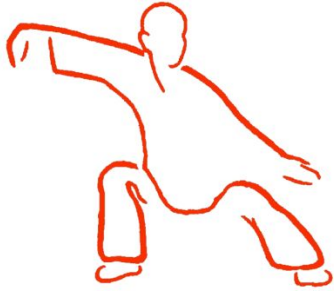


# Tai Chi

The background of the slide features a sunset scene with a large white sun partially obscured by a yellow horizon line. Below the horizon are several layers of orange and yellow hills. In the foreground, two black silhouettes of people are shown in Tai Chi poses. The person on the left is standing on one leg with arms extended. The person on the right is in a wide, low stance with arms in a circular motion. Small birds are scattered in the sky.

and it's application to  
health care

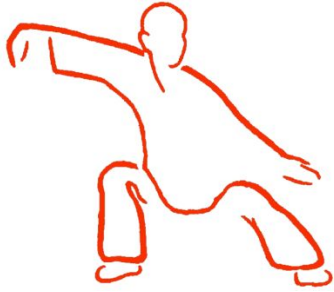
*Patricia Flatt, PhD  
Western Oregon University  
Monmouth, OR 97361*



## **How Do We Measure the Effectiveness of Tai Chi to Treat Disease States and Maintain Health?**

- What is Tai Chi?
- What elements of Tai Chi Practice promote health rehabilitation and maintenance?
- How do we effectively measure those elements and compare it with other treatment strategies?





# What is Tai Chi?

(A Scientific Perspective...)

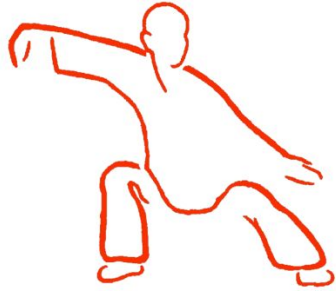
- Tai Chi is a multi-component mind-body exercise that is grounded in the holistic model of traditional Chinese medicine.

Wayne, P.M., et al., (2013) *Contemporary Clinical Trials* 34:21-34.

- The characteristics of Tai Chi include:
  - Mind concentration with breathing control
  - Whole-body exercise in a semisquat posture
  - Continuous, curved and spiral movements

Lan, C., et al. (2013) *Evidence Based Complementary and Alternative Medicine*. 2013:1-17.

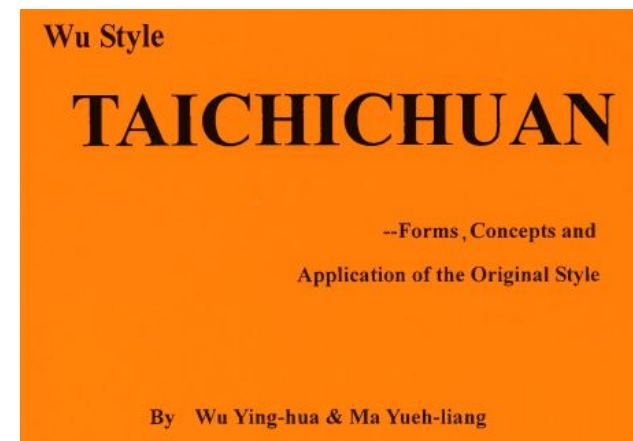




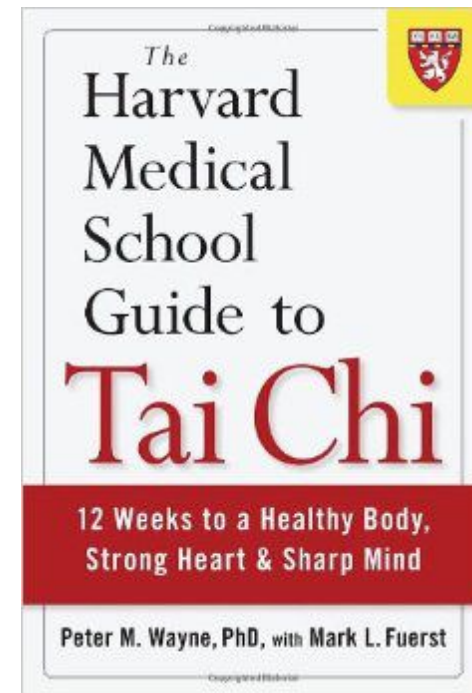
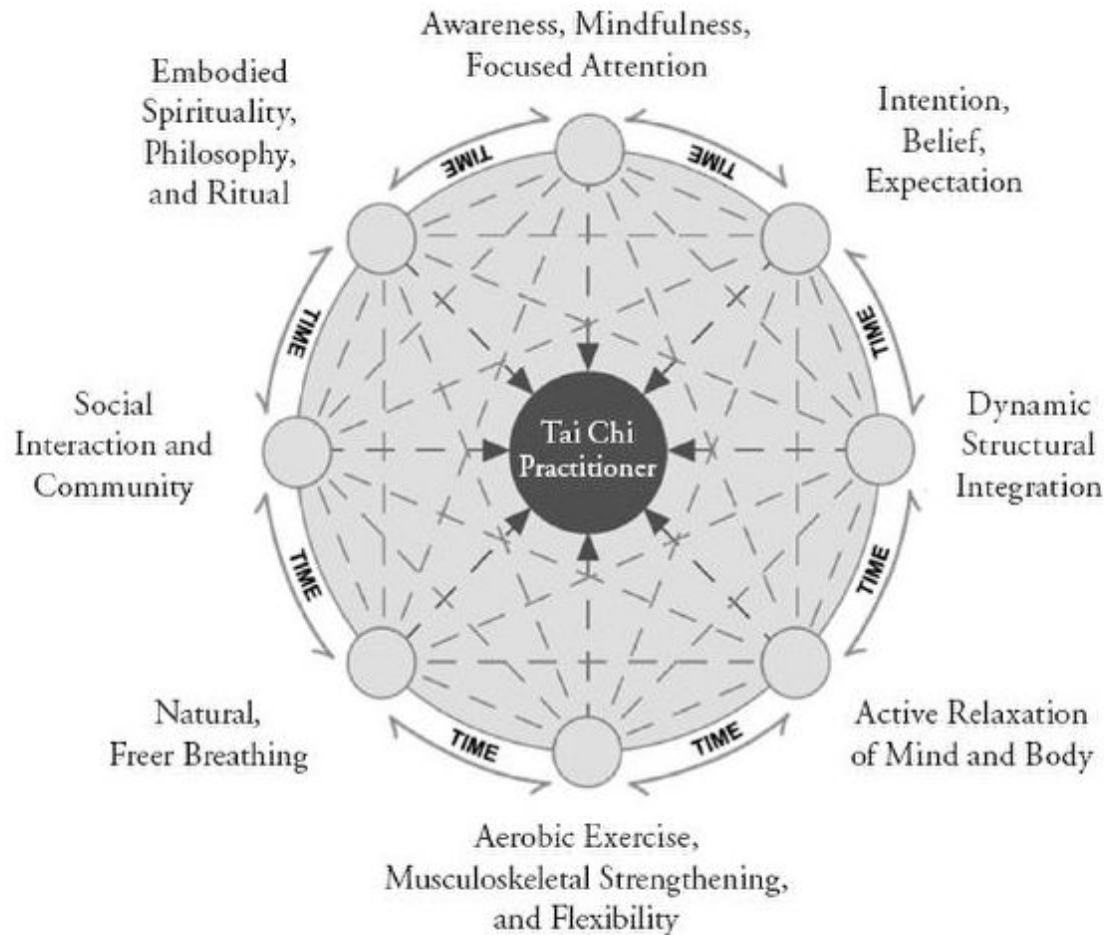
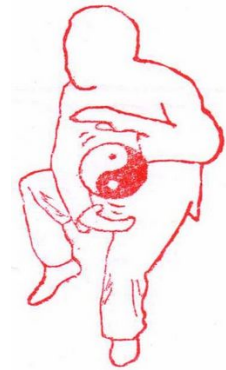
# What is Tai Chi?

(A Grandmaster's Perspective...)

- It has been stated in the taichichuan classic 'Chant of Thirteen Kinetic Movements' that the final purpose of practising taichichuan is to reach longevity and eternal spring (youth)
- The characteristics of practising taichichuan are stillness, lightness, slowness, relaxation of the muscles of the whole body, and more importantly, use of the mind and not force. The practitioner must be fully conscious of all the movements, that is all the movements are always controlled by the mind



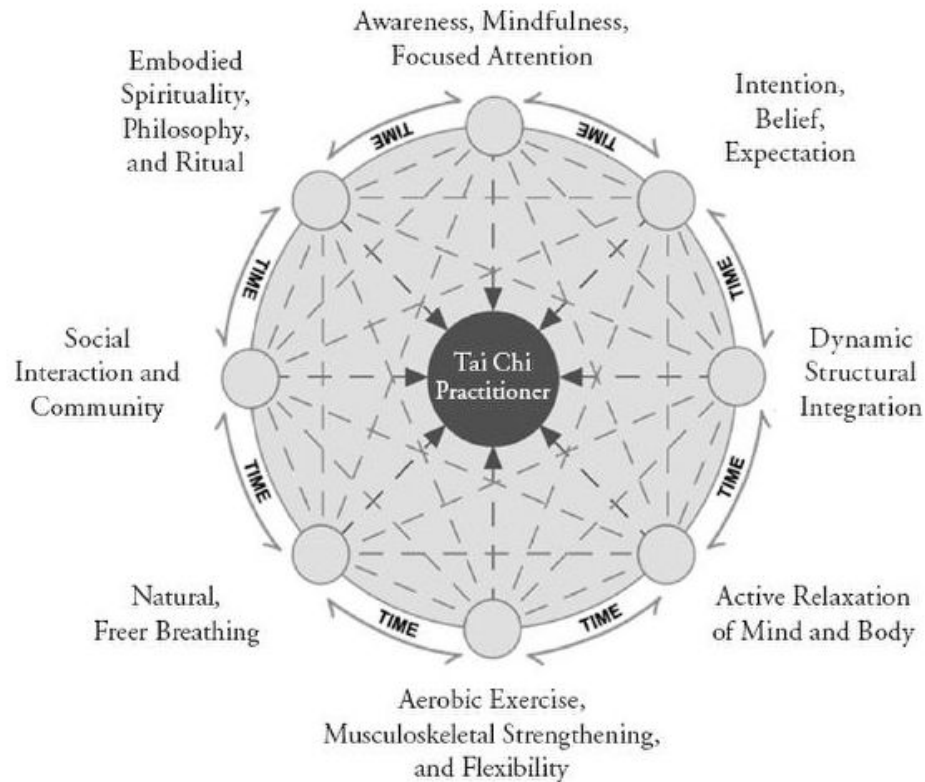
# The Eight Active Ingredients of Tai Chi



# Weaknesses of Current Scientific Studies

## CONCEPTUAL

What are current studies really measuring? Is it Tai Chi?

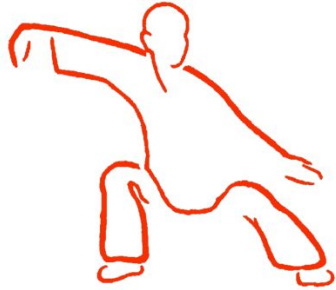


- **Duration**

Most of the studies conducted on tai chi are only 8-12 weeks in length, and study new practitioners.

Very little data on long-term practitioners.

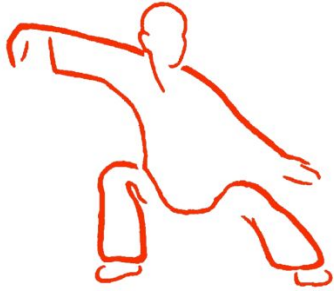




# How do you evaluate the effectiveness of Tai Chi in health care?

- **Measured Outcomes**
  - Integrity (Sample Randomness? Teacher Certification?)
  - Validity (Blinding during evaluation? Using proper control groups)
  - Repeatability (Low sample size; Style of Tai Chi being practiced)
  - Comparability (to other studies/other forms of treatment/what outcomes are best to measure?)
  - Qualitative vs Quantitative Data





# The Power of Meta-Analysis

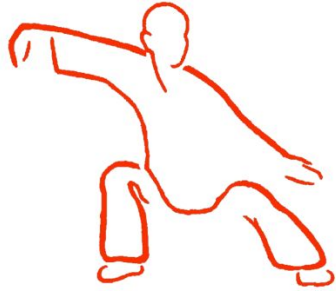
a **Meta-Analysis** refers to methods that focus on contrasting and combining results from different studies, in the hope of identifying:

- patterns among study results,
- sources of disagreement among those results,
- other interesting relationships that may come to light in the context of multiple studies

It is essentially "conducting research about research."







# Scales to Assess Methodological Quality and Risk of Bias

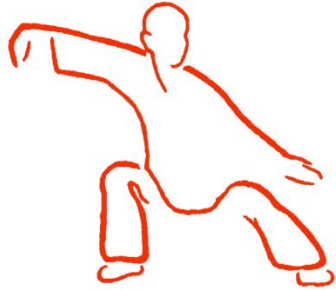
Cochrane Back Review Group

1. Method of randomization adequate?
2. Treatment allocation concealed? Was the knowledge of the allocated interventions adequately prevented during the study?
3. Was the patient blinded to the intervention?
4. Was the care provider blinded to the intervention?
5. Was the outcome assessor blinded to the intervention? Were incomplete outcome data adequately addressed?
6. Was the dropout rate described and acceptable
7. Were all randomized participants analyzed in the group to which they were allocated?
8. Are reports of the study free of suggestion and selective outcome reporting?
9. Were the groups similar at baseline regarding the most important prognostic indicators?
10. Were co-interventions avoided or similar?
11. Was the compliance acceptable in all groups?
12. Was the timing of the outcome assessment similar in all groups?

Serious Flaw

Overall Quality Score





# Efficacy of Tai Chi on Pain, Stiffness and Function in Patients with Osteoarthritis: A Meta-Analysis

Yan, J.H., et.al. (2013) PLOS ONE 8(4):e61672

- 7 randomized control trials involving 348 patients with osteoarthritis were pooled and analyzed using meta-analysis
- Significant improvements in pain and stiffness were seen in 12-week Tai Chi studies

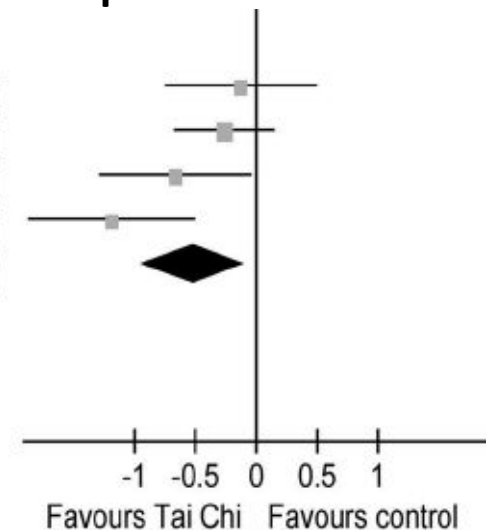
## Evaluation of Pain Relief from Osteoarthritis in TCC Participants

### 2.1.3 During = 12 weeks

Brismé 2007	-2.12	6.97	22	-1.34	4.69	19	23.4%	-0.13 [-0.74, 0.49]
Fransen 2007	-9.6	20.8	56	-4.4	18.2	41	32.1%	-0.26 [-0.67, 0.14]
Song 2003	-2.45	3.9	22	0.61	5.1	21	23.3%	-0.66 [-1.28, -0.05]
Wang 2009	-157.25	97.99	20	-38.45	97.99	20	21.2%	-1.19 [-1.87, -0.51]
<b>Subtotal (95% CI)</b>			<b>120</b>			<b>101</b>	<b>100.0%</b>	<b>-0.52 [-0.95, -0.09]</b>

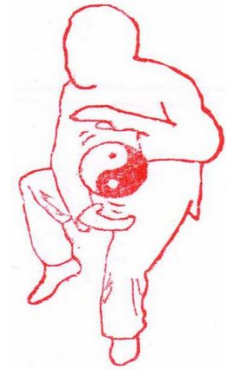
Heterogeneity:  $\tau^2 = 0.11$ ;  $\chi^2 = 6.91$ ,  $df = 3$  ( $P = 0.07$ );  $I^2 = 57\%$

Test for overall effect:  $Z = 2.37$  ( $P = 0.02$ )



# Effects of Tai Chi Training on Exercise Capacity and Quality of Life in Patients with Chronic Heart Failure: A Meta-Analysis

Pan L., et.al. (2012) European Journal of Heart Failure 15:316-323.

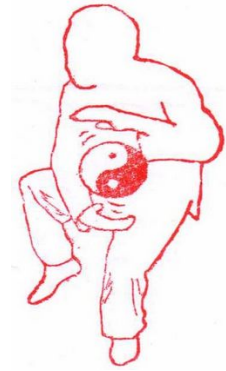


- 4 articles were included for meta-analysis.
- Evaluated Fitness (6 minute walk test)
- Quality of Life (Minnesota living with heart failure (MLHF) questionnaire)
- Evaluated Biophysical and Biochemical Parameters
  - N-terminal pro brain natriuretic peptide ( higher levels in the bloodstream indicate congestive heart failure)
  - Systolic and diastolic blood pressure
  - Peak oxygen uptake



# Effects of Tai Chi Training on Exercise Capacity and Quality of Life in Patients with Chronic Heart Failure: A Meta-Analysis

Pan L., et.al. (2012) European Journal of Heart Failure 15:316-323.



- 4 articles were included for meta-analysis.
- Evaluated Fitness (6 minute walk test)
- Quality of Life (Minnesota living with heart failure questionnaire)
- Evaluated Biomarkers and Parameters

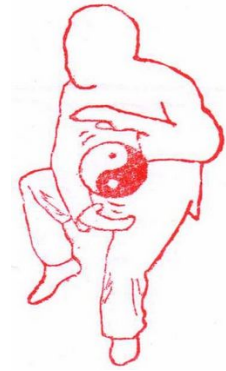
terminal pro brain natriuretic peptide (NT-pro-BNP) levels in the bloodstream indicate congestive heart failure)  
diastolic and systolic blood pressure

– Peak oxygen consumption

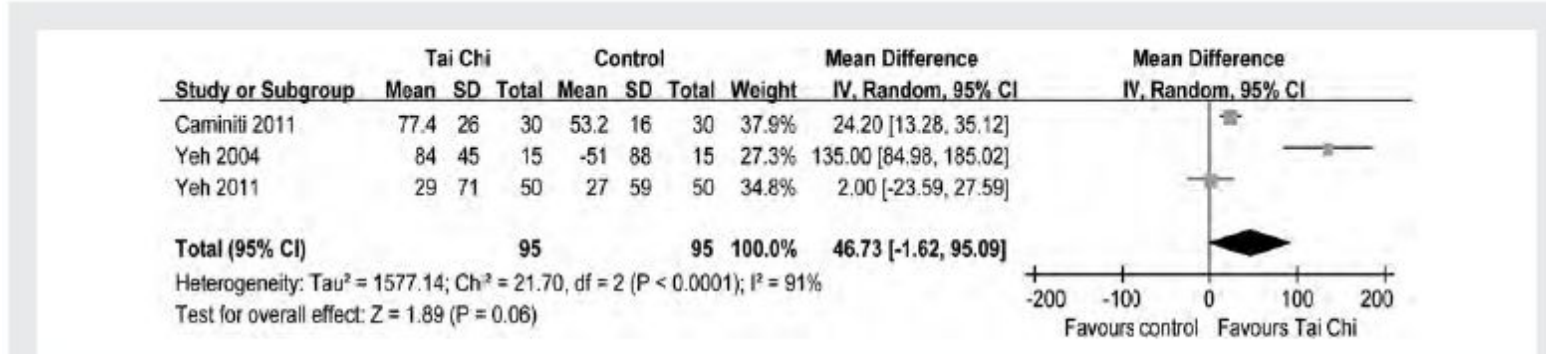


# Effects of Tai Chi Training on Exercise Capacity and Quality of Life in Patients with Chronic Heart Failure: A Meta-Analysis

Pan L., et.al. (2012) European Journal of Heart Failure 15:316-323.



- 4 articles were included for meta-analysis.
- Evaluated Fitness (6 minute walk test)
  - Showed a slight positive trend towards Tai Chi participation
  - However, it was not significant and heterogeneity was high ( $I^2 = 91\%$ )

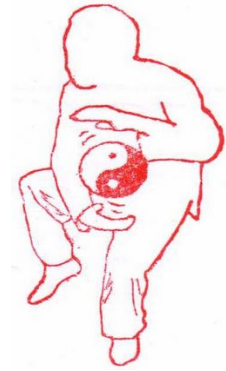


**Figure 2** A Forest plot of the meta-analysis of three studies comparing a Tai Chi group with a control group for changes in 6 min walk distance. Each block represents a study, and the area of each block is proportional to the precision of the mean treatment effect in that study. The horizontal line represents each study's 95% confidence interval (CI) for the treatment effect. The centre of the diamond is the average treatment effect across studies, and the width of the diamond denotes its 95% CI.

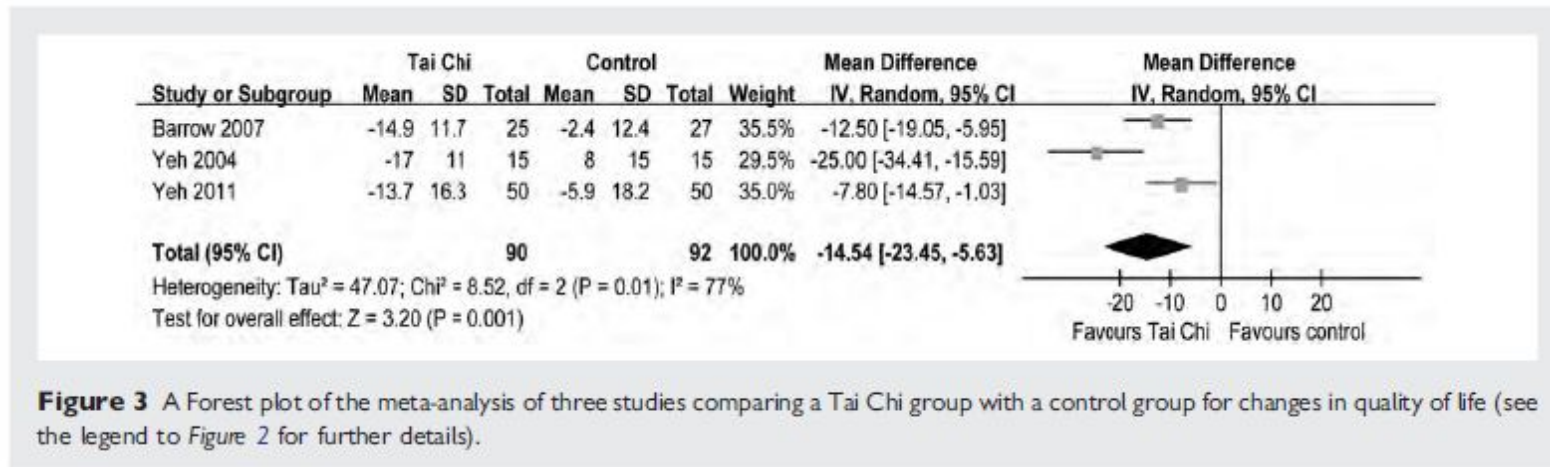


# Effects of Tai Chi Training on Exercise Capacity and Quality of Life in Patients with Chronic Heart Failure: A Meta-Analysis

Pan L., et.al. (2012) European Journal of Heart Failure 15:316-323.



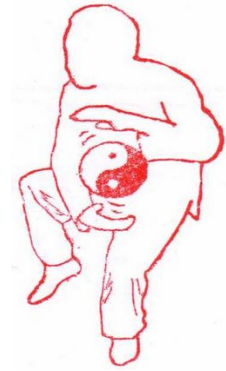
- 4 articles were included for meta-analysis.
- Quality of Life (Minnesota living with heart failure questionnaire)
  - Showed a statistically significant correlation with Tai Chi Practice
  - However, still high heterogeneity among the studies ( $I^2 = 77%$ )



**Figure 3** A Forest plot of the meta-analysis of three studies comparing a Tai Chi group with a control group for changes in quality of life (see the legend to Figure 2 for further details).

# Effects of Tai Chi Training on Exercise Capacity and Quality of Life in Patients with Chronic Heart Failure: A Meta-Analysis

Pan L., et.al. (2012) European Journal of Heart Failure 15:316-323.



- 4 articles were included for meta-analysis.
  - Only 12-16 weeks of tai chi practice

**The short duration of Tai Chi Chuan practice is a serious flaw in many scientific studies of TCC.**



## **Effect of skill level on cardiorespiratory and metabolic responses during Tai Chi training**

KAI-YU XIONG<sup>1</sup>, HUI HE<sup>1</sup>, & GUO-XIN NI<sup>2</sup>

*“...While the forms of TCC are easy to learn, their correct execution takes time and diligent practice. The coordination of the mind, the movements, and breathing in TCC exercise can only be achieved progressively through repeated practice....”*

This study analyzed cardiorespiratory and metabolic responses of young male athletes participating in TCC practice.

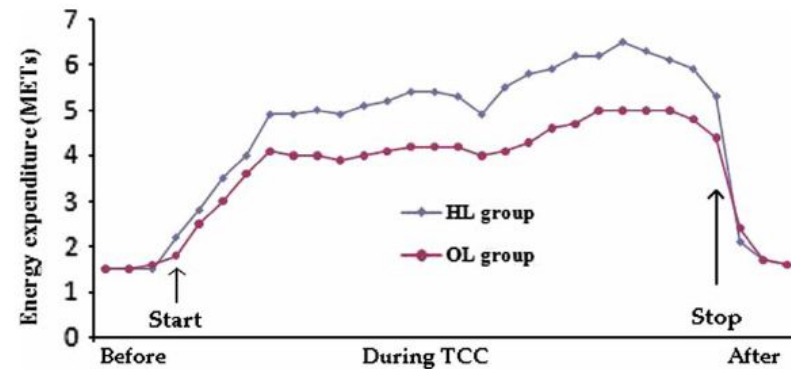
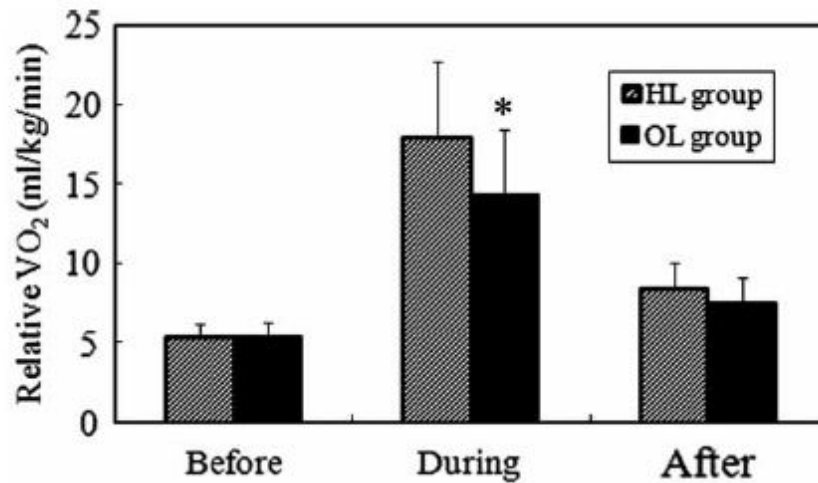
- High Level (HL) Group – 10 professional athletes from the Beijing Sport University Taijiquan Team (practicing for 10 years or more)
- Ordinary Level (OL) Group – 10 collegiate young males practicing the 24-form for about 2 years.



## Effect of skill level on cardiorespiratory and metabolic responses during Tai Chi training

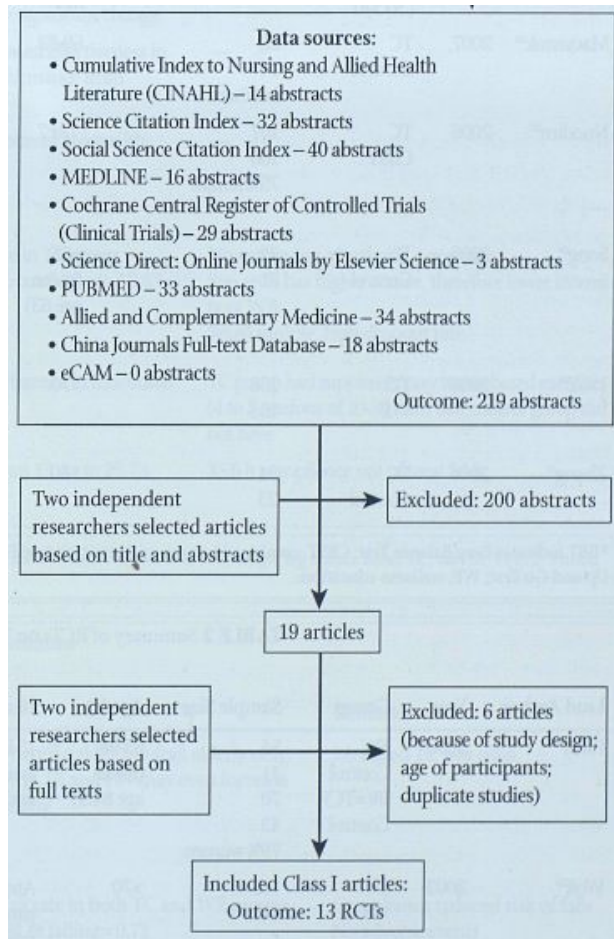
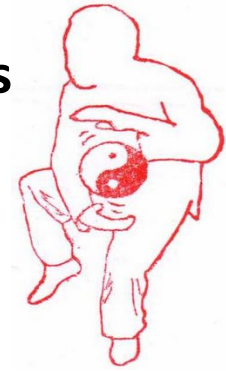
KAI-YU XIONG<sup>1</sup>, HUI HE<sup>1</sup>, & GUO-XIN NI<sup>2</sup>

- Both groups practiced the 24 form to music to control pace and tempo of the routine
- Cardiorespiratory response was measured continuously from 3 min before to 3 min after the end of the TCC exercise, measuring oxygen uptake, carbon dioxide production, and heart rate.



# Tai Chi as an Intervention to Improve Balance and Reduce Falls in Older Adults: A Systematic and Meta-analytical Review

Leung, D.P.K., et.al. (2011) *Alternative Therapies* 17(1):40-48.

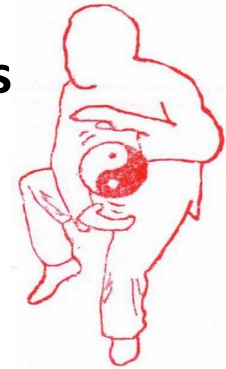


- 219 potentially relevant papers found in 10 databases.
- Excluded 200 abstracts based on title and abstracts
- Excluded 6 more articles based on flawed experimental design
- Total of 13 studies reviewed
- Only 3 studies had outcomes similar enough to allow for pooled Meta-Analysis

**FLAW: Many Studies Lack Robustness**  
**Lack Comparable Study Design**  
**Lack Randomization**  
**Contain Potential for Biased Data**

# Tai Chi as an Intervention to Improve Balance and Reduce Falls in Older Adults: A Systematic and Meta-analytical Review

Leung, D.P.K., et.al. (2011) *Alternative Therapies* 17(1):40-48.



## Main Findings of the Meta-Analysis:

- Balance
  - Did not show significant differences between TCC and control population
- Fall Reduction
  - Saw a reduction trend in TCC and Western Exercise Practitioners vs Sedentary Control Groups, But the differences were NOT statistically significant

**Is short duration of Tai Chi Chuan practice problematic in evaluating these elements?**





# Balance control, flexibility, and cardiorespiratory fitness among older Tai Chi practitioners

Youlian Hong, Jing Xian Li, P D Robinson

## Long-term TCC Practitioners have better:

Table 1 General description of subjects

	TCC group (n=28)	Sedentary group (n=30)	t	p
Age (years)	67.5 (5.8)	66.2 (6.5)	0.802	0.426
Body weight (kg)	65.7 (9.9)	68.6 (5.5)	1.391	0.170
Body height (cm)	166.4 (7.9)	168.5 (5.1)	1.211	0.231
Body mass index (kg/m <sup>2</sup> )	22.7 (3.6)	24.2 (2.9)	1.753	0.085
Exercise experience (years)	13.2 (3.7)	0	—	—
Frequency (times a week)	5.1 (1.1)	0	—	—
Duration (min per session)	55.6 (10.3)	0	—	—

Values are mean (SD). TCC, Tai Chi Chuan.

### Balance

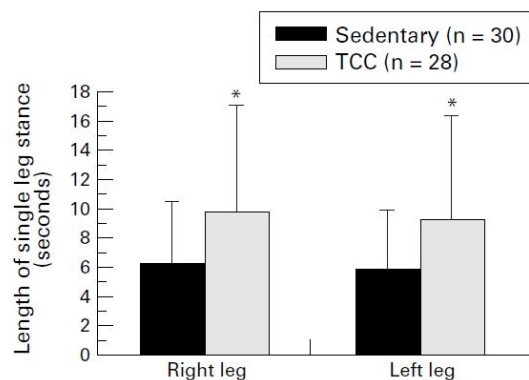


Figure 1 Comparison of measures in single leg standing with eyes closed between Tai Chi Chuan (TCC) and sedentary groups. \* $p < 0.05$  compared with the sedentary group.

### Flexibility

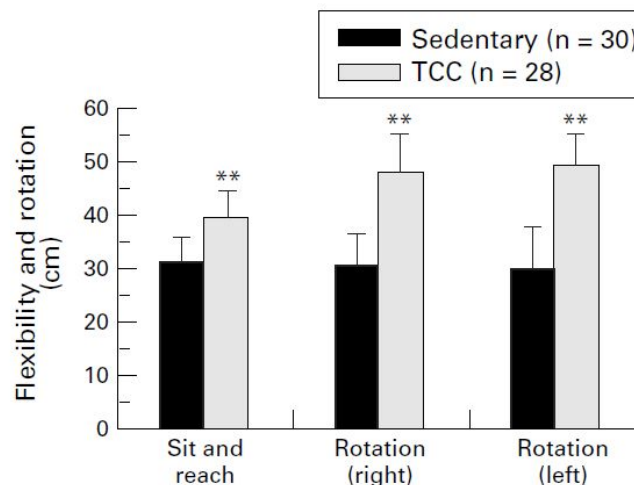


Figure 2 Comparison of body flexibility measures between the Tai Chi Chuan (TCC) and sedentary groups. \*\* $p < 0.01$  compared with the sedentary group.

### Lower Heart Rate

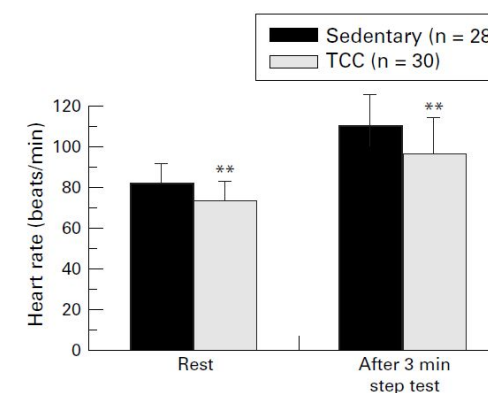


Figure 3 Comparison of heart rate measures between the Tai Chi Chuan (TCC) and sedentary groups. \*\* $p < 0.01$  compared with the sedentary group.



# The Effects of Tai Chi on Depression, Anxiety, and Psychological Well-Being: A Systematic Review and Meta-Analysis

Wang, F., et.al. (2013) Int. J. Behav. Med. DOI 10.1007/s12529-013-9351-9

- 42 studies included in the systematic review; 3 of these studies were found suitable for meta-analysis due to comparable outcome measurements
- Meta-analysis showed a strong correlation of Tai Chi Practice and the reduction of depression; other measures of anxiety, and overall quality of life showed similar trends

Center of Epidemiological Studies of Depression (CES-D) Scale

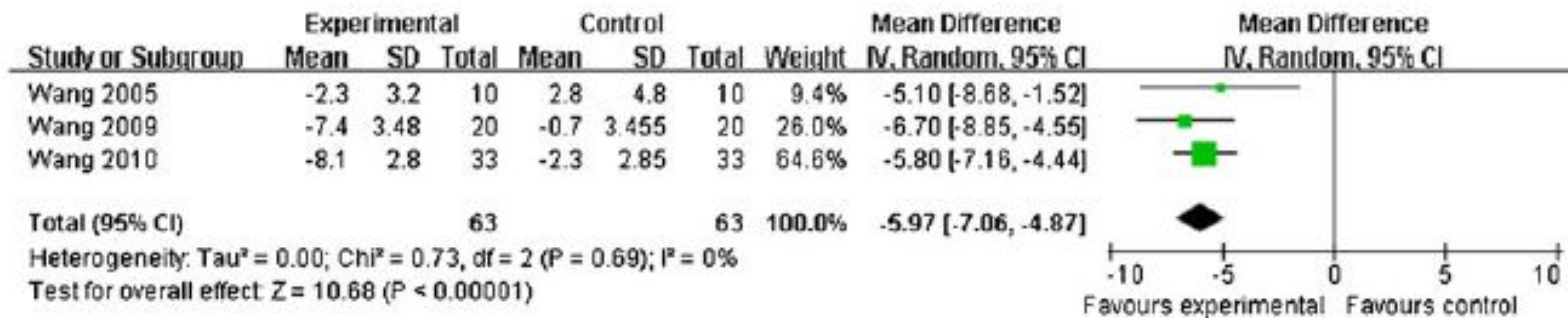
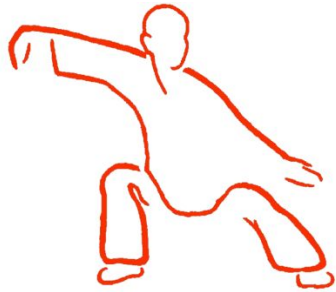


Fig. 2 Effects of tai chi on depression measured by CES-D





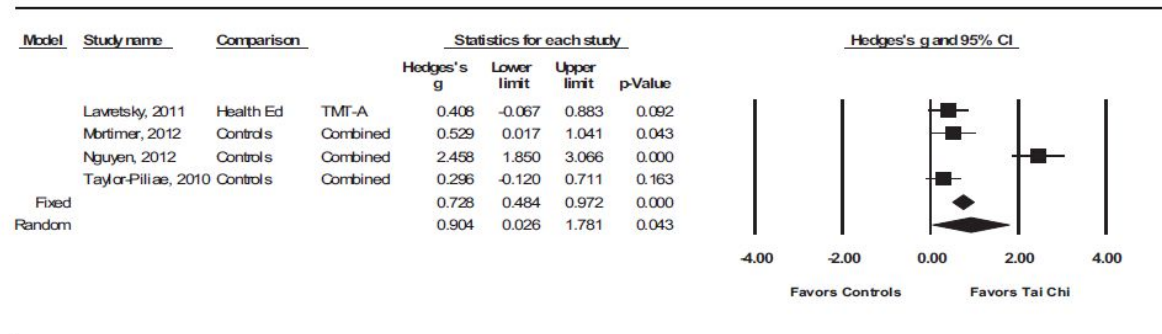
# Effect of Tai Chi on Cognitive Performance in Older Adults: Systematic Review and Meta-Analysis

Wayne, P.M., et.al. (2014) J Am Geriatr Soc 62:25-39

## COGNITIVELY HEALTHY

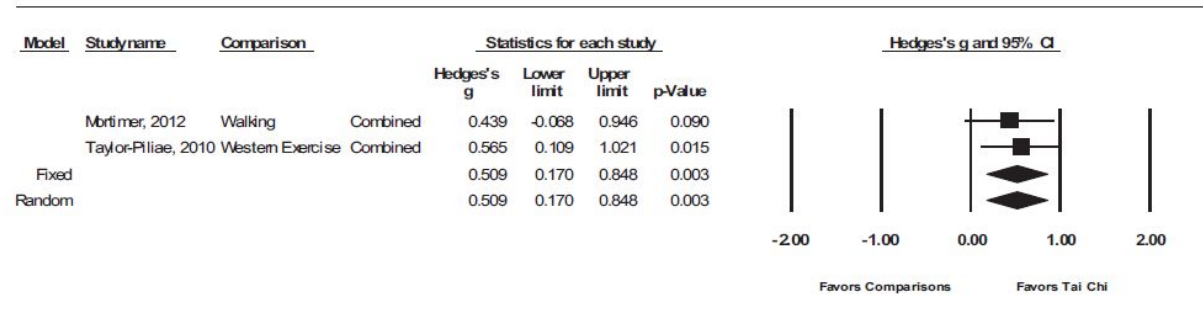
A

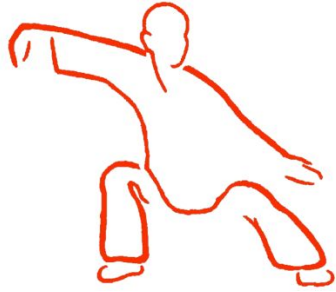
### Executive Function: Tai Chi vs Controls



B

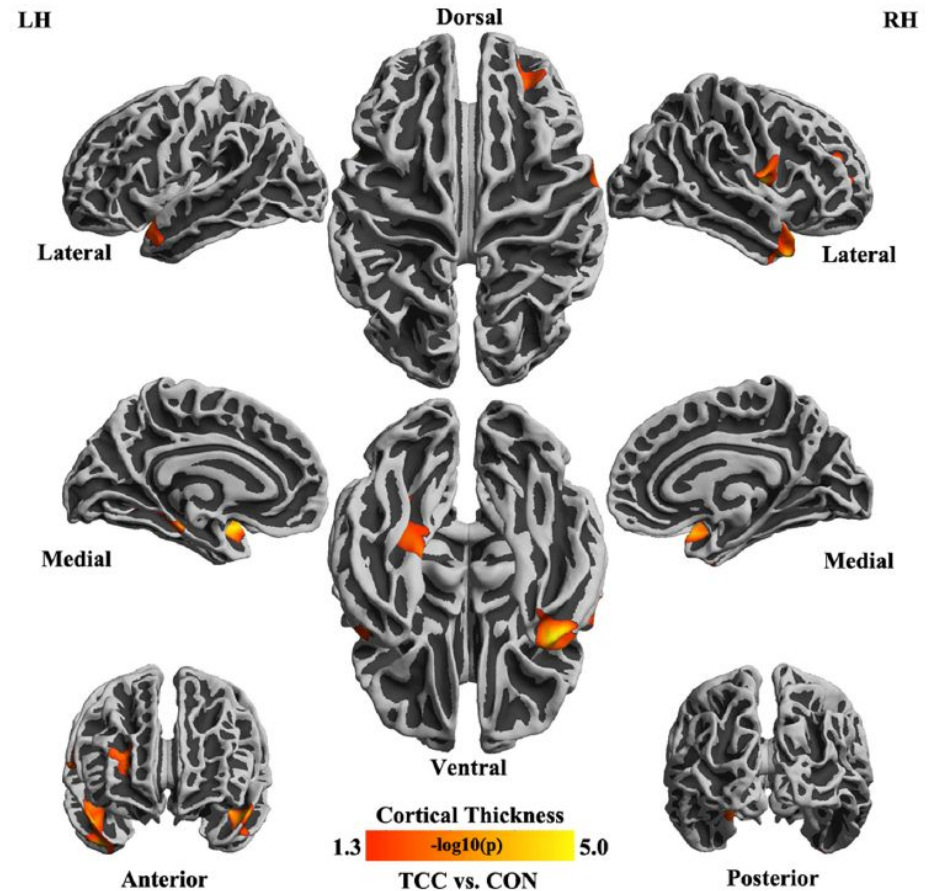
### Executive Function: Tai Chi vs Active Comparisons



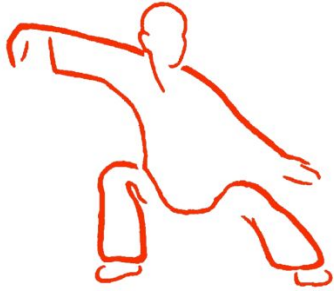


# MRI Analysis of Long-term Tai Chi Practitioners

- Thickness in the medial occipito-temporal sulcus and lingual sulcus were correlated with intensity of TCC practice
- Suggesting that TCC practice can change brain structure over time

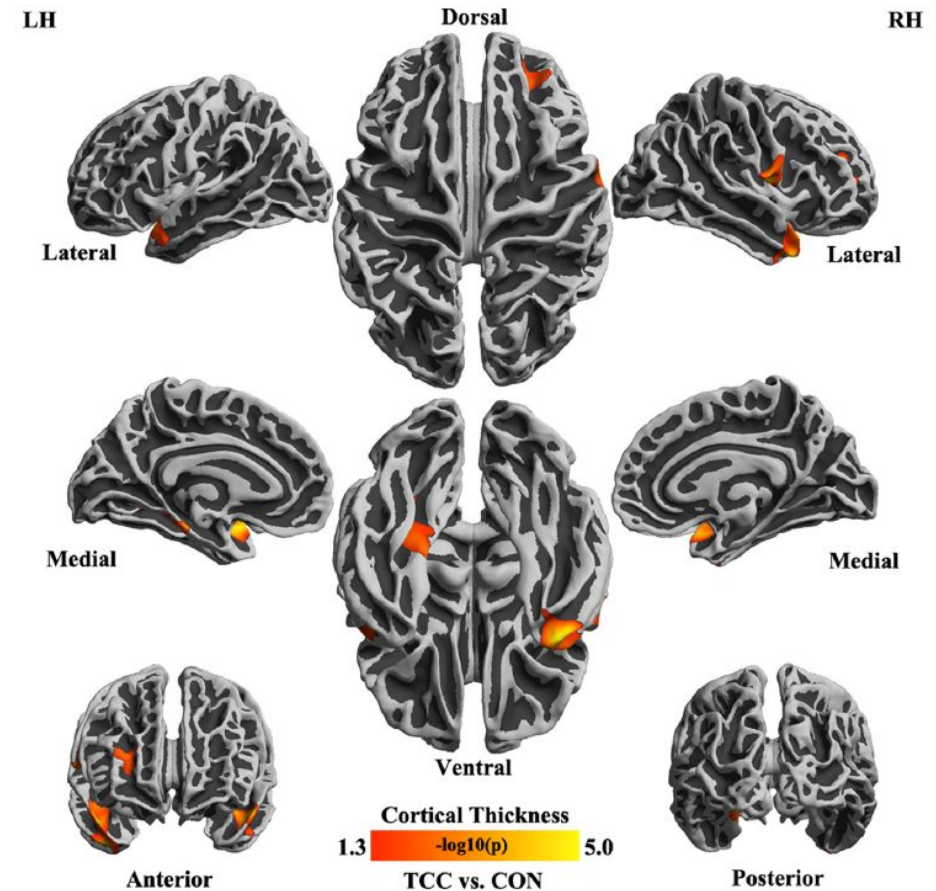


Wei, G.X., et al. (2013) *PLOS* 8(4):1-9



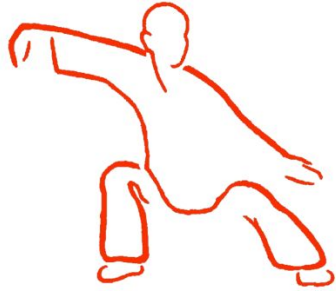
# MRI Analysis of Long-term Tai Chi Practitioners

- Regions of thickness correlated with:
  - Brain studies of long term meditation practitioners
  - Regions shown to increase in thickness with aerobic exercise
  - The largest differences were found in the precentral sulcus which mediates visuomotor actions and may lead to enhancement of the processing of motor-related information.

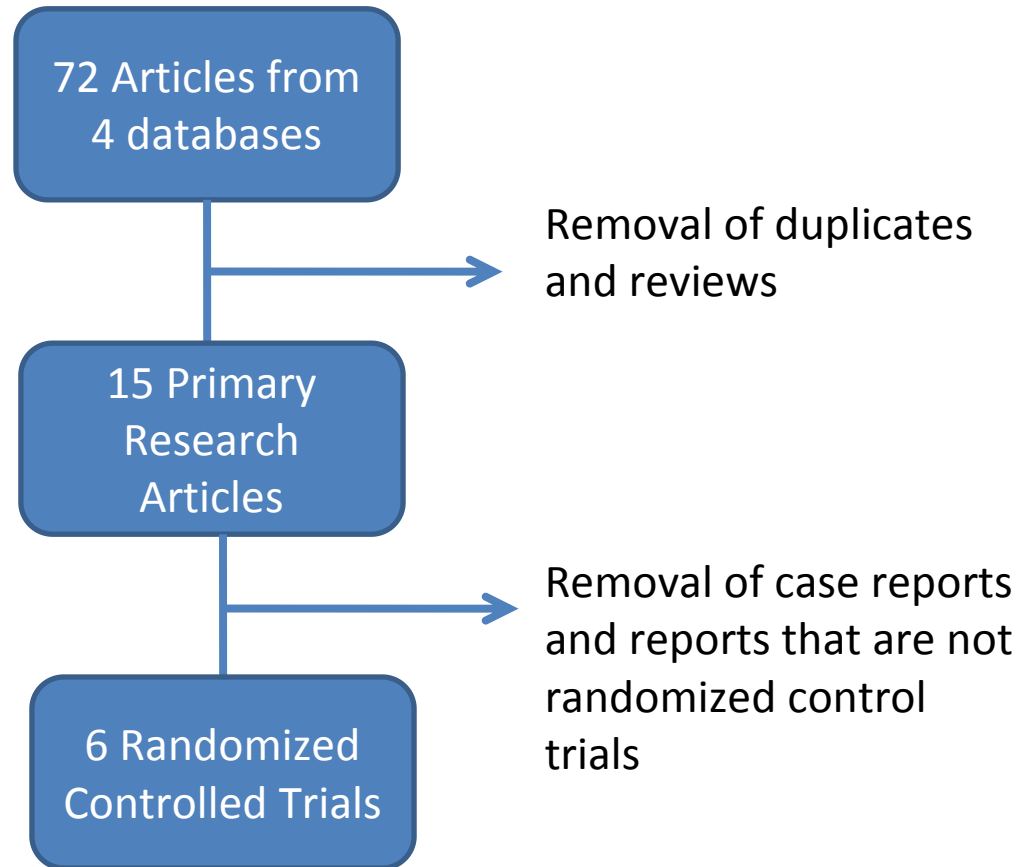


Wei, G.X., et al. (2013) *PLOS* 8(4):1-9





# Can Tai Chi have an impact in the treatment of chronic disease states like Parkinson's Disease?

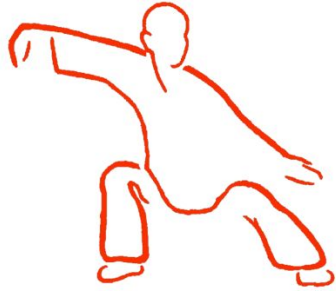




# Cochrane Back Review Group Scales to Assess Methodology

	Amano, et. al (2013)	Hackney, et. al. (2008)	Li, et al (2012)	Cheon, et al (2013)	Choi, et al (2013)	Gao, Q., et al (2014)
1.Method of randomization adequate?	Yes	Yes	Yes	No, consecutive	Yes	Yes
2.Treatment allocation concealed? Was the knowledge of the allocated interventions adequately prevented during the study?	Yes	Yes	Yes	unclear	Yes	Yes
3.Was the patient blinded to the intervention?	No	No	No	No	No	No
4.Was the care provider blinded to the intervention?	No	No	No	No	No	No
5.Was the outcome assessor blinded to the intervention? Were incomplete outcome data adequately addressed?	Yes	Yes	Yes	unclear	Yes	Yes
6.Was the dropout rate described and acceptable	Yes (0%)	Yes (12%)	Yes (9.8%)	No (25%)	Yes (9.0%)	Yes (10%)
7.Were all randomized participants analyzed in the group to which they were allocated?	Yes	Yes	Yes	No, males not	Yes	Yes
8.Are reports of the study free of suggestion and selective outcome reporting?	Yes	Yes	Yes	No	Yes	Yes
9.Were the groups similar at baseline regarding the most important prognostic indicators?	Yes	Yes	Yes	No	Yes	Yes
10.Were co-interventions avoided or similar?	Yes	Yes	Yes	Yes	unclear	Yes
11.Was the compliance acceptable in all groups?	Yes	Yes		unclear	Yes	Yes
12.Was the timing of the outcome assessment similar in all groups?	Yes	Yes	Yes	unclear	Yes	Yes
Serious Flaw				Yes		
Overall Quality Score	10	10	10	1	9	10



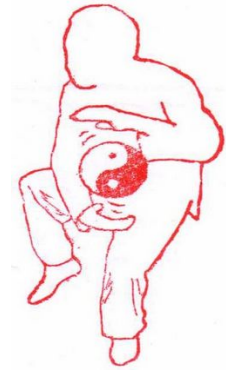


**Of the Remaining 5 RCT Studies, they all have one measured outcome in common: UPDRS Scale part III**

- *Unified Parkinson's Disease Rating Scale (UPDRS)*
  - Comprehensive and Complex Scale (44 items overall)
  - Part III = Motor examination section contains 27 items that are scored by a clinician
  - Each scored on an ordinal scale from 0-4
  - Most widely used scale in clinical research and practice

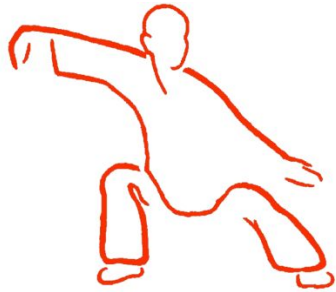


# Mixed Results in the UPDRS Evaluation in 5 RCT Articles



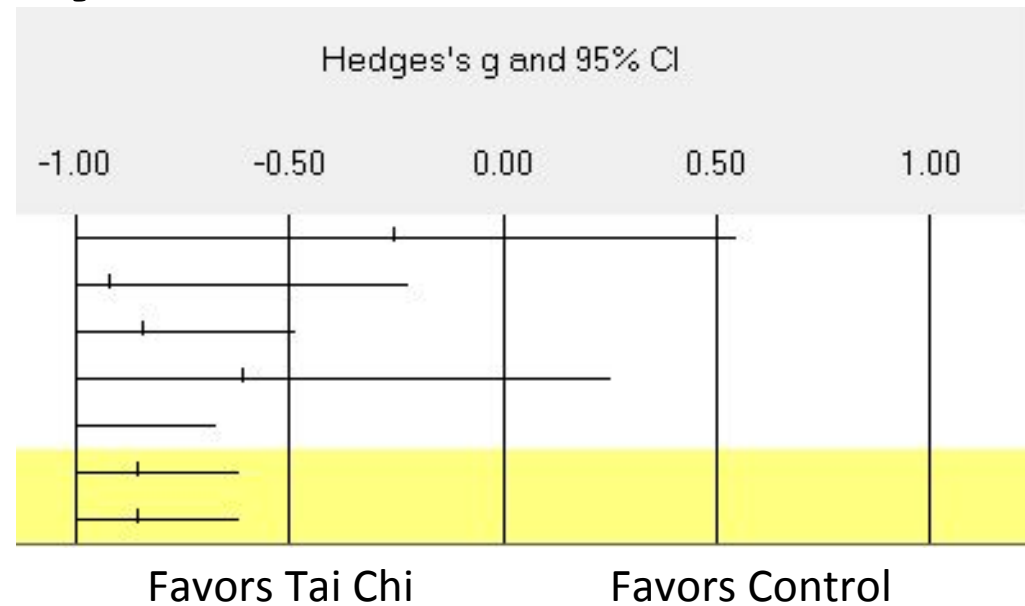
Study Name	UPDRS Evaluation	p Value
Amano, et. al (2013)	No significant improvement	0.48
Hackney, et. al. (2008)	Statistically significant improvement	0.025
Li, et al (2012)	Statistically significant improvement	0.001
Choi, et al (2013)	Improvement but not statistically significant	0.062
Gao, Q., et al (2014)	Improvement but not statistically significant	0.845





# Meta-Analysis of UPDRS Evaluation

- Tai Chi Group members showed statistical improvement in UPDRS scores compared with non-active or stretching control groups



Model	Study name	Statistics for each study						
		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Amano, et.	-0.255	0.409	0.167	-1.056	0.546	-0.624	0.532
	Hackney,	-0.922	0.358	0.128	-1.624	-0.220	-2.574	0.010
	Li, et al	-0.839	0.182	0.033	-1.196	-0.483	-4.613	0.000
	Choi, et al	-0.610	0.441	0.195	-1.475	0.254	-1.383	0.167
	Gao, Q., et	-1.137	0.239	0.057	-1.605	-0.669	-4.757	0.000
Fixed		-0.857	0.123	0.015	-1.097	-0.617	-6.996	0.000
Random		-0.857	0.123	0.015	-1.097	-0.617	-6.996	0.000



# Heterogeneity

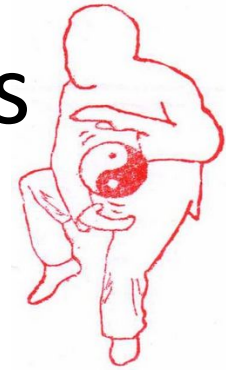


- was very low, suggesting that variability between the studies is due to low sample size, rather than major outcome differences from the studies.

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
3.895	4	0.420	0.000	0.000	0.061	0.004	0.000



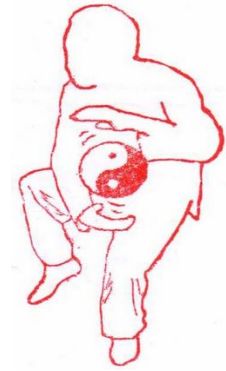
# Many studies showed positive trends but were not statistically significant



- Li, F., et al (2013) was the strongest study supporting the effectiveness of Tai Chi as a modality to improve function in Parkinson's Patients
  - Large study size (195 participants)
  - Longer study time (24 weeks)
  - Made comparisons to resistance training and stretching control groups
  - Conducted follow up studies 3 months and 6 months after the completion of the study.



# Conclusions

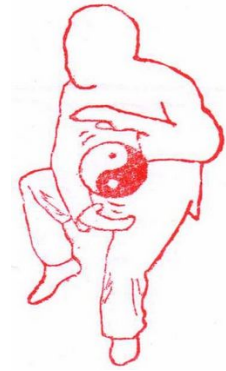


- Tai Chi can be an effective therapy to improve mobility of Parkinson's patients
- Small sample size and short duration studies do not often show statistically significant outcomes





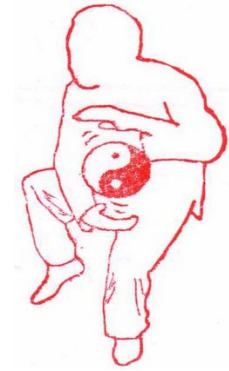
# Future Directions



- For disease treatment, need more studies that
  1. Follow RCT scales (randomization, blinding, etc)
  2. Use measurable outcomes that are consistent with other treatment modalities in the field.
  3. Have larger sample sizes
  4. Evaluate longer treatment duration
- More studies assessing biophysical, biochemical, and epidemiological aspects of long-term practitioners
- Studies evaluating the value of Tai Chi Chuan to younger practitioners (education, learning and memory, obesity, anxiety, depression, etc)



# Thank You to All of my Tai Chi Teachers



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Western Oregon University, Monmouth, OR



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Chen-Style Tai Chi Centre. Manchester, England



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