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Original article

Tai Chi as an intervention to reduce falls and improve balance function in the elderly: A meta-analysis of randomized controlled trials

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ABSTRACT

Objective: To systematically evaluate the effectiveness of fall prevention and balance function in the elderly.

Methods: Databases, including PubMed, Web of Science, Cochrane Library, Chinese Biomedical Literature Database (CBM), and CNKI were electronically searched, and the relevant references of the included papers were also manually searched. Two reviewers independently screened the articles according to the inclusion and exclusion criteria, extracted the data, and assessed the methodological quality. A meta-analysis was performed using the Cochrane Collaboration's RevMan 5.1 software.

Results: Six randomized controlled trials (RCTs) involving 2796 participants were included. The results of the meta-analysis showed that compared with a physiotherapy intervention, Tai Chi could significantly reduce the incidence rates of falls [relative risk (RR) = 0.82, 95% confidence interval (*CI*) (0.73, 0.92)], while there were significant differences in the Timed Up and Go test, Functional Reach Test and Berger Balance Scale.

Conclusions: Tai Chi is effective in reducing the risk of falls and improving balance in the elderly.

1. Introduction

Each year, approximately 30% of community-living adults aged 65 and older experience a fall. Falls are the second main cause of accidents with injuries among the elderly, and the medical waste and economic costs associated with non-lethal falls are considerable. In addition, falls among the elderly are considered to be unavoidable and an important research subject in public health.[1] Some previous studies have indicated that with advancing age, balance decreases more sharply than other physiological functions,[2] especially among people over the age of 60 years, in whom the ability to balance is significantly impaired and leads to an increased risk of falls; this directly influences the elderly's physical and psychological health.[3] Results of many studies have shown that physical exercise can improve motor function, the ability to balance, the ability to walk, and the stability and posture of the elderly.[4] As a traditional Chinese sport, Tai Chi exercises consist of a series of sequential, graceful, and balanced movements that are executed in a slow, meditative, and relaxed manner.[5] With its mild-to-moderate intensity, Tai Chi improves cardiopulmonary capacity, muscle strength, postural control, spinal flexibility and balance. This meta-analysis focused on reviewing and updating the current evidence on using Tai Chi as an intervention for improving balance and reducing falls in the elderly.

2. Methods

2.1. Types of studies

Studies were included for review only if they were randomized controlled trials (RCTs). We did not plan to include the results from quasi-RCTs in the analyses, but we may discuss them in the text if limited RCT evidence is available.

2.2. Types of participants

According to the definition of the elderly by the World Health Organization, we included individuals above 60 years of age who live in nursing institutions or local communities and have not practiced Tai Chi in the previous 12 months. Participants were excluded if they had a degenerative neurological condition, such as Parkinson's disease, dementia, or a severely debilitating stroke;

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severe arthritis; or marked vision impairments or if they were unable to walk across a room independently.

2.3. Types of interventions

2.3.1. TC group

Tai Chi exercises served as the intervention and were administered for 3 months or more with instructions of an experienced Tai Chi instructor. Participants were not given any particular instructions about performing Tai Chi outside the class.

2.3.2. Control group

Controls were offered regular exercises (RE) or physical treatments (PT), including resistance training, balance training, strength training, or walking training Types of outcome measures.

2.4. Outcomes

2.4.1. Primary outcomes

The primary outcome measure was the number of falls.

2.4.2. Secondary outcome

The secondary outcomes included functional balance and physical performance. Functional balance measures included the Berg Balance Scale (BBS), which evaluates a person's ability to perform 14 different tasks of increasing difficulty, and the Function Reach (FR) measure, which assesses the maximal distance a person can reach forward beyond an arm's length while maintaining a fixed base of support in a standing position. The physical performance tests involved the Timed Up and Go Test (TUG), which is reliable and valid in quantifying functional mobility and was used to assess mobility.

2.5. Search methods for identification of studies

The extensive nature of this topic was reflected in the search of a wide range of resources, both electronic and non-electronic, without language restrictions, covering all relevant databases, including PubMed, Web of Science, Cochrane Library, Chinese Biomedical Literature Database (CBM), and CNKI. For all of the databases, we used the highly sensitive search strategy for randomized controlled trials (RCTs), as suggested in the Cochrane Handbook. All of the relevant articles found were identified on PubMed using the 'related articles' feature, and a further search was carried out for newly published articles.

The PubMed search strategy included the following search terms: 'Aged'(Mesh) OR 'aged'(Title/Abstract) OR 'elderly' (Title/Abstract) AND ['Tai Ji'(Mesh) OR 'Tai Ji'(Title/Abstract) OR 'Tai Chi'(Title/Abstract)] AND ['clinical trial'(Publication Type) OR 'clinical trials as topic'(MeSH Terms) OR 'clinical trial'(All Fields) OR 'random'(All Fields) OR 'randomized'(All Fields) OR 'randomization'(All Fields) OR 'randomized'(All Fields) OR 'randomly'(All Fields) OR 'randomness'(All Fields)].

2.6. Data collection and analysis

2.6.1. Selection of studies

All of the titles and/or abstracts generated by the searches were screened by pairs of authors for potentially relevant studies. The full-length articles of the selected titles and/or abstracts were assessed for eligibility. Disagreement was resolved by consensus or third party adjudication.

2.6.2. Data extraction and management

Two authors independently extracted the data from eligible trials using a customized data extraction tool. We recorded information about the trial design, main characteristics of the participants, intervention modality assessed, and outcomes. Disagreement on the data extracted was resolved by consensus or third party adjudication. We contacted the authors of the studies where there was inadequate reporting of data to enable clarification and, where appropriate, to allow pooling.

2.6.3. Assessment of the risk of bias in the included studies

Two authors independently assessed the risk of bias for each study using the criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011). We resolved any disagreement by involving a third author in the discussion. We assessed the following domains: (1) Random sequence generation (checking for possible selection bias); (2) allocation concealment (checking for possible selection bias); (3) blinding (checking for possible performance bias); (4) incomplete outcome data (checking for possible attrition bias due to the amount, nature and handling of incomplete outcome data); (5) selective reporting (checking for reporting bias), and (6) other bias (checking for bias due to problems not covered by areas 1–5).

2.7. Measures of treatment effect

For each trial, the risk ratios and 95% confidence intervals were calculated for dichotomous outcomes, and the mean differences (MD) and 95% confidence intervals were calculated for continuous outcomes (reporting mean and standard deviation or standard error of the mean). The standardized mean differences (SMD) and 95% confidence intervals were calculated when combining the results from studies using different ways of measuring the same concept. The change in scores was reported separately, as these cannot be incorporated into a meta-analysis of standardized mean differences.

2.8. Assessment of heterogeneity

Heterogeneity between comparable studies was tested using visual inspection of the forest plot and a standard chi-square test and was considered statistically significant at $p < 0.1$; this was done with consideration of the value of the I^2 statistic, and a value greater than 50% may indicate substantial heterogeneity.

2.9. Data synthesis

Appropriate statistical analyses were performed using Review Manager in accordance with the Cochrane Handbook for Systematic Reviews of Interventions.[6] Where available and appropriate, quantitative data for the outcomes listed in the inclusion criteria are presented in the analyses. Where appropriate, the results of the comparable groups of studies were pooled using the fixed-effect model and the 95% confidence intervals were calculated. In the presence of substantial heterogeneity, or an I^2 statistic greater than 50%, the results of comparable groups of studies were pooled using the random-effects model and the 95% confidence intervals were calculated.

2.10. Sensitivity analysis

We planned to conduct sensitivity analyses to explore the effect of the trial quality as assessed by the concealment of allocation, high attrition rates, or both, with poor quality studies being excluded from the analyses to assess whether this made any difference in the overall result.