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ORIGINAL ARTICLE

The Effectiveness of Tai Chi for Chronic Musculoskeletal Pain Conditions: A Systematic Review and Meta-Analysis

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Objective. **To determine whether Tai Chi improves pain, disability, physical performance, and/or health-related quality of life (HRQOL) in people with chronic musculoskeletal pain.**

Methods. **Eight databases were searched for randomized controlled trials (RCTs). Two independent reviewers rated trial quality and extracted trial data. Effect sizes and 95% confidence intervals were calculated for individual trials, and pooled effect sizes were calculated using a random-effects model.**

Results. **Seven RCTs were selected for inclusion in the review. Of these, 6 studied people with chronic arthritis and 1 studied people with chronic tension headaches. The trials were typically small and of low methodologic quality. The pooled effect size for arthritic populations on a 0–100 scale was 10.1 (range 6.3–13.9) points for pain reduction, and was 9.6 (range 5.2–14.0) points for disability reduction. Additionally, physical performance and HRQOL outcomes favored the Tai Chi intervention, but of these outcomes, only the level of tension and satisfaction with general health were statistically significant.**

Conclusion. **The available data on the effect of Tai Chi are sparse and derived principally from low-quality studies. These data suggest that Tai Chi has a small positive effect on pain and disability in people with arthritis. The extent to which it benefits other forms of musculoskeletal pain is unclear.**

INTRODUCTION

Over the last 2 decades, musculoskeletal pain, including back pain and osteoarthritis (OA), has been consistently reported as an international health priority among industrialized countries (1,2). Of the various treatments for these conditions, exercise has been shown to be effective for both OA and chronic back pain (3,4). There are, however, many ways to implement exercise therapy, and because most reviews (3,5–7) combine all forms of exercise into a single category, the effects of specific exercise programs and doses are unknown. Thus, we have chosen a specific exercise form, Tai Chi, which incorporates supervision, stretching, and strengthening components, all of which have been associated with an optimal outcome (8).

Tai chi, which originated in China, is a form of exercise that focuses on controlled movements combined with deep diaphragmatic breathing (9). There are 5 major styles, Chen, Yang, Wu, Hao, and Sun, each with its own unique characteristics but all based on the same essential principles (10). Yang and Sun styles have recently become widely used to improve balance and decrease the risk of falls among the elderly population (11), and a specific Sun-style form of Tai Chi is currently endorsed by The Arthritis Foundation in the US as a means of managing OA pain (12). Considering the increased popularity of this exercise in both North America and Australia, a growing body of research aimed at investigating the health benefits of Tai Chi has emerged. Many of the individual trials have reported Tai Chi to have positive effects on pain, physical function, and quality of life in populations with chronic conditions (13–19), and these findings have been supported by a number of review papers (20–22). However, none of these reviews have provided a quantitative estimate of the magnitude of the effect of Tai Chi for chronic musculoskeletal conditions.

The aim of this systematic review was to determine the effectiveness of Tai Chi in decreasing pain and disability

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and improving physical function and quality of life in people with chronic musculoskeletal pain. In contrast to previous reviews, this review used a meta-analytical approach to provide an effect size for Tai Chi on musculoskeletal pain symptoms. Because there are a wide variety of musculoskeletal conditions that could potentially be affected differently with the practice of Tai Chi, this review pooled trials with sufficient homogeneity on the origin of the musculoskeletal pain, and separately analyzed trials with heterogeneous musculoskeletal conditions.

MATERIALS AND METHODS

Search strategy and exclusion process. A sensitive search of 8 electronic databases (EMBase, PEDro, AMED, Medline, CINAHL, SportDiscus, LILACS, and the Cochrane Central Register of Controlled Trials) using the search terms Tai Chi, Taiji.mp was performed to identify all articles on Tai Chi. The search was performed for articles through June 2008.

From these titles, only original studies were included and only if they 1) had a randomized controlled trial (RCT) design; 2) included patients with a primary symptom of musculoskeletal pain; 3) used Tai Chi exercise as the main intervention; and 4) had at least 1 outcome measure of either pain, self-reported disability, physical performance, or health-related quality of life (HRQOL). Only trials published in peer-reviewed literature were included. Non–English language trials were included if an appropriate translation was possible. Citation tracking of all included trials, as well as of all identified review articles of Tai Chi for musculoskeletal pain, was conducted to identify any studies missed in the electronic database search.

Data extraction and analysis. For each included trial, 2 reviewers (AH, MF) independently extracted the change scores and SDs for all relevant outcomes at 1 time point: the short-term followup. Short term is defined as <3 months from randomization (23); if there were multiple eligible time points, we chose the time point closest to 12 weeks. All data were extracted using a standardized data extraction form. Where change score data were not reported, attempts were made to obtain data from the authors. In cases where change scores and SDs were not obtainable, one of the following methods was used to provide data: postintervention scores were used if baseline scores were not significantly different between groups, or if baseline scores were different, the change scores and SDs were estimated according to methods endorsed in the Cochrane Handbook for Systematic Reviews of Interventions (23). If no usable data were listed or able to be retrieved, the trial was excluded.

One contrast was used: Tai Chi versus placebo, usual care, or minimal care. This review included all styles of Tai Chi. A meta-analysis of the included trials was performed where it was deemed sensible to combine trials. For trials included in the meta-analysis, continuous outcomes were rescaled to a common 0–100 scale. The meta-analysis used weighted mean difference and a random-effects model to calculate the pooled effect size. Trials not included in the meta-analysis were reported separately. It was planned to conduct subgroup analyses on specific musculoskeletal conditions where appropriate, but these analyses were not conducted.

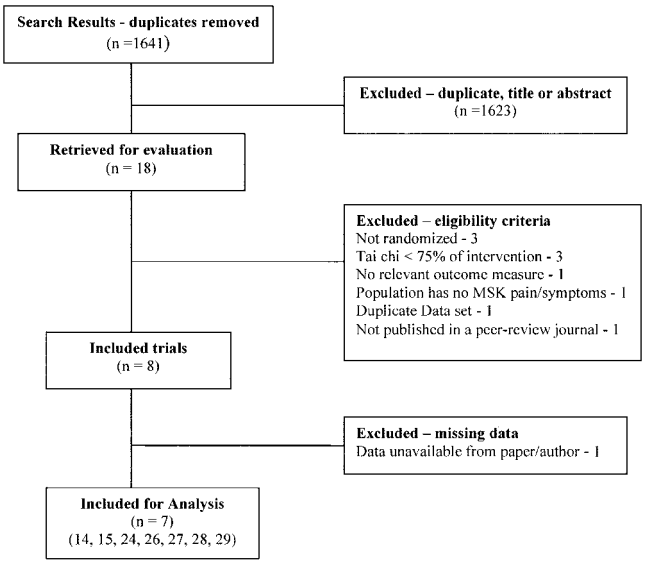

Figure 1. Flowchart showing the retrieval of studies for review. MSK = musculoskeletal.

RESULTS

Search strategy. A total of 2,063 titles were identified using the following databases: EMBase (n = 661), AMED (n = 1,299), LILACS (n = 4), and PEDro (n = 99). Titles were merged using EndNote X (Thomson Reuters, New York, NY; software license supplied by The University of Sydney) and duplicates were removed, resulting in a total of 1,641 titles from sources including newsletters, magazines, books, theses, abstracts, conference proceedings, and journal articles from both refereed and nonrefereed journals. Following the exclusion process, a total of 8 RCTs (13,14,24–29) met the inclusion criteria (Figure 1).

Included trials. From these 8 RCTs, 1 abstract (25) was excluded because it reported no numerical data and attempts to contact the authors were unsuccessful. Therefore, a total of 7 RCTs (13,14,24,26–29) were included in the study. For 1 study (27), change score data were not provided and were calculated according to section 8.5.2.10 in the Cochrane Handbook for Systematic Reviews of Interventions (23).

Participants. There was little variability among trials in terms of musculoskeletal pain origin and recruitment strategy (Table 1). The majority of participants' primary report was of chronic arthritis, i.e., OA in 5 trials (14,24,26,27,29) and rheumatoid arthritis (RA) in 1 trial (28). A single trial studied people with chronic tension-type headache (13). Because it is debatable whether tension headache is a musculoskeletal condition, we have chosen to include it in this review but to analyze it separately. Recruitment for 5

Table 1. Characteristics of included trials*

Author, year	No. patients	Age, mean ± SD years	Primary report	Tai Chi style	Frequency per week	Duration, weeks	Trial quality†
Abbott et al, 2007	30	44 ± 13	Tension headaches	Yang	1 time/2 weeks	15	3
Adler et al, 2000	16	77 ± 6	OA (hip, knee)	Wu	1 time	10	3
Lee et al, 2006	61	N/A	RA	Sun	1 time	12	4‡
Brismée et al, 2007	41	71 ± 10	Knee OA	Yang	3 times	6	5
Fransen et al, 2007	97§	70 ± 6	OA (hip, knee)	Sun	2 times	12	8
Hartman et al, 2000	33	67 ± 8	OA (lumbar spine, hip, knee, ankle)	Yang	2 times	12	5
Song et al, 2007	43	65 ± 6	Knee OA	Sun	3 times vs. 1 time	2 vs. 10	4

* OA = osteoarthritis; N/A = not applicable; RA = rheumatoid arthritis.
† Rated out of 10, using the PEDro score.
‡ Rated by an experienced PEDro scale user who speaks Korean.
§ This review includes the control and Tai Chi arms of this 3-arm trial.

of the 7 trials used community volunteers (13,14,24,26,27), and the remaining 2 trials recruited patients from public health centers (28,29).

Interventions. The intervention content (determined by the style of Tai Chi used) and the intervention dose (determined by the duration and frequency of the Tai Chi sessions) varied among all trials (Table 1). The Yang style was used by 42% of the trials (13,14,27), 42% used the Sun style (26,28,29), and 16% used the Wu style (24). Duration ranged 6–15 weeks, with 50% of trials using a 12-week Tai Chi program comprising 18–24 sessions (26–29). Sessions lasted 40–60 minutes. All trials used a group format for the intervention, and in most cases daily home practice was encouraged but not monitored.

Methodologic quality. The quality of the trials was assessed using the PEDro rating scale (30). Of the 7 trials, 6 had a rating of ≤5 on a scale of 0–10 (13,14,24,27–29), and 1 had a rating of 8 (26). There are a total of 11 nonweighted items on the PEDro rating scale that are used to measure trial quality. However, for RCTs, only 4 of these items (concealed allocation [item 3] and blinding [items 5–7]) have empirical evidence that associate their absence with overestimation of treatment benefit (31–33). We have chosen to report on these 4 individual items for the included trials. Only 2 of the RCTs reported having concealed allocation (26,29), and allocation procedure was not reported in the remaining 5 RCTs (13,14,24,27,28). The subjects and treatment practitioners in all trials were unblinded to treatment, and the assessor was unblinded to treatment allocation in 3 of the 7 RCTs (4,13,14,29).

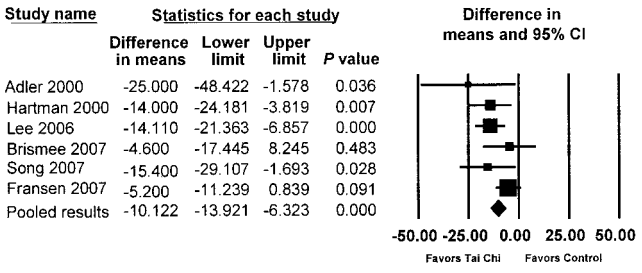

Figure 2. Pain meta-analysis. Self-reported pain was measured using 3 scales, a numerical rating scale, the Arthritis Impact Measurement Scales version 2 pain subscale, and the Western Ontario and McMaster Universities Osteoarthritis Index pain subscale. All scales were transformed to a 0–100-point scale with higher scores representing more pain. 95% CI = 95% confidence interval.

Outcome analysis. *Self-reported pain.* All trials had at least one outcome measure for pain. The outcome measures used to assess pain in the arthritic populations were the Western Ontario and McMaster Universities (WOMAC) OA Index pain subscale (26,29), the Arthritis Impact Measurement Scales version 2 (27), and a numerical rating scale (NRS) (14,24,28) (Figure 2). In situations where the trial used both the WOMAC and an NRS, the NRS was chosen as the outcome measure for analysis in this review. The pooled effect of Tai Chi on pain was 10.1 points on a 0–100 NRS (95% confidence interval [95% CI] 6.3, 13.9).

The outcome measure used to assess pain in the tension headache trial (13) was the Short Form 36 health questionnaire version 2 (SF-36 v. 2) bodily pain subscale, in which the average pain over the last week was measured (Figure 3). This showed an effect size of 6.4 points on a 0–100-point scale (95% CI 0.4, 12.4).

Self-reported disability. Six of the 7 trials included self-reported disability as an outcome measure (13,14,26–29) (Figure 4). Four of 5 arthritis trials (14,26,28,29) used the WOMAC physical function subscale, which is the summed total of participants' responses (using a Likert

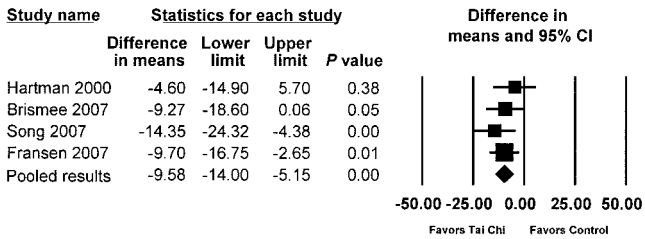

Figure 3. Self-reported disability meta-analysis. Self-reported disability was measured with 2 scales, the Western Ontario and McMaster Universities Osteoarthritis Index and the Arthritis Self-Efficacy Scale physical function subscale. All scales were transformed to a 0–100-point scale with higher scores representing more pain. 95% CI = 95% confidence interval.

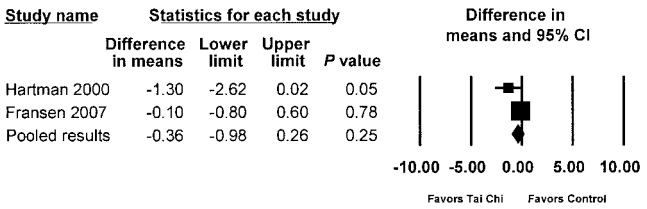

Figure 4. Physical performance meta-analysis with the 50-foot walk test, which measures how fast a person can walk a distance of 50 feet on a level surface from a standing start; time is recorded to the nearest tenth of a second. 95% CI = 95% confidence interval.

scale) about their level of physical function with respect to 17 different situations, i.e., standing, walking, sitting, shopping, putting on socks, etc. One trial (27) used the Arthritis Self-Efficacy Scale physical function subscale to measure disability, which has been shown to reliably correlate with health status (34). The pooled effect of Tai Chi was 9.6 points on a 0–100-point scale (95% CI 5.2, 14.0).

The tension headache trial (13) used the SF-36 v. 2 physical function subscale as an outcome for self-reported disability, yielding an effect size of 2.6 points on a 0–100 scale (95% CI −0.9, 6.0).

Physical performance. Three of the 7 trials (26,27,29) used physical performance as an outcome measure, but there was little consistency among trials with respect to which performance test was used to evaluate physical performance. Two trials used the 50-foot walk test as the primary measure of physical performance; test data were pooled in a meta-analysis (results described below). One trial used a submaximal cycle ergometer test as the primary measure of performance, and 2 of the 3 trials used additional measures of physical performance. These data were considered heterogeneous and the individual effect sizes are listed in Table 2.

Two of these 3 trials (26,27) with OA populations used the 50-foot walk test as an outcome measure before and after 12 weeks of Tai Chi. The pooled estimate of treatment effect was a 0.4-second (95% CI 0.3, 1.0) reduction in the time taken to walk 50 feet, but this effect was not statistically significant.

Quality of life. Four of the 7 trials (13,24,26,27) measured HRQOL (Table 2). One trial (24), which used the SF-36 v. 2, did not report any baseline or followup data. Several unsuccessful attempts were made to contact the authors, and thus we were not able to include this trial in the analysis for quality of life measures. The 3 trials with outcome measurement data for quality of life outcomes used different measures, which were found to be heterogeneous and could not be pooled in meta-analysis. Each outcome was thus analyzed separately; the individual ef-

Table 2. Single trial effect sizes due to heterogeneity of outcome assessment tools*

Author, year	No. patients: Tai Chi	No. patients: Controls	Effect size	Favors Tai Chi
Physical performance				
Fransen et al, 2007				
Get Up and Go†	56	41	0.5 (−0.1, 1.1)	Yes
Song et al, 2007				
CV function‡	22	21	0.7 (−2.4, 3.8)	Yes
Hartman et al, 2000				
Chair rises§	18	15	2.2 (−3.7, −0.7)	Yes
Quality of life indicators				
Abbott et al, 2007				
SF-36 v. 2 PCS¶	13	17	3.57 (−0.3, 7.4)	Yes
SF-36 v. 2 MCS¶	13	17	6.94 (1.4, 12.5)#	Yes
Fransen et al, 2007				
SF-12 v. 2 PCS**	56	41	2.1 (−1.2, 5.4)	Yes
SF-12 v. 2 MCS**	56	41	−0.2 (−4.4, 4.0)	No††
Hartman et al, 2000				
AIMS2 mood‡‡	18	15	0.5 (−0.3, 1.3)	Yes
AIMS2 tension‡‡	18	15	1.9 (0.7, 3.2)#	Yes
AIMS2 satisfaction‡‡	18	15	1.5 (0.7, 2.3)#	Yes

* CV = cardiovascular; SF-36 v. 2 = Short Form 36 health questionnaire version 2; PCS = physical component summary; MCS = mental component summary; SF-12 v.2 = Short Form 12 health questionnaire version 2; AIMS2 = Arthritis Impact Measurement Scales version 2.
† Measures the time it takes, to the nearest tenth of a second, to get up from a chair and walk 50 feet as quickly as possible.
‡ Estimated using a submaximal cycle ergometer test to measure $\dot{V}O_2$ in ml/kg/minute.
§ Measures the time it takes, to the nearest tenth of a second, to complete 5 full stands from a sitting position in a straight-backed chair without the use of upper extremities.
¶ Higher scores represent worse function.
# Significant at $P = 0.05$.
** Mean score is out of 50. Higher scores represent worse function.
†† Effect size favors control. The authors report that this is most likely due to a ceiling effect.
‡‡ Measures quality of life indicators. Scores are standardized on a range of 0–10 units, where higher scores represent greater pain.

fect sizes as well as the outcome measures used are presented in Table 2.

Participant adherence to treatment. Of the 7 RCTs included, only 3 trials (14,26,27) reported on the participants' adherence to treatment. Unfortunately, each of these trials used very different reporting styles to classify adherence, therefore the results provide little insight into the compliance of participants to Tai Chi sessions.

Report of treatment implementation. We assessed the reporting of treatment implementation using the extension of the Consolidated Standards of Reporting Trials (CONSORT) group statement for nonpharmacologic treatments for items regarding the reporting of participants and interventions in the Methods and Results sections (35).

Participants. The CONSORT statement recommends that eligibility criteria for centers and those performing the interventions should be listed in the Methods section (item 3). Only 1 trial reported eligibility criteria for centers and care providers performing the interventions (29). The CONSORT statement also recommends that the number of care providers or centers performing the intervention in each group, and the number of patients treated by each care provider or in each group, be listed in the Results section (item 13). No trials provided this information. Finally, the CONSORT statement recommends that where applicable, a description of care providers (case volume, qualification, expertise, etc.) and centers (volume) in each group be provided in the Results section (item 15). Only 3 trials (13,26,29) reported this information.

Intervention. With respect to reporting on the intervention and comparison groups, the CONSORT statement recommends that precise details of both the experimental and comparator groups be reported in the Methods section (item 4). This includes a description of the components of the interventions and, when applicable, descriptions for tailoring the interventions to individual participants (item 4A), details of how the interventions were standardized (item 4B), and details of how the adherence of the care provider with the protocol was assessed (item 4C). Although all trials reported the details of the Tai Chi intervention, only 2 trials reported the details of the control group (14,27). Most trials stated that they used a standardized form of Tai Chi, but only 4 trials (13,14,26,29) provided the reference material for the standardization. No trials reported on how care providers' adherence to the treatment protocol would be assessed or enhanced. The CONSORT group added a new item for implementation of intervention that states that details of the experimental treatment and comparator as they were implemented be reported in the Results section (new item). Of the 7 trials in this review, none reported on the implementation of either group in the Results section. A summary of these results is provided in Table 3.

Table 3. Report of treatment implementation according to the CONSORT group guidelines

	Methods					Results			
Author, year	Item 3: eligibility criteria for intervention providers	Item 4: details about subject/control groups	Item 4A: description of intervention components	Item 4B: standardization of the interventions	Item 4C: adherence assessment and enhancement	Item 13: numbers of providers and participants	New item: implementation of the intervention	Item 15: description of the care providers and centers
Abbott et al, 2007	No	Yes/No	No	Yes	No	No	No	Stated in the Methods
Adler et al, 2000	No	Yes/No	No	No	No	No	No	No
Brismee et al, 2007	No	Yes/Yes	Yes	Yes	No	No	No	No
Fransen et al, 2007	No	Yes/No	Yes	Yes	No	No	No	Stated in Methods
Hartman et al, 2000	No	Yes/Yes	Yes	Yes	No	No	No	No
Lee et al, 2006	N/A	Yes/No	N/A	N/A	N/A	N/A	N/A	N/A
Song et al, 2007	Yes	Yes/No	Yes	Yes	No	No	No	Stated in Methods

* CONSORT = Consolidated Standards of Reporting Trials; N/A = not applicable because we were not able to extract the data.

DISCUSSION

Previous reviews have reported that Tai Chi is beneficial for reducing pain and improving physical function

(22,36,37) in painful musculoskeletal conditions, but, to our knowledge, until now the size of the effect has not been quantified. We conducted the first meta-analysis of trials investigating Tai Chi interventions for musculoskeletal pain and have provided pooled estimates of the size of effects on pain and disability. Data were extracted from 7 RCTs (13,14,24,26–29) with a total of 321 participants with musculoskeletal pain. The pooled results of our meta-analysis suggest that Tai Chi has small positive effects on self-assessed pain and disability. It is important to note that these are short-term effects, seen directly after the course of treatment; data regarding long-term effects were not available. It is possible that these effects may decrease over time for individuals who do not continue to regularly practice Tai Chi.

Pooled effect sizes for pain and disability outcomes were fairly similar: both were an ~10-point improvement on a 0–100-point scale. Narrow 95% CIs suggest adequate precision of these estimates, and in both cases *P* values were <0.05. Of importance is consideration of whether these calculated effects are clinically worthwhile. Researchers have attempted to quantify clinically worthwhile effect sizes for some outcomes (38,39), but there remains no firm consensus on the size of a worthwhile effect. This is due in part to the fact that estimates provided in the literature are concerned with within-group differences, and when interpreting the results of meta-analyses we are actually interested in between-group differences.

Although the effects reported in our analysis are slightly below the worthwhile threshold reported by some researchers (39), the clinically worthwhile effect has generally been estimated with respect to treatments provided in a clinic where a patient pays for an individual session with a therapist. Tai Chi is not typically provided in a clinic, but rather is usually performed as a group exercise activity practiced at one's leisure. This difference in the style of treatment may impact a person's expectations of what is a worthwhile effect. The fact that Tai Chi is inexpensive, convenient, enjoyable, and conveys other psychological and social benefits (16) supports the idea that a smaller effect size may be considered worthwhile for this type of intervention.

In addition to pain and decreased function, people with chronic pain also experience psychological distress (40). Because Tai Chi has been said to improve mood and sleep patterns (17,41), we decided to include quality of life outcomes in this review. Three of 7 RCTs reported quality of life outcomes, but heterogeneity of assessment tools prevented a meta-analysis and we were therefore unable to calculate a pooled estimate of the effect of Tai Chi on quality of life. In general, Tai Chi showed a trend toward small positive effects for overall physical health, tension level, and satisfaction with general health for people with OA, and improved overall mental health for people with tension headaches. Improvements in mood were not found to be statistically significant in the one trial that measured it. The effect of Tai Chi on quality of life in people with musculoskeletal pain remains unclear. The authors recommend that future RCTs use reliable and valid outcome measures such as the SF-36 to measure quality of life (42).

Difficulty with performing physical activities such as walking, lifting, and bending is common in patients with chronic back pain (43). Previous trials have attempted to incorporate performance measures as treatment outcomes, but to date there is no consensus among authors regarding how best to measure these variables. Although reviews have suggested that regular Tai Chi practice can improve physical performance, our analysis found Tai Chi to have very small positive effects that could be due to chance. Also, only 3 of the 7 RCTs reported on physical performance, meaning that conclusions were drawn from a reasonably small sample. In addition, the performance tests used in the trials, including the 50-foot walk test and the Get Up and Go test, have been shown to have small, insignificant correlations with concurrent measures of physical function such as the WOMAC, and unfortunately to have low sensitivity to change in patients with knee OA (44,45). Future research could include outcome measures that have been shown to be reliable and responsive to change, such as the 6-minute walk test (46), or a comprehensive battery of physical performance tests such as those recommended by the American College of Sports Medicine guidelines, which include assessment of physical strength, endurance, and flexibility (47).

The I^2 values for pain, disability, and physical performance outcomes were 30%, 0%, and 55%, respectively. These values indicate that statistical heterogeneity ranges from "might not be important" (0–40%) to "may represent moderate heterogeneity" (30–60%) (23). There are several potential sources of clinical heterogeneity to be considered when interpreting the results. These include population, treatment implementation, and adherence.

All studies included in the meta-analysis investigated participants with a diagnosis of chronic arthritis; however, the type of arthritis varied among trials. Of the 6 included trials, 5 investigated lower extremity OA (14,24,26,27,29), and 1 investigated RA (28). In addition, there are various factors associated with the implementation of the intervention, such as Tai Chi style and treatment dose, that may influence effect size. There were 3 different styles of Tai Chi used among the included trials: Yang, Sun, and Wu. Treatment dose, including duration and frequency, may also affect treatment outcome. The duration was fairly consistent among the trials, with 4 of the 6 trials using Tai Chi programs with 12-week durations (26–29), 1 trial using 10-week programs (24), and 1 trial using 6-week programs (14). The frequency had a greater variation among trials, ranging from 10–24 sessions. However, based on visual inspection of the forest plot, the differences in study population, Tai Chi style, and dose did not appear to explain the differences in effect size between trials.

There are other potential sources of clinical heterogeneity that were not reported but which are recommended by the CONSORT guidelines. These include standardization of intervention, eligibility criteria for treatment providers, and adherence to treatment. The trials in this review did not provide any summary data on these factors and thus they should still be considered as potential contributing factors to the variability of the effect sizes.

All RCTs included reported pain and disability as outcome measures, but the assessment tools to measure pain outcomes were inconsistent, which limits the generaliz-

ability of the pooled results. Inclusion of a simple NRS of average pain over the last week in RCTs, in addition to any specific condition-based pain measures, would help to resolve this issue. The reporting quality of the included trials was inconsistent. This could be improved by adhering to the CONSORT recommendations (48,49). Future research should also focus on designing higher-quality trials with larger sample sizes in order to provide more precise estimates of the effects of treatment.

Meta-analysis necessarily involves assumptions of homogeneity with respect to outcomes, treatment, sample, and data. We recognize that some heterogeneity in all these areas exists but believe that the included trials are sufficiently similar to support our choice of methodology. Further, descriptive information is reported for each trial (Table 1) and individual effect sizes are presented in the forest plots (Figures 2, 3, and 4). The authors also recognize that there is some controversy about whether or not to confine a systematic review to trials published in peer-reviewed journals. We excluded this type of literature because it is difficult to access the data required for a meta-analysis. Although some authors have shown that the exclusion of unpublished work may lead to an overestimation of the effect of Tai Chi, others have shown that the inclusion of unpublished results may introduce bias if favorable results are provided more readily (23,50).

From the available data, Tai Chi appears to have a small positive effect for reducing pain and improving disability in people with arthritis. The extent to which Tai Chi reduces other types of musculoskeletal pain, however, requires further high-quality studies with larger sample sizes considering a wider range of musculoskeletal conditions. The data also showed a positive trend toward improving physical performance, reducing tension, and improving quality of life. However, due to the questionable quality of performance measures and the heterogeneity of quality of life measures, an accurate estimate of effect for these outcomes was not possible. It is of importance to note that the results reported in this systematic review are indicative of the effect of Tai Chi versus minimal intervention (usual care or health education) or wait list control. To establish the specific effects of Tai Chi, a placebo-controlled trial would be necessary; however, no such trial has yet been conducted.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Ms Hall had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Hall, Maher, Latimer, Ferreira.
Acquisition of data. Hall, Maher, Latimer, Ferreira.
Analysis and interpretation of data. Hall, Maher, Latimer, Ferreira.

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