# Does Tai Chi improve balance and reduce falls incidence in neurological disorders? A systematic review and meta-analysis

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## Abstract

***Objective:*** To evaluate the effect of Tai Chi on balance and reducing falls incidence in neurological disorders.

***Data sources:*** AMED, Embase, Web of Science, SCOPUS, EBSCO, and Medline from inception until February 2018.

***Review method:*** Randomized controlled trials of Tai Chi compared with active or no treatment control, measuring balance with the Berg Balance Scale or the Timed Up and Go test and number of falls in neurological disorders were included. Methodological quality was assessed using PEDro and quality of evidence using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system.

***Results:*** Ten studies involving 720 participants were reviewed. Seven studies were in Parkinson’s disease and three in stroke. Seven studies were of high methodological quality and three were low. Meta-analyses of balance measured with the Timed Up and Go test in Parkinson’s disease revealed a statistically significant effect of Tai Chi compared to no treatment (WMD, -2.13, 95% CI -3.26 to -1.00, p<0.001) and was insignificant (WMD,-0.19, 95%CI -1.74 to 1.35, p=0.81) when compared with active treatment. Tai Chi significantly reduced falls incidence in Parkinson’s disease (OR 0.47, 95%CI 0.29 to 0.77, p = 0.003) and stroke (OR 0.21

95% CI 0.09 to 0.48 p<0.001). Balance measured with the Timed Up and Go test comparing Tai Chi and active treatment was insignificant (WMD 0.45, 95%CI -3.43 to 2.54, p=0.77) in stroke.

***Conclusion:*** Tai Chi is effective in reducing falls incidence in Parkinson’s disease and stroke. This systematic review did not find high-quality studies among other neurological disorders.

**Keywords**: Nervous System Diseases, Tai Ji, Tai Chi, Accidental Falls, Meta-Analysis

## Introduction

Falls are common in many neurological disorders,[1] and one treatment that may improve balance and reduce falls incidence is Tai Chi[2]. Tai Chi translated as "*supreme ultimate*" is a form of Chinese martial art practised for defence and health benefits.[3] Synonymous terminologies for Tai Chi include Tai Chi Chuan, Tai Chi Quan, Taijiquan, and T'ai Chi.[2] Tai Chi has been in practice for over 300 years and has undergone multiple modifications resulting in the emergence of different schools such as, Yang, Chen, Ng, Sun and Yin, however, the underlying principles of Tai Chi remains the same.[2 4] Tai Chi moves are performed in a smooth, relaxed and circular fashion involving multiple joints of the extremities and trunk.[2] In practice, a set of moves are called forms and the forms are named after the number of moves involved.

Tai Chi is thought to improve balance and reduce falls incidence by strengthening muscles of the knee[5] and ankle,[6] promote even weight distribution and improve awareness of the body and movement.[7] Tai Chi may benefit balance and reduce falls incidence in a variety of neurological conditions including, Parkinson's disease,[8 9] stroke,[10] Multiple Sclerosis,[11] traumatic brain injury[12], cerebellar ataxia[13] and spinal cord injury;[14] and reduce falls incidence in Parkinson's disease[8 9] and stroke[10] although the evidence base is poor.

Previous systematic reviews and meta-analyses of Tai Chi for Parkinson's disease,[15-17] Multiple sclerosis[18] and stroke[19] found Tai Chi may benefit balance,[15 17] motor function[15-17] and mobility[20] in Parkinson's disease, improve physical function in Multiple sclerosis[18] and balance in stroke.[19] However, the available reviews are condition-specific and have pooled either all controls or all active treatments together in a meta-analysis. The efficacy of Tai Chi compared to specific controls (no treatment/active) is therefore not known. To our knowledge there are no systematic reviews evaluating the efficacy of Tai Chi for other neurological disorders such as traumatic brain injury, cerebellar ataxia, or spinal cord injury. The recent review by Song et al (2017),[16] is not specific to Tai Chi; they have included another form of Chinese martial art, Qigong. Therefore, this review will include all neurological disorder in addition to Parkinson's disease, Multiple sclerosis and stroke. The aim of this systematic review with meta-analysis was to determine if Tai Chi training improve balance and reduce falls incidence when compared to control conditions of either active treatment or no treatment in people with neurological disorders.

## Methods

The following databases were searched from database inception to 28 February 2018: AMED, Embase, Web of Science, SCOPUS, EBSCO, and Medline. Search terms were constructed with four themes which included, neurological disorders, intervention, outcome measures and study type. Appendix 1 reports our search strategy for each database. Studies were included for this systematic review if they (1) included participants with one of the following neurological disorders: Parkinson's disease, stroke, Multiple Sclerosis, Alzheimer's disease, traumatic brain injury, cerebellar ataxia, cerebral palsy, spinal cord injury and peripheral neuropathy, (2) included participants with neurological disorders without limiting to a specific diagnosis, (3) delivered Tai Chi as an intervention, (4) assessed balance using the Berg Balance Scale or Timed up and go test or both and falls incidence using number of falls, and (5) were randomized controlled trials. Unpublished work (thesis) and Non-English publications were also included for the review. No alternative outcome measures of balance were used in the searches. Studies were excluded if they were: conference abstracts and conducted among elderly with or without neurological disorder.

Duplicates were removed and titles were screened by one reviewer (SW). Abstract and full-text screening was conducted by two reviewers (SW and KK). Discrepancies were resolved by discussion until consensus was reached. If consensus was not reached, a third reviewer (PK) was consulted. Manual searches of the reference list of included studies were conducted. Authors of the included studies were approached to obtain additional information not reported in the publication.

The methodological quality of all included studies was assessed using the Physiotherapy Evidence Database (PEDro) scale.[21] We did not exclude studies based on quality however, quality was considered when interpreting the findings. The methodological quality scores for the included studies were obtained from the PEDro website (https://www.pedro.org.au/) and if the score was not available, two independent reviewers (KK and PK) scored the methodological quality across the 10 items of the PEDro scale. Scores above 6 were interpreted as high quality and scores less than or equal to five were interpreted as low quality.[22]

The quality of evidence for each outcome measure was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system.[23] The GRADE profiler software 3.6.1 (http://tech.cochrane.org/revman/other-resources/gradepro/download) was used for this estimation. The quality of evidence was classified in one of four levels- 'very low', 'low', 'moderate', or 'high';[23] the overall quality of evidence is based on the lowest quality of evidence for the outcome.[24]

***Data analysis***

Two independent reviewers (SW and KK) extracted the following data: (1) author and year of publication (2) population, recruitment setting, country, language and sample size (3) intervention(s), and dosage of intervention (4) time-points of assessment and (5) pre-and-post treatment means. Studies of similar neurological disorder, outcome measures and time-points were grouped together for pooling. We considered usual care control as active treatment control. Post-intervention data was used to obtain the pooled estimate of the difference between groups using Review Manger 5.3 software. For continuous data, size of treatment effect and its 95% CI were estimated. For dichotomous data, the size of the treatment effect as the odds ratio (OR), along with the 95% CI was estimated. To obtain pooled estimates of the difference between groups weighted mean difference (WMD) was calculated. Chi-square test was used to determine heterogeneity. A fixed effects model was used for minimal heterogeneity ($I^2<50\%$) or else a random effects model was used.[25] A $p$-value of $\leq 0.05$ (two-tailed) indicated statistical significance.

**Results**

The electronic searches identified 344 studies of which eight studies met the inclusion criteria. Hand searching of reference lists of included studies yielded two additional studies. We had ten studies included in the systematic review (Figure 1). Appendix 2 reports the number of studies obtained from each database and the reasons for exclusion during screening.

*Insert Figure 1 about here*

The studies were published between 2008 and 2015. Nine studies were published in English[8-10 26-31] and one in Chinese.[32] Nine of the ten included studies were journaled publications and one was a published thesis.[28] The sample sizes of included studies ranged from 20[27 28] to 195.[9] The included studies reported eight comparisons involving 720 participants, with an average of 72 participants per study. Seven studies examined Tai Chi for improving balance or fall incidence or both in people with Parkinson's disease[8 9 27-29 31 32] and three studies in stroke.[10 26 30] Summary of the included studies is reported in Table 1. The mean age range of the included participants with Parkinson's disease was between 60 and 72 and those with stroke were between 53.4 and 69.9 years. Among studies in Parkinson's disease, Yang style 24-form Tai Chi was delivered in three[8 31 32], 6-movement with 8-form Tai Chi in one[9], and Yang style short-form Tai Chi in two studies.[28 29] One study did not report the Tai Chi form used.[27] Among the three stroke studies, one[30] used 10-form Tai Chi, one[10] used Yang style 24-form and one study used the short-form of Sun style Tai Chi.[26] The duration of the intervention ranged between 4 weeks[32] and 24 weeks.[9] Except for two studies,[27 31] all the others reported employing a trained Tai Chi instructor for teaching the Tai Chi moves to participants.

*Insert Table 1 about here*.

The methodological quality of individual studies included in this review is reported in Appendix 3. The mean PEDro score of included studies was 6.1. All included studies reported random allocation and between-group statistical comparisons. Nine of ten studies reported point estimate variability and eight studies reported adequate follow-up. The common methodological flaws identified in the included studies were a failure to conceal allocation (80%) and failure to conduct analysis on an intention-to-treat basis (60%). No included study reported participants or therapist blinding; three studies (30%) reported failure to blind the outcome assessor.

The GRADE evidence profile presented in Appendix 4 provides quality of evidence for the available comparisons using one of the three outcome measures in participants with Parkinson's disease and stroke. The GRADE quality of evidence for the outcome number of falls in Parkinson's disease contributed by four studies[8 9 27 28] was high; this GRADE quality rating concurs with the PEDro quality rating obtained for all four studies. The outcome, number of falls in Parkinson's disease obtained high GRADE quality because the quality of evidence for both comparisons Tai Chi versus active therapies and no treatment was high. Similarly, number of falls in stroke, reported by one high methodological quality study[10] obtained high GRADE quality. As described in the PEDro quality assessment, GRADE evaluation of study limitations found lack of allocation concealment in eight studies (80%), failure to use intention-to-treat analysis in six studies and failure to blind participants and therapist in all included studies. No reporting/publication bias or serious indirectness was identified in any of the included studies. All included studies allowed acceptable *precision* based on the 'optimal information size' calculated for the review. No other limitations such as selective reporting of outcomes, use of non-validated outcome measures, or stopping early for benefit were identified in any of the included studies.

***Tai Chi for Parkinson's disease***

The pooled analysis for the outcome Berg Balance Scale showed a non-significant effect of Tai Chi compared to active therapies (WMD = 4.21, 95% CI -1.98 to 10.39, p = 0.18) (Figure 2a) and Tai Chi compared to no treatment control after 12 weeks of intervention (WMD = 1.55, 95% CI -0.80 to 3.90, p = 0.20) (Figure 2b). While the pooled analysis for the outcome Timed up and go test showed a non-significant effect of Tai Chi compared to active therapies (WMD = -0.19, 95% CI -1.74 to 1.35, p = 0.81) (Figure 3a ) and a significant effect of Tai Chi when compared with no treatment (WMD = -2.13, 95% CI -3.26 to -1.00, p = 0.0002) (Figure 3b). Meta-analysis found a statistically significant effect of Tai Chi compared with active therapies (OR = 0.47, 95% CI 0.29 to 0.77, p = 0.003) (Figure 4a) and Tai Chi compared with no treatment after 12 weeks of intervention (OR 0.29, 95% CI 0.11 to 0.79, p = 0.02) for the outcome number of falls (Figure 4b). Detailed forest plots are reported in Appendix 5.

*Insert Figures 2a,2b,3a,3b,4a and 4b.*

***Tai Chi for stroke***

Tai Chi compared to active therapies on balance assessed with the Timed up and go test was non-significant at 12 weeks (WMD = -0.45, 95% CI -3.43 to 2.54, p = 0.77) (Figure 5a) and 18 weeks (WMD = 1.81, 95% CI -5.39 to 9.02, p = 0.62) (Figure 5b) of training. However, the pooled odds ratio from fixed effects meta-analysis showed a statistically significant effect of Tai Chi compared with active therapies after 12 weeks of intervention for number of falls in stroke (OR = 0.21, 95% CI 0.09 to 0.48, p = 0.0003) (Figure 6). No included study evaluated the effect of intervention on balance with Berg Balance Scale in stroke.

*Insert Figures 5a,5b and 6 about here*

*Insert Table 2 about here*

*Sensitivity analysis*

No sensitivity analyses were conducted because meta-analysis was only performed on two-three studies.

## Discussion

This systematic review provides high quality and high GRADE evidence for the efficacy of Tai Chi for reducing falls incidence in people with Parkinson's disease and stroke. The pooled analysis showed a non-significant effect of Tai Chi for balance measured with Berg Balance Scale in people with Parkinson's disease. Meta-analysis of the no-treatment controlled studies for balance measured with the Timed up and go test was significant in Parkinson's disease, however, non-significant effect of Tai Chi was observed when the control group received active therapies. This does not exclude the possibility that these effects could be a result of placebo. Meta-analysis showed no significant effect of Tai Chi for balance in stroke.

This systematic review has several strengths; a comprehensive and detailed search strategy was used to identify studies of Tai Chi for neurological disorders. This review is the most comprehensive to date as it included common neurological disorders as search terms in the search strategy. We did not restrict studies to the English language, thereby minimizing the possibility of language bias. Most importantly, Tai Chi is a traditional Chinese martial art from ancient China, research in this area is popular and common in China and Hong Kong region. By including studies published in the Chinese language we have enabled inclusion of most of the studies published until February 2018. The other strengths are the rigorous and systematic methodology and use of GRADE for evaluation of the quality of evidence; GRADE is reported to provide the most explicit and transparent judgements of the quality of evidence.[23]

This systematic review did have some limitations: (1) less number of studies were included for meta-analysis and therefore sensitivity analysis could not be done. (2) Quality of studies was not considered as one of the criteria for inclusion. This could have possibly influenced the outcomes of our systematic review. (3) Lastly, we restricted our review to randomised controlled trials. Although systematic reviews of randomissed controlled trials are considered highest level of evidence for investigating the efficacy of interventions, we excluded studies of Tai Chi in people with diseases other than Parkinson's disease and stroke due to study design.

This systematic review is the first to include all neurological conditions with balance problems; previous systematic reviews were condition specific.[15-19] A recent systematic review of Tai Chi for Parkinson's disease by *Zhou et al* (2015) found significant effects of Tai Chi for balance measured with the Timed up and go test.[15] Their results can however not be compared with this systematic review because they pooled all studies of Tai Chi for balance in Parkinson's disease and did not separate no-treatment controlled studies from active treatment controlled studies. Our systematic review found no significant effect of Tai Chi for balance measured with Berg Balance Scale in Parkinson's disease. Our findings are contradictory to the findings of the systematic review by *Yang et al* (2014) [17] on Tai Chi for balance measured with the Berg Balance Scale in Parkinson's disease. Their meta-analysis found significant effects for Tai Chi when compared with no-treatment control which reported that the effects of Tai Chi were superior to no treatment control in improving balance among people with Parkinson's disease. Despite inclusion of the same two no treatment controlled Tai Chi studies for pooling in their review, the discrepancy in findings is due to the method adopted for estimating the group difference in meta-analysis. We calculated weighted mean difference whereas standardized mean difference was calculated in their review.[17] In meta-analysis when the same outcome measure is considered it is more appropriate to use the weighted mean difference in comparison to the standardized mean difference.[33] The method we adopted for meta-analysis is supported by the Cochrane handbook for systematic reviews of interventions.[33]

Our meta-analysis of Tai Chi for balance in Parkinson's disease partly concurs with the results of the recent review by *Song et al* (2017)[16] which report an overall improvement of balance. Nevertheless, it is worth noting the remarkable differences between the two reviews: Firstly, our systematic review restricted the intervention to Tai Chi whereas they included both Tai Chi and Qigong. Secondly, their systematic review considered Berg Balance Scale, posturography or single leg standing for balance assessment whereas we restricted balance assessment to the Berg Balance Scale and Timed up and go test. (3) Lastly, we restricted our review to randomised controlled trials but their review included randomised, non-randomised and quasi experimental designs. Providing evidence for Tai Chi based on high-quality studies using the most commonly used outcome measure of balance (Berg Balance scale and Timed up and go test)[34] adds focus to our finding making it unique.

Tai Chi is postulated to improve balance by progressively challenging the base of support[9] through persistent weight shifts between the lower extremities.[9 26 30] This is also thought to improve efficiency of the ankle and hip strategy while maintaining balance.[9] Secondly, Tai Chi improves proprioceptive inputs from the trunk and lower limb resulting in an improvement in balance[8 27 30]. Among people with stroke, Tai Chi practice reduces visual dependence by improving the interaction between the vestibular and visual inputs.[26] Tai Chi has also demonstrated an improvement in reaction time resulting in a reduction in number of falls in people with stroke.[26] However, there is limited evidence in literature to substantiate this theory. Future research may consider testing the reaction time to improve the understanding of the underlying mechanism for falls prevention in people with Parkinson's disease.

Heterogeneity existed in the style, forms, frequency and duration of Tai Chi in the included studies. Recommendations on Tai Chi parameters requires standardization. Future research is required to provide definitive guidelines regarding Tai Chi parameters recommendations for balance and falls prevention in this population. We recommend a qualitative survey among Tai Chi experts on the parameter recommendations for Tai Chi among neurological disorders.

This systematic review found high methodological quality and high GRADE evidence for the efficacy of Tai Chi for reducing falls incidence in people with Parkinson's disease. The meta-analyses were conducted among two to four studies and therefore these results need to be considered with caution. Data from individual study found that Tai Chi is beneficial for reducing falls incidence in people with stroke. The effect on Tai Chi on balance in Parkinson's disease and stroke is uncertain owing to the limited number of studies included in meta-analysis. At present the evidence is not strong enough to warrant any strong clinical recommendation in the two conditions studied. One or two large well designed clinical trials are needed in Parkinson's disease and stroke. Review found no randomised trials of Tai Chi for other neurological disorders apart from Parkinson’s disease and stroke. Well- designed controlled studies are required to determine whether Tai Chi can improve balance and reduce falls risk in other neurological disorders such as multiple sclerosis, traumatic brain injury, spinal cord injury, and cerebellar ataxia.

**Clinical message:**

- Tai Chi reduces falls incidence in people with Parkinson's disease but the evidence is limited.
- Data from an individual study found Tai Chi is beneficial for reducing falls incidence in people with stroke.
- There is insufficient evidence at present to conclude if Tai Chi does or does not improve balance in people with Parkinson's disease and stroke.

**Competing interests**: None

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Table 1: Summary of the included studies (n=10)

| Study | Participants | Intervention | Outcome measures[a] | PEDro quality (score) |
|---|---|---|---|---|
| Au-Yeung[26]<br>English<br>Hong Kong | Chronic Stroke<br>n = 136<br>Age (yr)= 63.4 (SD 10.7)<br>Gender= 79 M, 57 F | Exp = Sun style Tai Chi (Short form) (60 min, 1/wk × 12 wk)<br>Con = Breathing and active mobilization exercises plus 1 educational talk (60 min, 1/wk × 12 wk) | TUG<br>Follow up= 0,6,12 and 18 wk | High (6) |
| Choi[27]<br>English Republic of Korea | PD<br>n=20<br>Age (yr)= n/s<br>Gender= n/s | Exp= Tai Chi. Clinic practice (60 min, 1/wk × 12 wk). Self-practice (60 min, 1/wk × 12 wk)<br>Con = No treatment | TUG<br>Follow up= 0 and 12 wk | High (6) |
| Gao [8]<br>English<br>Hong Kong and China | PD<br>n=76<br>Age (yr)= n/s<br>Gender= 50 M, 26 F | Exp = 24-form of Yang style Tai Chi (60 min, 3/wk × 12 wk)<br>Con= No treatment | BBS<br>TUG<br>Number of falls<br>Follow up= 0,12 and 24 wk | High (6) |
| Gladfelter [28]<br>English<br>USA | PD<br>n= 17<br>Age (yr)= 72.0 (SD 8.5)<br>Gender= 12 M, 5 F | Exp= Yang style short form of Tai Chi (60 min, 2/wk × 12 wk)<br>Con= No treatment | BBS<br>TUG<br>Number of falls<br>Follow up= 0 and 12 wk | High (6) |

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|---|---|---|---|---|
| Hackney [29]<br>English<br>USA | PD<br>n = 26<br>Age (yr)= 63.76 (SD 9.91)<br>Gender= 21 M, 5 F | Exp= Yang Short Style form of tai Chi (60 min, 2/wk × 13 wk)<br>Con= No treatment | BBS<br>TUG<br>Follow up= 0 and 13 wk | Low (5) |
| Kim [30]<br>English<br>Korea | Chronic Stroke<br>n=22<br>Age (yr)= n/s<br>Gender= 13 M, 9 F | Exp= General Physical therapy (30 min, 2/wk × 6wk) and Tai Chi exercise (60 min, 2/wk × 6 wk)<br>Con= General Physical therapy (30 min, 2/wk × 6wk) | TUG<br>Follow up= 0 and 6 wk | Low (5) |
| Li [9]<br>English<br>USA | PD<br>n=195<br>Age (yr)= n/s<br>Gender= 122 M, 73 F | Exp= Tai Chi, six movements with eight-form routine (60 min, 2/wk × 24 wk)<br>Con 1= Resistance training (60 min, 2/wk × 24 wk)<br>Con 2= Stretching (60 min, 2/wk × 24 wk) | TUG<br>Number of falls<br>Follow up= 0.12,24 and 36 wk | High (7) |
| Taylor-Piliae [10]<br>English<br>USA | Stroke<br>n=145<br>Age (yr)= 69.9 (SD 10.0)<br>Gender= 77 M, 68 F | Exp= Yang style 24-form of Tai Chi (60 mins, 3/wk × 12wk)<br>Con 1= Group-based aerobic exercises (60 mins, 3/wk × 12wk)<br>Con 2= Usual care | Number of falls<br>Follow up= 0 and 12 wk | High (8) |
| Zhang [31]<br>English<br>China | PD<br>n=40 | Yang style 24-posture short-form Tai Chi (60 min, 2/wk × 12 wk) | BBS<br>TUG<br>Follow up= 0 and 12 wk | High (7) |

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|---|---|---|---|---|
| | Age (yr)= n/s<br>Gender= 24 M, 16 F | Multimodal exercise training (60 min, 2/wk × 12 wk) | | |
| Zhu [32]<br>Chinese<br>Taipei, Taiwan and China | PD<br>n=40<br>Age (yr)= n/s<br>Gender= 23 M, 17 F | Tai Chi Quan (Yang style - 24 form) (30-45 min, 2/day, 5/wk × 4 wk)<br>Walking practice (30-45 min, 2/day, 5/wk × 4 wk) | BBS<br>Follow up= 0 and 4 wk | Low (5) |

M- male, F- female, [a]- Outcome measures considered for GRADE and meta-analysis, PD- Parkinson's disease, n/s- not stated, wk-week, SD- standard deviation, Exp- experimental group, Con- control group, min- minute, wk- week, BBS- Berg Balance Scale, TUG- Timed up and go test, USA- United States of America

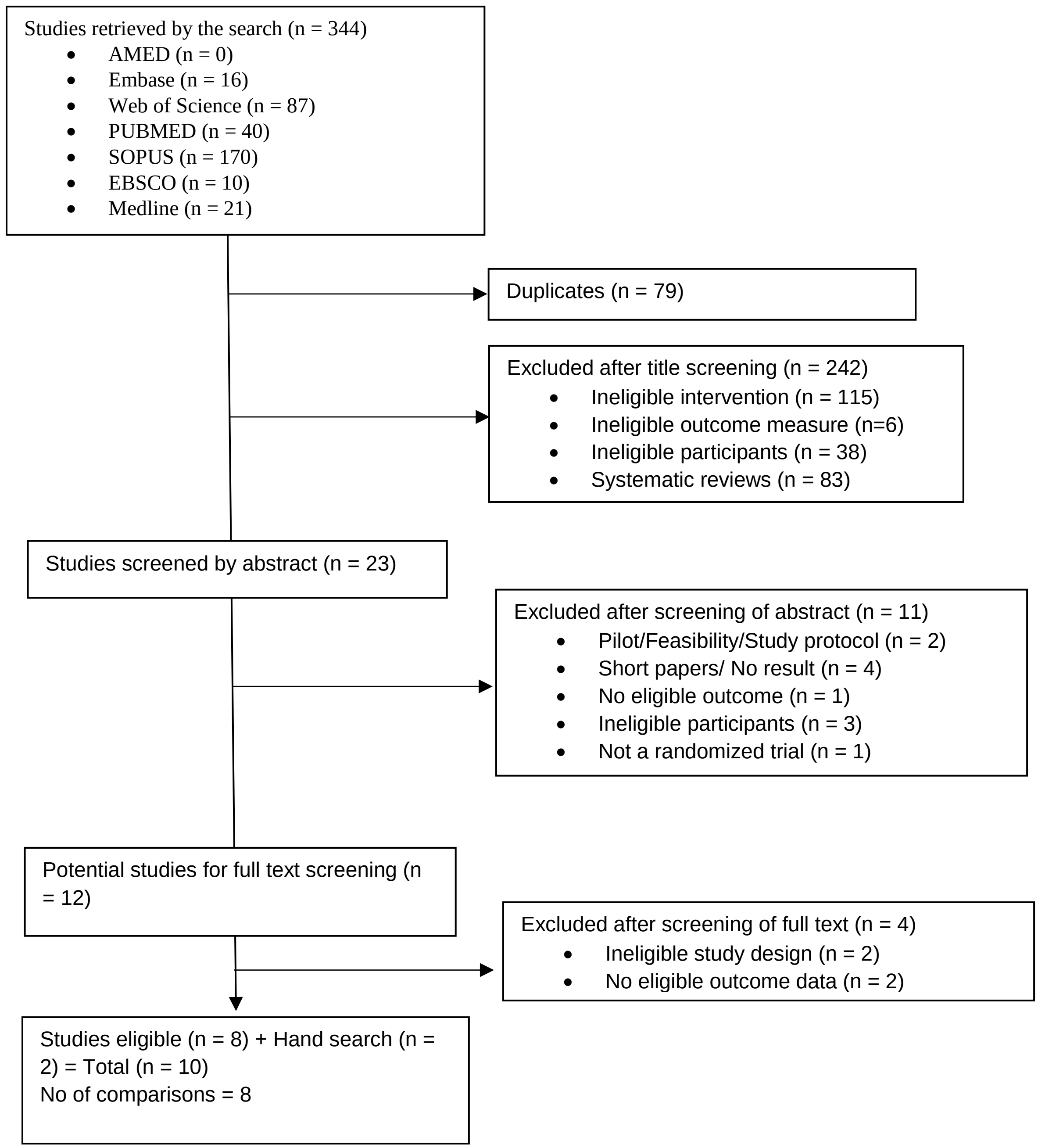
**Table 2:** The effects of Tai Chi compared to active control or no treatment control at 12 weeks' post-intervention

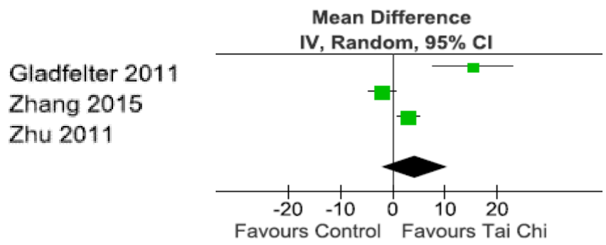
| Intervention vs. Control (Reference) | WMD | 95% CI | p |
|---|---|---|---|
| **Parkinson's disease** | | | |
| **BBS** | | | |
| Tai Chi versus active therapies (Gladfelter,[28] Zhang,[31] Zhu,[32]) | 4.21 | -1.98 to 10.39 | 0.18 |
| Tai Chi versus no treatment (Gao,[8] Hackney[29]) | 1.55 | -0.80 to 3.90, | 0.20 |
| **TUG** | | | |
| Tai Chi versus active therapies (Gladfelter,[28] Zhang,[31] Li [9]) | -0.19 | -1.74 to 1.35 | 0.81 |
| Tai Chi versus no treatment (Choi,[27] Gao[8]) | -2.13 | -3.26 to -1.00 | 0.0002***** |
| **Number of falls** | | | |
| Tai Chi versus active therapies (Gladfelter,[28] Li[9]) | 0.47 (OR) | 0.29 to 0.77 | 0.003***** |
| Tai Chi versus no treatment (Gao[8]) | 0.29 (OR) | 0.11 to 0.79 | 0.02***** |
| **Stroke** | | | |
| **TUG** | | | |
| Tai Chi versus active therapies (Au-Yeung[26], Kim[30]) | 0.45 | -3.43 to 2.54 | 0.77 |
| **Number of falls** | | | |

| | | | |
|---|---|---|---|
| Tai Chi versus active therapies (Taylor-Piliae[10]) | 0.21 (OR) | 0.09 to 0.48 | 0.0003* |

Abbreviations and symbols: BBS: Berg Balance Scale; OR: Odds Ratio; TUG: Timed Up-and-Go Test; WMD: Weighted Mean Difference; *statistical significance ($p \leq 0.05$)

Figure 1: Screening of studies for inclusion





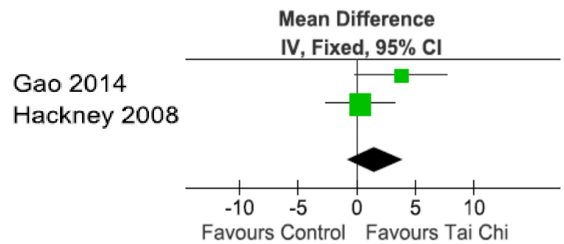




Fig 2a: Effect of Tai Chi compared with active therapies on balance measured with Timed up and go test in Parkinson's disease after 12 weeks

Fig 2b: Effect of Tai Chi compared with no treatment for balance measured with Berg Balance Scale in Parkinson's disease

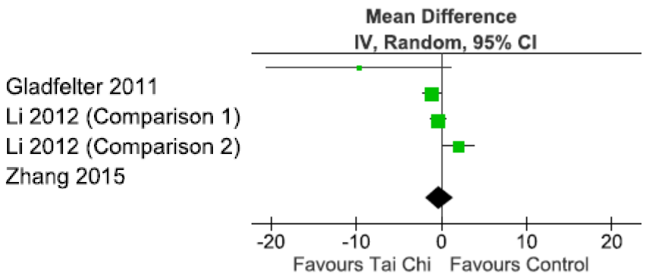



Fig 3a: Effect of Tai Chi compared with active therapies for balance measured with Tined up and go test in Parkinson's disease

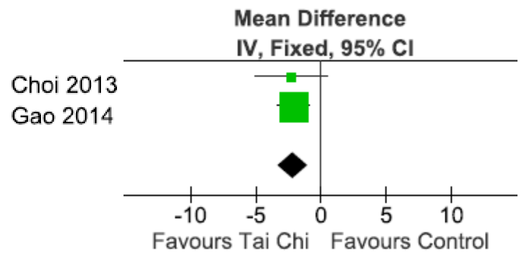



Fig 3b: Effect of Tai Chi compared with no treatment for balance measured with Timed up and go test in Parkinson's disease

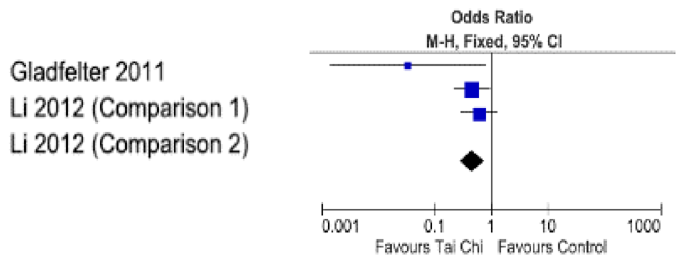




Fig 4a: Effect of Tai Chi compared with active therapies on rate of falls in Parkinson's disease

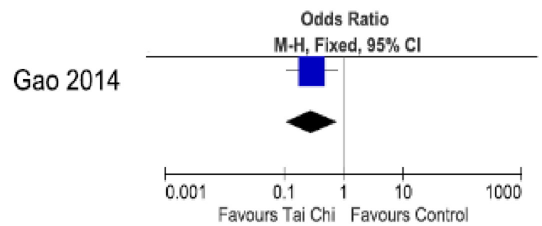
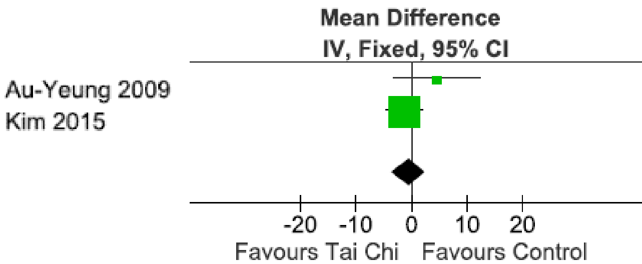




Fig 4b: Effect of Tai Chi compared with no treatment on rate of falls in Parkinson's disease



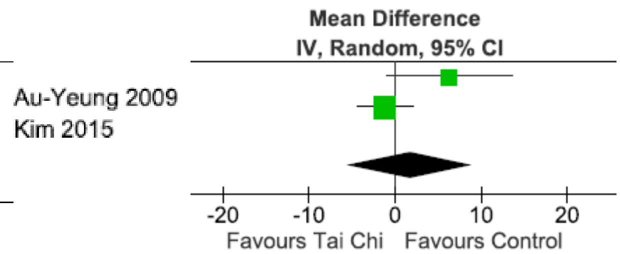




Fig 5a: Effect of Tai Chi compared with active therapies on balance measured with Timed up and go test in stroke after 12 weeks

Fig 5b: Effect of Tai Chi compared with no treatment on balance measured with Timed up and go test in stroke after 18 weeks

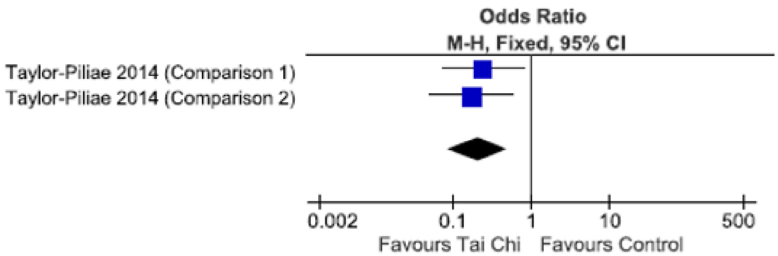



Fig 6: Effect of Tai Chi compared with active therapies on balance measured with number of falls in stroke after 12 weeks

## Appendix 1

### Search terms for databases

Database: Medline.

1. 'Neurological disorders'.mp.
2. 'Parkinson's disease'.mp.
3. 'Alzheimer's disease'.mp.
4. 'Traumatic Brain Injury'.mp.
5. Stroke.mp.
6. 'Cerebellar ataxia'.mp.
7. 'Spinal Cord Injury'.mp.
8. 'Multiple Sclerosis'.mp.
9. 'Cerebral Palsy'.mp.
10. 'Peripheral neuropathy'.mp.
11. 'Tai Chi'.mp.
12. 'Tai Chi Chuan'.mp.
13. 'Taiji quan'.mp.
14. Balance.mp.
15. Gait.mp.
16. Posture.mp.
17. Falls.mp.
18. 'Berg Balance Scale'.mp.
19. BBS.mp.
20. ('Timed Up and Go test').mp.
21. TUG.mp.
22. 'Falls rates'.mp.
23. RCT.mp.
24. 'randomize controlled clinical trials'.mp.
25. 'randomized control trials'.mp.
26. 'Randomized Controlled Trial'.mp.
27. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
28. 11 or 12 or 13
29. 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
30. 23 or 24 or 25 or 26
31. 27 and 28 and 29 and 30

Database: AMED

1. 'Neurological disorders'.mp.
2. 'Parkinson's disease'.mp.
3. 'Alzheimer's disease'.mp.
4. 'Traumatic Brain Injury'.mp.
5. Stroke.mp.
6. 'Cerebellar ataxia'.mp.
7. 'Spinal Cord Injury'.mp.

8. 'Multiple Sclerosis'.mp.
9. 'Cerebral Palsy'.mp.
10. 'Peripheral neuropathy'.mp.
11. 'Tai Chi'.mp.
12. 'Tai Chi Chuan'.mp.
13. 'Taiji quan'.mp.
14. Balance.mp.
15. Gait.mp.
16. Posture.mp.
17. Falls.mp.
18. 'Berg Balance Scale'.mp.
19. BBS.mp.
20. ('Timed Up and Go test').mp.
21. TUG.mp.
22. 'Falls rates'.mp.
23. RCT.mp.
24. 'randomize controlled clinical trials'.mp.
25. 'randomized control trials'.mp.
26. 'Randomized Controlled Trial'.mp.
27. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
28. 11 or 12 or 13
29. 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
30. 23 or 24 or 25 or 26
31. 27 and 28 and 29 and 30

Database: CINAHL_EBSCOhost

1. S31) S27 AND S28 AND S29 AND S30
2. S30) S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10
3. S29) S11 OR S12 OR S13
4. S28) S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22
5. S27) S23 OR S24 OR S25 OR S26
6. S26) 'Randomized Control trials'
7. S25) 'Randomized Controlled trials'
8. S24) 'Randomize Controlled Clinical trials'
9. S23) 'RCT'
10. S22) 'Falls rates'
11. S21) 'Falls'
12. S20) 'TUG'
13. S19) 'Timed Up and Go test'
14. S18) 'Posture'
15. S17) 'Gait'
16. S16) 'BBS'
17. S15) 'Berg Balance Scale'
18. S14) 'Balance'
19. S13) 'Taiji quan'
20. S12) 'Tai Chi Chuan'

21. S11) 'Tai Chi'
22. S10) 'Peripheral Neuropathy'
23. S9) 'Cerebral Palsy'
24. S8) 'Multiple sclerosis'
25. S7) 'Spinal cord Injury'
26. S6) 'cerebellar ataxia'
27. S5) 'Stroke'
28. S4) 'Traumatic Brain Injury'
29. S3) 'Alzheimer's disease'
30. S2) 'Parkinson's disease'
31. S1) 'Neurological Disorders'

Database: Embase

1. #1 'neurological disorders'
2. #2 'parkinsons disease'
3. #3 'alzheimer disease'
4. #4 'traumatic brain injury'
5. #5 'stroke'
6. #6 'cerebellar ataxia'
7. #7 'spinal cord injury'
8. #8 'multiple sclerosis'
9. #9 'cerebral palsy'
10. #10 'peripheral neuropathy'
11. #11 'tai chi'
12. #12 'tai chi chuan'
13. #13 'taiji quan'
14. #14 'Balance'
15. #15 'gait'
16. #16 posture
17. #17 falls
18. #18 'berg balance scale'
19. #19 bbs
20. #20 'timed up and go test'
21. #21 tug
22. #22 'falls rates'
23. #23 'rct'
24. #24 'randomize controlled clinical trials'
25. #25 'randomized control trials'
26. #26 'randomized controlled trial'
27. #23 OR #24 OR #25 OR #26
28. #14 OR #15 OR #16 OR #17 OR #18 OR #1
29. #11 OR #12 OR #13
30. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7
31. #27 AND #28 AND #29 AND #30

Database: PubMed

1. #1 Neurological disorders
2. #2 Parkinson's disease
3. #3 Alzheimer's disease
4. #4 Traumatic Brain Injury
5. #5 Stroke
6. #6 ‘cerebellar ataxia’
7. #7 'spinal cord injury'
8. #8 'Multiple sclerosis'
9. #9 'Cerebral Palsy'
10. #10 'peripheral neuropathy'
11. #11 'Tai Chi'
12. #12 'Tai Chi Chuan' Schema: syn
13. #13 'Taiji quan'
14. #14 balance
15. #15 gait
16. #16 posture
17. #17 falls
18. #18 'Berg balance scale'
19. #19 BBS
20. #20 Timed up and go test
21. #21 TUG
22. #22 falls rates
23. #23 RCT
24. #24 randomize controlled clinical trials
25. #25 randomized control trials
26. #26 Randomized Controlled Trial
27. #27 ((Neurological disorders) OR Parkinson's disease) OR Alzheimer's disease) OR Traumatic Brain Injury) OR Stroke) OR cerebellar ataxia) OR spinal cord injury) OR multiple sclerosis) OR cerebral palsy) OR peripheral neuropathy
28. #28 (('Tai Chi') OR taiji quan) OR #20
29. #29 ((balance) OR gait) OR posture) OR falls) OR Berg balance scale) OR BBS) OR (Timed up and go test)) OR TUG) OR falls rates
30. #30(RCT) OR randomize controlled clinical trials) OR randomized control trials) OR Randomize d Controlled Trial
31. #31 ((Neurological disorders) OR Parkinson's disease) OR Alzheimer's disease) OR Traumatic Brain Injury) OR Stroke) OR cerebellar ataxia) OR spinal cord injury) OR multiple scl erosis)OR cerebral palsy) OR peripheral neuropathy)) AND (((tai chi) OR #20) OR taiji quan)) A ND((((((((balance) OR gait) OR posture) OR falls) OR Berg balance scale) OR BBS) OR (Time d up and go test)) OR TUG) OR falls rates)) AND (((RCT) OR randomize controlled clinical trials) OR randomized control trials) OR Randomized Controlled Trial)

Database: Scopus

1. 'Neurological Disorders'
2. 'Parkinson's disease'

3. 'Alzheimer's disease'
4. 'Traumatic Brain Injury'
5. 'Stroke'
6. 'Cerebellar ataxia'
7. 'Spinal Cord Injury'
8. 'Multiple Sclerosis'
9. 'Cerebral Palsy'
10. 'Peripheral neuropathy'
11. 'Tai Chi'
12. 'Tai Chi Chuan'
13. 'Taiji quan'
14. 'RCT'
15. 'Randomize Controlled Clinical Trials'
16. 'Randomized Controlled Trials'
17. 'Randomized Control Trials'
18. 'Berg Balance Scale'
19. 'BBS'
20. 'Timed Up and Go test'
21. 'TUG'
22. 'Falls'
23. 'Falls rates'
24. 'Balance'
25. 'Gait'
26. 'Posture'
27. "neurological disorders" OR "Parkinson's disease" OR "Alzheimer's disease" OR "Traumatic Brain Injury" OR "Stroke" OR "Cerebellar Ataxia" OR "Spinal Cord Injury" OR "Multiple Sclerosis" OR "Cerebral Palsy" OR "Peripheral Neuropathy"
28. "Tai Chi" OR "Taiji quan" OR "Tai Chi Chuan"
29. "Berg Balance Scale" OR "BBS" OR "Timed Up and Go test" OR "TUG" OR "Falls" OR "Falls rates" OR "Balance" OR "Gait" OR "Posture"
30. "RCT" OR "Randomize Controlled Clinical Trials" OR "Randomized Control Trails" OR "Rando mized Controlled Trail"
31. "neurological disorders" OR "Parkinson's disease" OR "Alzheimer's disease" OR "Traumatic Brain Injury" OR "Stroke" OR "Cerebellar Ataxia" OR "Spinal Cord Injury" OR "Multiple Sclerosis" OR "Cerebral Palsy" OR
    "Peripheral Neuropathy" AND "Tai Chi" OR "Taiji quan" OR
    "Tai Chi Chuan" AND "RCT" OR "Randomize Controlled Clinical Trials" OR "Randomized Control Trails" OR "Randomized Controlled Trail" AND "Berg Balance Scale" OR "BBS" OR "Timed Up and Go test" OR "TUG" OR "Falls" OR "Falls rates" OR "Balance" OR "Gait" OR "Posture"

Database: Web of Science

1. TS = Neurological disorders
2. TS = Parkinson's Disease
3. TS = Alzheimer’s disease
4. TS = Traumatic brain injury

5. TS = Stroke
6. TS = Cerebellar ataxia
7. TS = Spinal Cord Injury
8. TS = Multiple sclerosis
9. TS = Cerebral Palsy
10. TS = Peripheral Neuropathy
11. TS = Tai Chi
12. TS = Tai Chi Chuan
13. TS = Taiji quan
14. TS = Balance
15. TS = Posture
16. TS = Gait
17. TS = Falls
18. TS = Berg Balance Scale
19. TS = BBS
20. TS = TUG
21. TS = Timed Up & Go test
22. TS = Falls rates
23. TS = RCT
24. TS = randomize controlled clinical trials
25. TS = randomized control trials
26. TS = Randomized Controlled Trial
27. #26 OR #25 OR #24 OR #23
28. #22 OR #21 OR #20 OR #19 OR #18 OR #17 OR #16 OR #15 OR #14
29. #13 OR #12 OR #11
30. #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1
31. #30 AND #29 AND #28 AND #27

## Appendix 2:

| Database | Total studies | Duplicates removed | Removed after title screening | Removed after abstract screening | Removed after full-text screening | Included |
|---|---|---|---|---|---|---|
| AMED | 0 | 0 | 0 | 0 | 0 | 0 |
| Embase | 16 | 3 | 7 | 1 | 1 | 4 |
| Web of Science | 87 | 20 | 61 | 4 | 1 | 1 |
| PUBMED | 40 | 9 | 30 | 1 | 0 | 0 |
| SCOPUS | 170 | 39 | 130 | 1 | 0 | 0 |
| EBSCO | 10 | 1 | 5 | 2 | 1 | 1 |
| Medline | 21 | 7 | 9 | 2 | 1 | 2 |
| Total | 344 | 79 | 242 | 11 | 4 | 8 |

Articles were excluded after abstract screening (n = 22).

| | **Reasons for exclusion** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Studies** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **Excluded articles** | | | | | | | | |
| Amona, et al. (2013) | | | | ✓ | | | | |
| Azimzadeh, et al. (2015) | ✓ | | | | | | | |
| Blake, et al. (2009) | | ✓ | | | | | | |
| Hart, et al. (2004) | | | | | | | ✓ | |
| Li, et al. (2015) | | | | | | | ✓ | |
| Li, et al. (2014) | | | | ✓ | | | | |
| Scianni, (2015) | | | | | ✓ | | | |
| Solloway, et al. (2016) | | | | | | | ✓ | |
| Tao, et al. (2015) | | | | | | | ✓ | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Taylor – Pilliae, et al. (2007) | | | | | | | | ✓ |
| Tousignant, et al. (2013) | | | ✓ | | | | | |
| Tousignant, et al. (2012) | | | ✓ | | | | | |
| Tsang, et al. (2013) | | | | | ✓ | | | |
| Yang, et al. (2015) | | | | | | | | ✓ |
| **Included studies** | | | | | | | | |
| Au-Yeung, et al. (2009) | | | | | | | | |
| Choi, et al. (2013) | | | | | | | | |
| Gao, et al. (2014) | | | | | | | | |
| Gladfelter. (2013) | | | | | | | | |
| Hackney, et al. (2008) | | | | | | | | |
| Kim, et al. (2015) | | | | | | | | |
| Li, et al. (2012) | | | | | | | | |
| Taylor – Piliae, et al. (2014) | | | | | | | | |
| Zhang, et al. (2015) | | | | | | | | |
| Zhu-Yi, et al. (2011) | | | | | | | | |

(some studies had more than one reason for exclusion)

1 = Research design was not RCT.

2= Participants were tested among other than neurological disorders.

3= Tai Chi was not tested among the experimental group.

4= Outcome measure was other than BBS or TUG or falls rate.

5 = Not enough information, e.g. conference abstract, short papers/ No result.

6= Duplicate study or duplicate participants in previous study.

7 = Pilot/Feasibility/Study protocol/ review paper.

8 = Effect of Tai chi could not be distinguished.

References for appendix 2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Kim, H., Kim, Y. L., & Lee, S. M. Effects of therapeutic Tai Chi on balance, gait, and quality of life in chronic stroke patients. *International Journal of Rehabilitation Research, 38*(2), 156-161.

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Li, F., Harmer, P., Fitzgerald, K., Eckstrom, E., Stock, R., Galver, J., . . . Batya, S. S. Tai chi and postural stability in patients with Parkinson's disease. *New England Journal of Medicine, 366*(6), 511-519.

Li, F., Harmer, P., Liu, Y., Eckstrom, E., Fitzgerald, K., Stock, R., & Chou, L.-S. (2014). A randomized controlled trial of patient-reported outcomes with tai chi exercise in Parkinson's disease. *Movement Disorders, 29*(4), 539-545. doi:10.1002/mds.25787

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**Appendix 3:**

Methodological quality of the included studies using PEDro

| Study | Random allocation | Concealed allocation | Groups similar at baseline | Participant blinding | Therapist blinding | Assessor blinding | < 15% dropouts | Intention-to-treat analysis | Between-group difference reported | Point estimate and variability reported | Total (0 to 10) | RCT quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Au-Yeung[26] | Y | N | Y | N | N | Y | N | Y | Y | Y | 6 | High |
| Choi[27] | Y | N | Y | N | N | Y | Y | N | Y | Y | 6 | High |
| Gao[8] | Y | N | Y | N | N | Y | Y | N | Y | Y | 6 | High |
| Gladfelter[28] | Y | N | Y | N | N | Y | Y | N | Y | Y | 6 | High |
| Hackney[29] | Y | N | Y | N | N | Y | N | N | Y | Y | 5 | Low |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kim[30] | Y | N | Y | N | N | N | Y | N | Y | Y | 5 | Low |
| Li [9] | Y | N | Y | N | N | Y | Y | Y | Y | Y | 7 | High |
| Taylor-Piliae[10] | Y | Y | Y | Y | N | N | Y | Y | Y | Y | 8 | High |
| Zhang[31] | Y | Y | Y | N | N | N | Y | Y | Y | Y | 7 | High |
| Zhu[32] | Y | N | Y | N | N | Y | Y | N | Y | N | 5 | Low |

Y-Yes, N- No

## Appendix 4

GRADE evidence profile and summary of findings table

| Quality assessment | | | | | | No. of participants | | Effect | | GRADE quality |
|---|---|---|---|---|---|---|---|---|---|---|
| No of studies Author | Risk of bias | Inconsistency | Indirectness | Imprecision | Publication bias | Tai Chi | Active therapies | Relative (95% CI) | Absolute (95% CI) | |
| | | | | | **Parkinson's disease** | | | | | |
| | | | | | **BBS** | | | | | |
| Tai Chi versus active therapies (better indicated by higher values) | | | | | | | | | | |
| (n=3) Gladfelter[28] Zhang[31] Zhu[32] | Serious[a] | Serious[b] | No serious indirectness | No serious imprecision | none | 48 | 47 | - | MD 4.21 (1.98 to 10.39) | Low |
| Tai Chi versus no treatment (better indicated by higher values) | | | | | | | | | | |
| (n=2) Gao[8] Hackney[29] | Serious[c] | No serious inconsistency | No serious indirectness | No serious imprecision | none | 50 | 52 | - | MD 1.79 (1.6 to 5.19) | Moderate |
| | | | | | **TUG** | | | | | |
| Tai Chi versus active therapies (better indicated by lower values) | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (n=4) Gladfelter[28] Li[9] (2 comparison) Zhang[31] | Serious[d] | Serious[e] | No serious indirectness | No serious imprecision[c] | none | 159 | 158 | - | MD 0.19 (1.74 to 1.35) | Low |
| Tai Chi versus no treatment (better indicated by lower values) | | | | | | | | | | |
| (n=2) Choi[27] Gao[8] | No serious[f] risk of bias | no serious inconsistency | no serious indirectness | no serious imprecision | none | 48 | 48 | - | MD 2.13 (3.26 to 1) | High |
| **Falls** | | | | | | | | | | |
| Tai Chi versus active therapies | | | | | | | | | | |
| (n=3) Gladfelter[28] Li[9] (2 comparison) | No serious[g] | No serious inconsistency | No serious indirectness | No serious imprecision | None | 38/139 (27.3%) | 62/138 (44.9%) | OR 0.47 (0.29 to 0.77) | 172 fewer per 1000 (63 to 258) | High |
| Tai Chi versus no treatment | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (n=1) Gao[8] | No serious | No serious inconsistency[h] | No serious indirectness | No serious imprecision | None | 8/37 (21.6%) | 19/39 (48.7%) | OR 0.29 (0.11 to 0.79) | 271 fewer per 1000 (58 to 393) | High |
| | | | | | **Stroke** | | | | | |
| | | | | | **TUG** | | | | | |
| Tai Chi versus active therapies (better indicated by lower values) | | | | | | | | | | |
| (n=2) Au-Yeung[26] Kim[30] | Serious[i] | No serious inconsistency | No serious indirectness | No serious imprecision | None | 66 | 70 | - | MD 0.45 (3.43 to 2.54) | Moderate |
| | | | | | **Falls** | | | | | |
| Tai Chi versus active therapies | | | | | | | | | | |
| (n=1) Taylor-Piliae[10] (2 comparisons) | No serious risk of bias | No serious inconsistency[h] | No serious indirectness | No serious imprecision | None | 10/60 (16.7%) | 29/59 (49.2%) | OR 0.21 (0.09 to 0.48) | 323 fewer per 1000 (175 to 411) | High |

Abbreviations: n: Number of studies; BBS: Berg Balance Scale; CI: Confidence Interval; MD: Mean Difference; OR: Odds Ratio; TUG: Timed up-and-go

[a] Lack of blinding of assessor (Zhang 2015) and no intention-to-treat analysis (Gladfelter 2011 and Zhu 2011)

[b] Point estimates widely varies across studies, wide confidence intervals and high heterogeneity denoted by low *P* value and large $I^2$

[c] No intention-to-treat analysis (Gao 2014 and Hackney 2008) and inadequate follow-up (Hackney 2008)

[d] Lack of blinding of assessor (Zhang 2015); no intention-to-treat analysis (Gladfelter 2011)

[e] Point estimates widely varies across studies and high heterogeneity denoted by low *P* value and large $I^2$

[f] No intention-to-treat analysis (Choi 2013 and Gladfelter 2011) but not downgraded because of adequate follow-up in both studies

[g] No intention-to-treat analysis but not downgraded because of adequate follow-up (Gladfelter 2011)

[h] Not applicable: single study

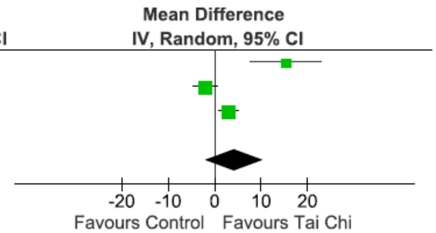
[i] Lack of blinding of assessor (Kim 2015) and lack of intention-treat-analysis (Kim 2015) and inadequate follow-up (Au-Yeung 2009). However, quality was rated down only by one level because the study that failed to conduct intention-to-treat analysis had adequate follow-up (Kim 2015) and the study with inadequate follow-up performed analysis on an intention-to-treat basis (Au-Yeung 2009)

## **Appendix 5:**

Effect of Tai Chi compared with active therapies for balance measured with BBS in Parkinson's disease

| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Gladfelter 2011 | 54 | 2.3 | 9 | 38.6 | 10.8 | 8 | 24.8% | 15.40 [7.77, 23.03] |
| Zhang 2015 | 50.9 | 5.2 | 20 | 52.9 | 2.5 | 20 | 37.3% | -2.00 [-4.53, 0.53] |
| Zhu 2011 | 48.1 | 3.3 | 19 | 45.1 | 3.4 | 19 | 38.0% | 3.00 [0.87, 5.13] |
| **Total (95% CI)** | | | **48** | | | **47** | **100.0%** | **4.21 [-1.98, 10.39]** |

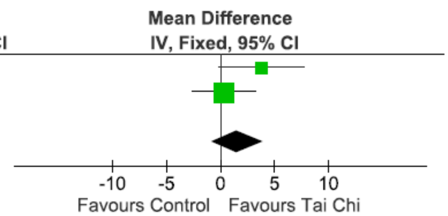
Heterogeneity: Tau² = 25.05; Chi² = 22.00, df = 2 (P < 0.0001); I² = 91%
Test for overall effect: Z = 1.33 (P = 0.18)




Effect of Tai Chi compared with no treatment for balance measured with BBS in Parkinson's disease

| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Gao 2014 | 50.2 | 8.3 | 37 | 46.4 | 9.2 | 39 | 35.7% | 3.80 [-0.14, 7.74] |
| Hackney 2008 | 51.4 | 3.5 | 13 | 51.1 | 4.1 | 13 | 64.3% | 0.30 [-2.63, 3.23] |
| **Total (95% CI)** | | | **50** | | | **52** | **100.0%** | **1.55 [-0.80, 3.90]** |

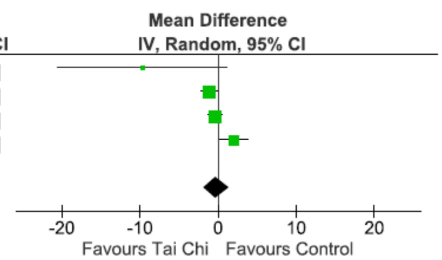
Heterogeneity: Chi² = 1.95, df = 1 (P = 0.16); I² = 49%
Test for overall effect: Z = 1.29 (P = 0.20)




Effect of Tai Chi compared with active therapies for balance measured with TUG in Parkinson's disease

| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Gladfelter 2011 | 8.5 | 1.9 | 9 | 18.2 | 15.5 | 8 | 1.9% | -9.70 [-20.51, 1.11] |
| Li 2012 (Comparison 1) | 7.6 | 2.7 | 65 | 8.7 | 3.5 | 65 | 35.0% | -1.10 [-2.17, -0.03] |
| Li 2012 (Comparison 2) | 7.6 | 2.7 | 65 | 8 | 2.6 | 65 | 36.7% | -0.40 [-1.31, 0.51] |
| Zhang 2015 | 11.7 | 3.7 | 20 | 9.7 | 2 | 20 | 26.3% | 2.00 [0.16, 3.84] |
| **Total (95% CI)** | | | **159** | | | **158** | **100.0%** | **-0.19 [-1.74, 1.35]** |

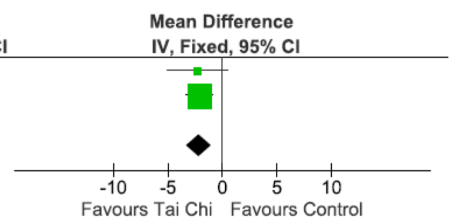
Heterogeneity: Tau² = 1.47; Chi² = 10.98, df = 3 (P = 0.01); I² = 73%
Test for overall effect: Z = 0.25 (P = 0.81)




Effect of Tai Chi compared with no treatment for balance measured with TUG in Parkinson's disease

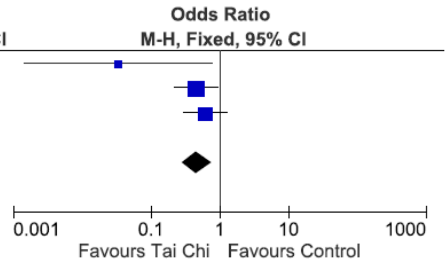
| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Choi 2013 | 7 | 0.9 | 11 | 9.3 | 4.2 | 9 | 16.4% | -2.30 [-5.10, 0.50] |
| Gao 2014 | 9.5 | 2.6 | 37 | 11.6 | 2.9 | 39 | 83.6% | -2.10 [-3.34, -0.86] |
| **Total (95% CI)** | | | **48** | | | **48** | **100.0%** | **-2.13 [-3.26, -1.00]** |

Heterogeneity: Chi² = 0.02, df = 1 (P = 0.90); I² = 0%
Test for overall effect: Z = 3.70 (P = 0.0002)



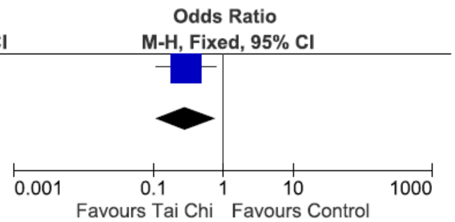

Effect of Tai Chi compared with active therapies on rate of falls in Parkinson's disease

| Study or Subgroup | Experimental Events | Experimental Total | Control Events | Control Total | Weight | Odds Ratio M-H, Fixed, 95% CI |
|---|---|---|---|---|---|---|
| Gladfelter 2011 | 0 | 9 | 5 | 8 | 12.0% | 0.03 [0.00, 0.78] |
| Li 2012 (Comparison 1) | 19 | 65 | 31 | 65 | 47.9% | 0.45 [0.22, 0.93] |
| Li 2012 (Comparison 2) | 19 | 65 | 26 | 65 | 40.1% | 0.62 [0.30, 1.28] |
| **Total (95% CI)** | | **139** | | **138** | **100.0%** | **0.47 [0.29, 0.77]** |
| Total events | 38 | | 62 | | | |
| Heterogeneity: Chi² = 3.27, df = 2 (P = 0.19); I² = 39% | | | | | | |
| Test for overall effect: Z = 2.99 (P = 0.003) | | | | | | |



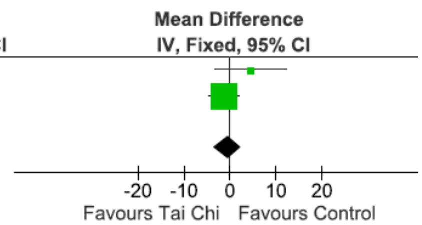

Effect of Tai Chi compared with no treatment on rate of falls in Parkinson’s disease

| Study or Subgroup | Experimental Events | Experimental Total | Control Events | Control Total | Weight | Odds Ratio M-H, Fixed, 95% CI |
|---|---|---|---|---|---|---|
| Gao 2014 | 8 | 37 | 19 | 39 | 100.0% | 0.29 [0.11, 0.79] |
| **Total (95% CI)** | | **37** | | **39** | **100.0%** | **0.29 [0.11, 0.79]** |
| Total events | 8 | | 19 | | | |
| Heterogeneity: Not applicable | | | | | | |
| Test for overall effect: Z = 2.42 (P = 0.02) | | | | | | |



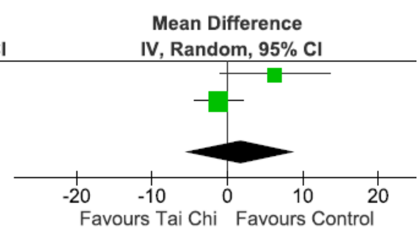

Effect of Tai Chi compared with active therapies on balance measured with TUG in stroke after 12 weeks

| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Au-Yeung 2009 | 27.3 | 22.5 | 55 | 22.8 | 19.7 | 59 | 14.7% | 4.50 [-3.29, 12.29] |
| Kim 2015 | 19.9 | 3.5 | 11 | 21.2 | 4.2 | 11 | 85.3% | -1.30 [-4.53, 1.93] |
| **Total (95% CI)** | | | **66** | | | **70** | **100.0%** | **-0.45 [-3.43, 2.54]** |
| Heterogeneity: Chi² = 1.82, df = 1 (P = 0.18); I² = 45% | | | | | | | | |
| Test for overall effect: Z = 0.29 (P = 0.77) | | | | | | | | |




Effect of Tai Chi compared with active therapies on balance measured with TUG in stroke after 18 weeks

| Study or Subgroup | Tai Chi Mean | Tai Chi SD | Tai Chi Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Au-Yeung 2009 | 27.5 | 23 | 52 | 21.2 | 14.2 | 56 | 40.2% | 6.30 [-0.97, 13.57] |
| Kim 2015 | 20 | 3.5 | 11 | 21.2 | 4.2 | 11 | 59.8% | -1.20 [-4.43, 2.03] |
| **Total (95% CI)** | | | **63** | | | **67** | **100.0%** | **1.81 [-5.39, 9.02]** |
| Heterogeneity: Tau² = 19.88; Chi² = 3.41, df = 1 (P = 0.06); I² = 71% | | | | | | | | |
| Test for overall effect: Z = 0.49 (P = 0.62) | | | | | | | | |




Effect of Tai Chi compared with active therapies on balance measured with number of falls in stroke after 12 weeks

| Study or Subgroup | Experimental Events | Experimental Total | Control Events | Control Total | Weight | Odds Ratio M-H, Fixed, 95% CI |
|---|---|---|---|---|---|---|
| Taylor-Piliae 2014 (Comparison 1) | 5 | 30 | 14 | 31 | 47.0% | 0.24 [0.07, 0.80] |
| Taylor-Piliae 2014 (Comparison 2) | 5 | 30 | 15 | 28 | 53.0% | 0.17 [0.05, 0.58] |
| **Total (95% CI)** | | **60** | | **59** | **100.0%** | **0.21 [0.09, 0.48]** |
| Total events | 10 | | 29 | | | |

Heterogeneity: $Chi^2 = 0.15$, $df = 1$ ($P = 0.70$); $I^2 = 0\%$
Test for overall effect: $Z = 3.64$ ($P = 0.0003$)

**Odds Ratio**
**M-H, Fixed, 95% CI**