi schools and practice stages.

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