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Original Article

Effect of Tai Chi on bone mineral density in postmenopausal women: A systematic review and meta-analysis of randomized control trials

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Abstract

Background: This meta-analysis of relative randomized control trials (RCTs) aimed to investigate whether Tai Chi exercise is able to alleviate bone mineral density (BMD) loss in postmenopausal women.
Methods: Electronic databases including PubMed, Embase, Springer link, Cochrane library, Wanfang and China National Knowledge Infrastructure (CNKIi) were used to search the eligible literature up to January 28, 2016. The pooled weighted mean difference (WMD) method combined with 95% confidence interval (CI) was used as the effect size of BMD values. The quality assessment of the included articles was performed by the Cochrane Collaboration Risk of Bias Tool (CCRBT).
Results: Total of six eligible articles with 182 participants in the Tai Chi intervention group and 168 participants in the control group were included in this study. Compared with control group, the overall analysis with the fixed-effect model showed no significant difference in BMD at the lumber spine between the intervention and control groups (WMD = 0.02, 95% *CI*: −0.00 to 0.05, $P = 0.09$). Moreover, there was no obvious difference in BMD at the femoral neck between Tai Chi interventions and controls (WMD = 0.01, 95% *CI* = −0.03 to 0.05, $P = 0.51$) via the pooled analysis with the random effects model.
Conclusion: Tai Chi exhibits no significant role in attenuating BMD loss in postmenopausal women at the lumber spine and femoral neck.

Keywords: Bone mineral density; Meta-analysis; Postmenopausal women; Randomized control trial; Tai Chi

1. Introduction

In postmenopausal women, osteoporosis is one prevalent bone remodeling disease, and it is characterized by a low bone mass and high risks of fractures.[1] Osteoporosis in postmenopausal women is attributed to the decrease of estrogen levels which results in the out control of osteoclast activity and further leads to bone resorption over bone formation.[2] Currently, several medicines have been developed for the treatment of osteoporosis, however, many patients have low adherence to these medicines due to long-term treatments, high medical costs and severe side-effects.[3,4] Recently, regular physical exercise with a positive influence on quality of life, has been suggested as a potential regimen against involutional bone loss.[5]

Tai Chi, as a mild-body activity for health and fitness, has gained increasing popularity in China and worldwide.[6,7] A previous study has pointed out that Tai Chi is a therapeutic intervention with safety and efficacy for various health concerns, such as postmenopausal bone mineral density (BMD) loss.[8] Moreover, a significant retardation of bone loss has been observed in both trabecular and distal tibia after Tai Chi intervention in a randomized study.[9] Besides, an increased

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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level of BMD at the lumbar spine and proximal femur in postmenopausal women is detected after Tai Chi intervention.[10,11] However, some studies indicate the positive effects of Tai Chi on BMD are modest and no convincing evidence has been found for Tai Chi in the improvement of bone mass.[12,13] In such circumstances, a thorough analysis is required to evaluate whether Tai Chi is beneficial for retarding BMD loss in postmenopausal women.

In this study, to provide sufficient evidence for clarifying the discrepancies, a meta-analysis of randomized controlled trials (RCTs) was carried out to compare BMD in postmenopausal women received with and without Tai Chi intervention. The results were expected to increase the precision of assessment of Tai Chi intervention benefit to bone health in postmenopausal women.

2. Methods

2.1. Literature search

The eligible literatures were retrieved by systematically searching through English databases (PubMed, Embase, Springer link, Cochrane library) and Chinese databases (Wanfang, China National Knowledge Infrastructure (CNKI)) based on their reception until January 28, 2016. Searching keywords included “Tai Ji” or “Tai Chi” or “Tai Ji quan” and “Osteoporosis” or “Bone density” and “Postmenopausal” or “Menopause” or “elderly”. There was no language restriction. References of the retrieved studies and reviews were scanned to obtain additional relevant articles. Besides, the manual search strategy was also performed to identify more potentially eligible citations published in paper.

2.2. Inclusion and exclusion criteria

Articles would be included in this meta-analysis if they met the following inclusion criteria: (1) all studies were RCTs; (2) the participants in the studies were postmenopausal women; (3) the interventions were Tai Chi or Tai Chi pushing hand, and the participants in the control group were not intervened with designed exercises; (4) BMD in lumbar spine, femoral neck or distal tibia was measured; (5) BMD was measured by dual energy X-ray absorptiometry (DEXA); (6) no significant difference at baseline was observed in BMD between the interventions and controls.

The exclusion criteria were as follows: (1) articles with incomplete data or the results of BMD measurement were unavailable for statistical analysis; (2) reviews, letters or comments were irrespective.

2.3. Data extraction and quality assessment

After the completion of article screening, two investigators independently extracted the data from the eligible studies according to the predesigned protocol. The extracted information was as follows: the first author's name, publication year, geographical area of study population, age and gender of the participants, sample size of the intervention and control groups, training frequency and results of each article. Disagreements among them were resolved by discussion with a third investigator to reach an agreement.

The quality of the included articles was assessed objectively and comprehensively using the following 9 items that were used in the study of Wayne et al.,[8] as recommended by Alperson and Berger,[14] including randomization (yes or no); details of randomization methods; clear inclusion and exclusion criteria; blinding of outcomes assessors; description of withdrawal and dropouts; sample size estimates and justification; use of appropriate statistical analyses; details of Tai Chi intervention (e.g. style, training schedule); and experience of Tai Chi instructors (Table 1).

2.4. Statistical analysis

The pooled weighted mean difference (WMD) combined with 95% confidence interval (CI) was used to calculate the pooled effect size of continuous data in order to estimate BMD values in the intervention and control groups after follow-up. Heterogeneity across studies was assessed by Cochran Q statistic and the I^2 test. If significant heterogeneity was identified ($P < 0.05$, $I^2 > 50\%$), the random-effect model was performed. Otherwise, the fixed-effect model was used for homogeneous outcomes ($P > 0.05$, $I^2 < 50\%$).

In order to test the reliability of our meta-analysis, we performed a sensitivity analysis by removing each study one time. All analyses were performed using Review Manager

Table 1
Quality of design and methodologic features of studies evaluating Tai Chi for low bone mineral density.

Features	Chan 2004[1]	Zhou 2004[2]	Wayne 2012[3]	Mao 2009[4]	Zhou 2005[5]	Zhou 2003[6]
Randomization employed	√	√	√	√	√	√
Randomization methods	–	–	√	–	–	–
Clear inclusion/exclusion criteria	√	–	√	√	√	√
Outcome assessors blinded	–	–	√	–	–	–
Withdrawal and dropouts reported	√	–	√	√	√	√
Sample size justified/estimated	√	–	–	–	–	–
Appropriate data analysis	√	√	√	√	√	√
Tai Chi intervention described	√	√	√	√	√	√
Qualifications of Tai Chi instructors	–	–	–	–	–	–

√, design and methodology feature adequately reported; –, design and methodology feature not adequately reported.

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