The effectiveness of tai chi exercise in improving aerobic capacity: a meta-analysis
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CRD summary
This review assessed the effects of t’ai chi on aerobic capacity. The authors concluded that t’ai chi may improve aerobic capacity but further research is required. There were considerable limitations to this review but, overall, the authors’ cautious conclusion and the recommendations for future research appear reasonable.

Authors' objectives
To evaluate the effects of t’ai chi exercise on aerobic capacity.

Searching
PubMed, CINAHL, Current Contents, the Cochrane Library, Digital Dissertations, PsycINFO and SocAbstracts were searched without any language restrictions. The review authors listed the various English language spellings of t’ai chi that were used as keywords.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs), or studies comparing t’ai chi with a control group, were eligible for inclusion. Reviews, commentaries, case reports, reanalyses of data, meta-analyses, overviews and qualitative research studies were excluded. One prospective cohort study was subsequently excluded from the analysis because the baseline VO2 scores differed between treatment groups.

Specific interventions included in the review
Studies of t’ai chi exercise were eligible for inclusion. The included studies used different forms of t’ai chi, including the classical Yang style and a modified 13-movement Yang style. Most studies compared t’ai chi with a sedentary control condition; in some studies walking, aerobic exercise or Wing Chun were used as control treatments. The duration of the interventions ranged from 12 to 52 weeks.

Participants included in the review
Inclusion criteria for the participants were not specified. Most participants in the included studies were healthy older men and women. Where reported, the mean ages ranged from 30 to 70 years, with most participants aged between 55 and 65.

Outcomes assessed in the review
Studies that assessed aerobic capacity were eligible for inclusion. The review assessed aerobic capacity using the peak oxygen uptake (VO2peak in mL/kg per minute). In all but one of the included studies VO2peak was estimated from the participants' expired air; in one study it was obtained from the estimated workload at the predicted maximal heart rate.

How were decisions on the relevance of primary studies made?
The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.

Assessment of study quality
Experimental and cross-sectional studies were assessed for the following criteria described by Chan and Bartlett (see Other Publications of Related Interest): study design, sample selection, description of the t’ai chi intervention, description of aerobic capacity, data analysis and results. The maximum possible quality score was 32 points. The authors did not state how the validity assessment was performed.
Data extraction
One reviewer extracted the data. For each study, the mean and standard deviation of VO2peak was extracted for each group and used to calculate the standardised mean difference effect size (ES) with 95% confidence interval (CI). For experimental studies (RCTs and quasi-experimental), this was calculated from the difference in postintervention means, although the mean change in aerobic capacity was used in one study. The results were extracted separately for men and women.

Methods of synthesis
How were the studies combined?
ESs from each study were pooled in a meta-analysis, weighted by sample size and pooled variance. Separate analyses were conducted for experimental and cross-sectional studies. ESs were classified as advised by Cohen as small (0.2), medium (0.5) or large (0.8).

How were differences between studies investigated?
Subgroup analyses were used to examine the influence of gender, type of control intervention (sedentary versus other exercise), type of t'ai chi (classical Yang style versus simplified Yang or not specified) and duration of the intervention (52 weeks versus 12 to 16 weeks) in the experimental studies. Separate forest plots were presented for experimental and cross-sectional studies to illustrate the treatment effects on male and female participants.

Results of the review
Seven studies (n=344) were included: 2 RCTs (n=100), 2 quasi-experimental studies (n=58) and 3 cross-sectional studies (n=186). The sample size ranged from 20 to 90.

The quality scores ranged from 22 to 28 (mean 25.1) out of 32. Six studies adequately described the characteristics of the participants and all 7 studies clearly defined aerobic capacity. One study reported blinding of the outcome assessor. In the cross-sectional studies, treatment groups were matched on age, gender and body composition.

The pooled ES for cross-sectional studies was large and statistically significant (ES 1.01, 95% CI: 0.37, 1.66; based on n=186), while the ES for experimental studies was small and not significant (ES 0.33, 95% CI: 0.41, 1.07; based on n=158).

The pooled ES (and hence the aerobic capacity) was larger for women (ES 0.83, 95% CI: -0.43, 2.09; based on n=126) than for men (ES 0.65, 95% CI: -0.04, 1.34; based on n=167), but in neither subgroup was the ES statistically significant.

The pooled ES for the physical activity level of the control group showed that t'ai chi significantly improved aerobic capacity in comparison with sedentary controls (ES 0.80, 95% CI: 0.19, 1.41; based on n=253), but not in comparison with other forms of exercise (ES 0.22, 95% CI: -0.81, 1.24; based on n=91).

The pooled ES for type of t'ai chi showed that the classical Yang style significantly improved aerobic capacity compared with control (ES 1.10, 95% CI: 0.82, 1.38; based on n=224), but no significant difference was observed for modified or unspecified t'ai chi (ES -0.17, 95% CI: -0.54, 0.20; based on n=120).

The pooled ES for duration of t'ai chi showed that interventions lasting 52 weeks significantly improved aerobic capacity compared with control (ES 0.94, 95% CI: 0.06, 1.81; based on n=58), whereas 12 to 16 weeks of t'ai chi was associated with significantly less improvement in aerobic capacity versus the control (ES -0.28, 95% CI: -0.53, -0.02; based on n=100).

Authors’ conclusions
The findings suggest that t'ai chi may improve aerobic capacity and may be an additional form of aerobic exercise suitable for sedentary older adults and those with heart disease. Further research is required.
CRD commentary
The review addressed a clear question that was defined in terms of the intervention, study design and outcomes; inclusion criteria relating to the participants were not specified. Several relevant sources were searched without language restrictions, but the dates searched were not given and no clear attempts to locate unpublished studies were reported; this raises the possibility of publication bias. Since the methods used to select studies and assess validity were not described and only one reviewer extracted the data, it is not known whether any efforts were made to reduce reviewer errors and bias. Validity was assessed, but the results of the assessment were not reported in full for each study.

There was little information on the characteristics of the participants, thus the comparability of study populations could not be adequately assessed. Statistical heterogeneity was not assessed and the fact that some studies had been included twice in the meta-analyses means that the pooled results may not be appropriate. The review authors did not state whether the subgroup analyses were planned in advance and they also combined data from different study designs, so these results should also be viewed with caution. The studies generally had small sample sizes and, as the review authors acknowledged, many of the analyses might have been underpowered. There were considerable limitations to this review but, overall, the authors' cautious conclusion appears reasonable and the recommendations for future research seem justified.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that future RCTs should examine the effects on aerobic capacity of t'ai chi regimens that adhere to the guidelines of the American College of Sports Medicine; compare t'ai chi with other forms of exercise; use an established style of t'ai chi such as the classical Yang style; and include diverse populations such as patients with chronic diseases. Future studies could also examine the effects of t'ai chi according to gender and the duration of the interventions.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.