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ORIGINAL ARTICLE

Tai Chi Exercise for Treatment of Pain and Disability in People With Persistent Low Back Pain: A Randomized Controlled Trial

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Objective. **To determine the effect of tai chi exercise on persistent low back pain.**
Methods. **We performed a randomized controlled trial in a general community setting in Sydney, New South Wales, Australia. Participants consisted of 160 volunteers between ages 18 and 70 years with persistent nonspecific low back pain. The tai chi group (n = 80) consisted of 18 40-minute sessions over a 10-week period delivered in a group format by a qualified instructor. The waitlist control group continued with their usual health care. Bothersomeness of back symptoms was the primary outcome. Secondary outcomes included pain intensity and pain-related disability. Data were collected at pre- and postintervention and analyzed by intent-to-treat.**
Results. **Tai chi exercise reduced bothersomeness of back symptoms by 1.7 points on a 0–10 scale, reduced pain intensity by 1.3 points on a 0–10 scale, and improved self-report disability by 2.6 points on the 0–24 Roland-Morris Disability Questionnaire scale. The followup rate was >90% for all outcomes. These results were considered a worthwhile treatment effect by researchers and participants.**
Conclusion. **This is the first pragmatic randomized controlled trial of tai chi exercise for people with low back pain. It showed that a 10-week tai chi program improved pain and disability outcomes and can be considered a safe and effective intervention for those experiencing long-term low back pain symptoms.**

INTRODUCTION

Low back pain is one of the most common reasons for presenting to a general practitioner (1–3). Despite numerous treatments aimed at remedying this condition, it is estimated that 43% of patients with an acute episode will have disabling symptoms 3 months later and develop persistent low back pain (4,5). In addition to their pain symptoms, people with persistent symptoms typically report reduced physical function and social participation, increased psychological distress, and resulting work loss. These factors, in combination with its high prevalence, have made low back pain the single most costly musculoskeletal disorder in Australia, with an estimated $1 billion spent on direct health care costs per annum and a further $8 billion on indirect costs (6).

A recent review of the current nonpharmacologic treatments for long-term low back pain reported 16 different types of interventions that have been tested in clinical trials, with the majority showing little to no effect (7). Exercise therapy is among the more effective interventions showing small to moderate effects (8,9). It can be delivered at low cost, making it an attractive choice for such a prevalent condition. However, there are many exercise therapy approaches and the most effective exercise approach remains uncertain. Recently, a meta-analysis of 23 types of exercise therapy found the components of supervision, strengthening, and stretching to be the most predictive of good outcome, and consequently these elements have been recommended for inclusion in exercise therapy programs (10).

Tai chi originating in China is an established form of

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Significance & Innovations

- This research provides new evidence to support beneficial effects of tai chi for reducing pain and disability associated with chronic low back pain.
- It adds to the growing body of literature regarding exercise therapies as well as complementary and alternative therapies for persistent pain conditions.
- This is the first randomized controlled trial to gain a patient perspective of what is considered a meaningful change in pain symptoms to make tai chi a worthwhile intervention for their pain management.

gentle exercise and incorporates balance, strengthening, stretching, and body awareness, and is commonly practiced throughout Asia for general health and well-being. It has recently gained popularity in Australia, Canada, the UK, and the US for use in various health conditions, including fall prevention (11) and management of arthritis (12). It is currently endorsed by the Arthritis Foundation of Australia (13), Arthritis Care of the UK (14), and the Arthritis Foundation of the US (15). This increased recognition and widespread use of tai chi for health problems has driven the need for scientific research to establish its value.

For arthritis pain conditions, tai chi has been shown to have small to moderate effects for reducing pain and improving physical function (12), which is similar to other exercise-based interventions evaluated in clinical trials for this population (16,17). However, the included studies in the tai chi review (12) were mostly small and of low methodologic quality, highlighting the need for more high-quality research in this area.

Currently, to our knowledge, there has been no study evaluating tai chi for people with low back pain; however, it would seem plausible that tai chi, as a gentle form of exercise that incorporates strengthening, stretching, and supervision, may help this condition. This study is the first randomized controlled trial (RCT) of tai chi for persistent low back pain with a primary aim of investigating the effects of a 10-week tai chi intervention for reducing bothersomeness of pain and pain-related disability.

SUBJECTS AND METHODS

Trial design and allocation sequence. The trial was prospectively registered and followed a published protocol (18). The design was an RCT with 2 arms: an intervention arm and a waitlist control arm. The randomization sequence was computer generated (using the random number function in Microsoft Excel) by one of the investigators (CGM) who was not involved in recruitment. The sequence was blocked (block size of 8). The treatment codes were placed sequentially into sealed opaque envelopes and thus, allocation sequence was blinded to investigators involved in recruitment. Eligible participants who completed the baseline assessment were sequentially assigned a trial number. The randomization envelope with a corresponding number was attached to the participant's file but remained unopened until the block of 8 eligible participants with completed baseline assessments was complete (i.e., subjects 1–8 or 9–16). Once there were 8 completed assessments with corresponding sealed randomization envelopes, the envelopes were opened and randomization assigned to the participants. The use of such a method allowed for 4 people to be allocated to the tai chi treatment group and 4 people to be allocated to the waitlist control group. The participants and treatment provider were therefore unblinded. The investigator who provided treatment was also responsible for screening potential patients for eligibility and opening envelopes; this investigator was subsequently not involved in interpretation of the data.

Participants. One hundred sixty subjects ages 18–70 years with persistent nonspecific low back pain volunteered to take part in the study. All of the subjects were recruited via community advertisements from Sydney, New South Wales, Australia, between July 2008 and April 2010. Interested individuals were screened via telephone and deemed eligible if they reported a minimum level of "moderate" pain or "moderate" activity limitation as determined by their response to questions 7 or 8 on the Short Form 36 health survey. Additionally, they required a diagnosis of "nonspecific low back pain ± leg pain" and were considered appropriate for exercise management of their back pain. Specific exclusion criteria included 1) known or suspected serious spinal pathology (19–21), 2) any contraindication to exercise (22), and 3) scheduled for spinal surgery. All of the subjects signed informed consent forms and the trial was approved by the University of Sydney Human Research Ethics Committee (HREC approval 10452).

Interventions. Tai chi sessions were 40 minutes in duration, which included a warm-up and cool down, and were taught by a certified tai chi instructor (certification was gained from the Tai Chi for Health Program, created by PL). Specific details of the tai chi class procedures as well as a complete description of the intervention components used in each of the 18 sessions can be found in the tai chi study instructor's manual (18). The intervention was standardized using the instructor's manual containing the lesson plan for each tai chi session. The instructor in the study also received a 1-week training course on how to use specific tai chi teaching techniques to teach each of the 18 sessions. As part of the teacher training, the tai chi study instructor had to teach several nonstudy tai chi classes and was observed and rated by a qualified tai chi teacher trainer on his/her ability to teach the standardized tai chi program. During the course of the study the instructor's adherence to the protocol was self-monitored via a protocol checklist for each session and objectively monitored via an unannounced visit from an observer who would attend the session and rate the instructor's performance according to the protocol.

Participants allocated to the tai chi group received 18 tai chi sessions over 10 weeks (2 times per week for 8 weeks followed by once per week for 2 weeks). All tai chi sessions were conducted at community venues (i.e., not clinical facilities; community venues included The George Institute for Global Health, The University of Sydney, and The City of Sydney Ultimo Community Centre) within the Sydney metropolitan area. Participants allocated to both the tai chi and waitlist control groups were advised to continue with their usual health care (defined as their normal general practitioner care or any fitness or health regimen they were currently undertaking). Participants in both groups were asked to refrain from starting a new course of treatment over the 10-week study period and asked to advise one of the investigators if they had exacerbation of pain for which they wanted to seek care. In these instances, the care sought was recorded.

To improve adherence to treatment in the tai chi group, participants were sent a weekly reminder of the tai chi class times. The reminder was sent to all participants via e-mail and/or a mobile phone text message. Participants who missed a session were followed up with a reminder e-mail. Additionally, to minimize the risk of dropout and/or loss to followup in the waitlist control group, participants were sent an e-mail by the tai chi instructor during week 5 and week 9 to update them in regard to their followup assessment. In order to encourage continued study participation of waitlisted controls, prior to randomization, all of the participants were told that if they were assigned to the waitlist control group, following completion of the first series of tai chi sessions and the followup assessment (approximately 10 weeks from baseline), they would have the opportunity to attend a subsequent series of tai chi sessions. If they were unable to attend the classes at that time they could receive a free copy of the instructional tai chi DVD to keep for their own home learning (specific information can be found in the published protocol) (18).

Outcome measures. Outcome measures were collected from July 2008 to September 2010. Outcome assessment included administration of a questionnaire at baseline (prior to randomization) and again directly after treatment (week 10). Participants were not blinded to treatment, which precluded blinding of assessment with self-report outcomes. The primary outcome was bothersomeness of pain symptoms (over the last week) measured using a 0–10 numerical rating scale (NRS). Originally, the study included a larger set of secondary outcomes (including measures of health-related quality of life, mood, and cognitions); however, partway through the trial the number of secondary outcomes had to be decreased to lessen the time and burden of outcome assessment for participants. This did not impact the primary outcome of the study. The secondary outcomes that were measured for all of the participants included average pain intensity over the last week measured using a 0–10 NRS. Pain-related disability was measured using 3 standardized disease-specific questionnaires, the Roland-Morris Disability Questionnaire (RMDQ), the Pain Disability Index (PDI), and the Quebec Back Pain Disability Scale (QBPDS), as well a patient-specific measure, the Patient-Specific Functional Scale (PSFS) (23). The patient's perception of their overall recovery was measured using the 11-point global perceived effect (GPE) scale (−5 to +5) (24).

Clinical importance. Prior to the study, the investigators (all of whom have a clinical background in physiotherapy or exercise therapy) agreed that a 1.5-unit between-group difference for the 0–10 bothersomeness scale would be considered clinically meaningful. Additionally, previous literature suggests that a 30% reduction in pain-related outcomes indicates an estimate of a clinically worthwhile effect (25). Therefore, a secondary analysis was conducted to determine what proportion of participants in each group achieved a 30% reduction from their baseline score. At the conclusion of the trial we sought the participant's perspective on this issue by interviewing a random sample of 15 participants from the waitlist control group. These participants were asked to nominate the smallest treatment effect on pain bothersomeness that would make them decide to undertake the treatment (i.e., the smallest worthwhile effect of treatment) (see Supplementary Appendix A, available in the online version of this article at http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)2151-4658).

Statistical analysis. A sample size of 160 participants was nominated in the trial protocol (18). We allowed for 15% noncompliance with treatment and 15% loss to followup and assumed a correlation of 0.5 between baseline scores and outcomes. This sample size provides 80% power to detect an effect of tai chi exercise of 1.5 units on the 0–10 bothersomeness scale (estimated SD 2.0), 1 unit on the 0–10 pain intensity scale, 1 unit on the 0–10 PSFS, 1 unit on the GPE scale, and 4 units on the 24-item RMDQ, with an alpha level of 0.05.

Data were double entered and checked for accuracy. The data were analyzed using linear mixed models in SPSS, version 18.0. The statistical analysis was performed on an intent-to-treat basis. The statistician was given coded data, and thus was blinded to treatment allocation. The code was broken after the investigators had inspected the results of the statistical analyses and agreed on their interpretation. The mean effects of intervention on bothersomeness of pain symptoms, pain intensity, function, and disability were calculated using linear mixed models (random intercepts and fixed coefficients) that incorporated terms for treatment allocation, time, and a treatment by time interaction.

RESULTS

Recruited participants. Of the recruited participants (n = 160), 80 were randomized to the tai chi exercise group and 80 were randomized to the waitlist control group (Figure 1). Of the 80 participants randomized to the tai chi group, 78 received the tai chi treatment as 2 participants dropped out of the study postrandomization but before

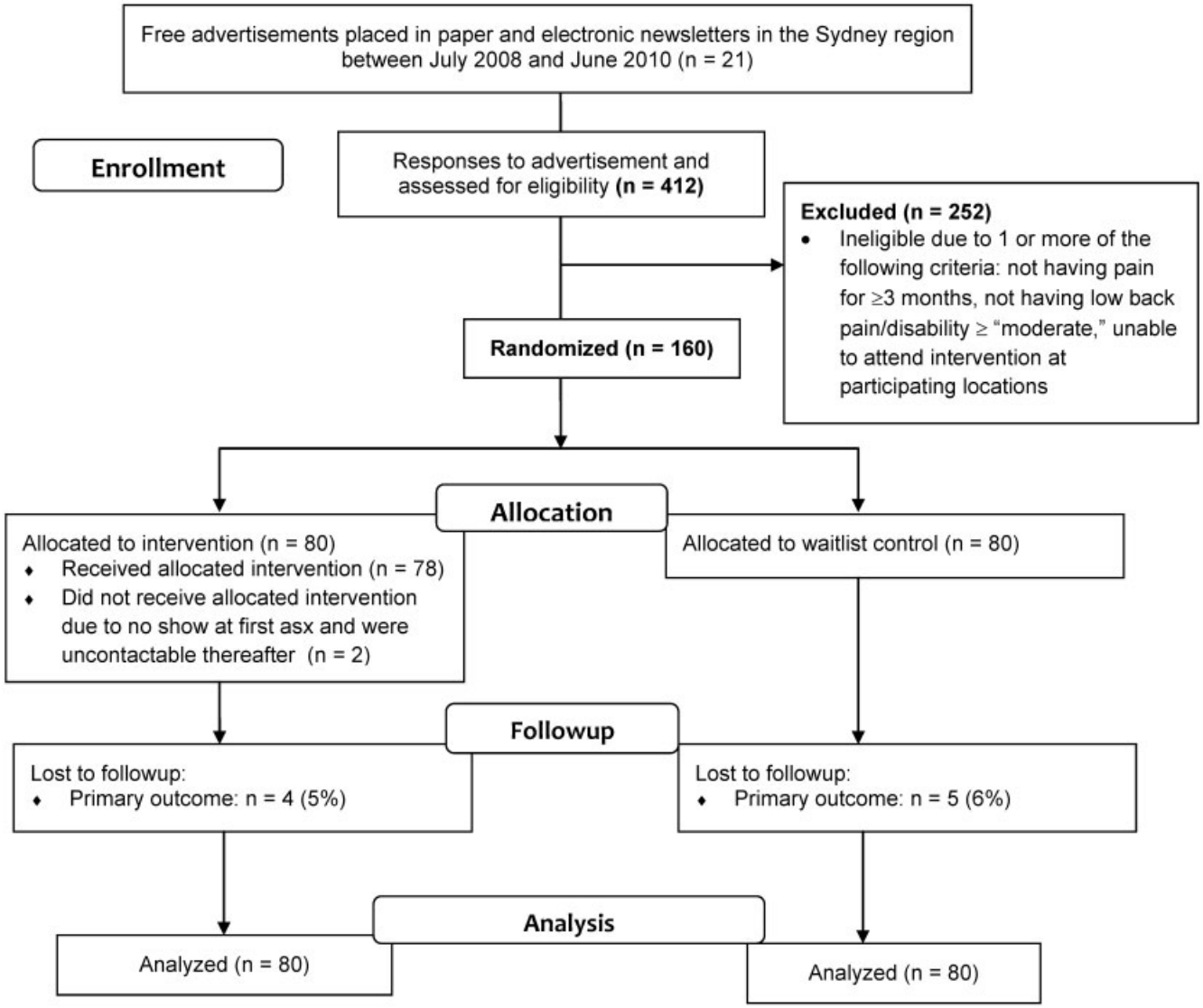

Figure 1. Consolidated Standards of Reporting Trials 2010 flow diagram: participant tracking from enrollment to analysis. asx = assessment.

receiving treatment. The mean ± SD age of all 160 participants was 44.4 ± 13.2 years, with 119 (74.4%) women. All of the participants had pain symptoms persisting for longer than 3 months, with a mean ± SD score on the Chronic Pain Grade Scale of 30.1 ± 11.2 points of a maximum 64 points. The groups were not statistically significantly different at baseline with regard to age, sex, self-reported chronic pain grade, and scores for the outcomes (Table 1).

Loss to followup. Of the 160 participants randomized, the followup rate at 10 weeks after baseline was 94% (control group) and 95% (tai chi group) for bothersomeness of pain, pain intensity, and GPE; 90% (control group) and 91% (tai chi group) for the RMDQ; 88% (control) and 93% (tai chi group) for the PSFS and PDI; and 83% (control group) and 89% (tai chi group) for the QBPDS. The primary analysis was by intent-to-treat with participants analyzed in the treatment group they were allocated to (n = 160). The results are reported in Table 2.

Treatment adherence. Adherence to treatment was defined as attendance at 75% or more of the 18 tai chi sessions over the 10-week period. According to this definition, 28.8% of the treatment group adhered to the intervention. Further analysis of attendance indicated that in total, 57.5% of the total treatment group attended 50% or more of the tai chi sessions. Three people discontinued treatment after 3 weeks due to medical complications not associated with the intervention.

Outcome measures. The tai chi intervention produced greater reductions in pain symptoms and pain-related disability than the control intervention (Table 2). The group mean for treatment effects on the primary outcome of bothersomeness of pain symptoms was 1.7 points (95%

Table 1. Baseline demographic and clinical characteristics for each group

	Tai chi (n = 80)	Control (n = 80)
Age, mean ± SD years	43.4 ± 13.5	44.3 ± 13.0
Female sex, no. (%)*	63 (78.8)	56 (70.0)
Smoking status (current), no. (%)	9 (11.3)	5 (6.6)†
Pain duration >3 months, no. (%)	80 (100)	80 (100)
Previous episode of back pain, no. (%) yes	64 (81)‡	59 (71.4)§
Previous treatment for back pain, no. (%) yes	67 (83.8)	64 (83.1)§
Previous sick leave for back pain, no. (%) yes	35 (43.8)	43 (55.8)§
Chronic Pain Grade Questionnaire, mean ± SD	30.6 ± 11.0‡	29.6 ± 11.6§
Expectation of tai chi, mean ± SD¶	7.3 ± 1.8†	7.5 ± 2.2#

* Pearson's chi-square for sex × allocation = 0.205.
† N = 76.
‡ N = 79.
§ N = 77.
¶ Patient expectation regarding how helpful tai chi would be for their low back pain problems measured using a 0–10 numerical rating scale, with 0 = "not at all helpful" and 10 = "extremely helpful."
# N = 69.

confidence interval [95% CI] 0.9, 2.5). Additionally, there was a small between-group difference in perception of recovery, with those in the tai chi group reporting the perception of their condition to be in the "improved" end of the scale and the control group reporting their condition to be in the "no change" portion of the scale.

The random sample of participants who participated in the interview regarding the smallest worthwhile effect of tai chi were not statistically significantly different from the total study sample on any baseline characteristic listed in Table 1 or any baseline outcome measure listed in Table 2. Therefore, it can be considered that the interviewed participants constitute a representative sample of the study group. The results of the participant interviews indicated that a treatment effect of 1.7 points on the 0–10 bothersomeness of pain scale was large enough to make a 10-week course of tai chi worthwhile for 75% of the interviewed participants (Table 3). The results of secondary analysis regarding clinical importance are reported in Table 3.

Negative side effects of treatment. Three participants reported a small initial increase in back pain symptoms that were alleviated by the third or fourth week of treatment, and 1 participant reported an increase in upper back pain that was alleviated once they corrected upper extremity posture.

DISCUSSION

To our knowledge, this is the first RCT of tai chi exercise for people with low back pain symptoms persisting for greater than 3 months. The results support a beneficial effect of tai chi exercise compared to usual care on bothersomeness of pain symptoms, pain intensity, function, and disability. The trial results were interpreted by 4 investigators who were blinded to treatment allocation. All of the investigators agreed that there was a statistically significant and clinically meaningful between-group difference in the bothersomeness of back pain symptoms. Likewise, 75% of the interviewed participants reported that the treatment effect met their requirements for the smallest worthwhile effect of tai chi for their back pain problems.

The magnitude of the treatment effects on all outcomes for tai chi is similar to that reported for other exercise interventions for chronic low back pain. For example, the results observed in our study are consistent with those

Table 2. Effect of tai chi*

	Tai chi (n = 80)		Control (n = 80)		Between-group difference, mean difference (95% CI)†	Statistically significant *P*
	Baseline, mean (95% CI)	10 weeks, mean (95% CI)	Baseline, mean (95% CI)	10 weeks, mean (95% CI)		
Bothersome (0–10)‡	5.0 (4.5, 5.5)	3.7 (3.2, 4.217)	4.53 (4.00, 5.05)	4.9 (4.4, 5.4)	1.7 (0.9, 2.5)	0.000
Pain (0–10)	4.4 (4.0, 4.9)	3.4 (2.91, 3.8)	4.44 (3.98, 4.89)	4.7 (4.2, 5.1)	1.3 (0.7, 1.9)	0.000
PDI (0–70)	22.7 (19.8, 25.7)	17.0 (13.9, 20.0)	23.9 (20.9, 26.9)	23.8 (20.7, 27.0)	5.7 (1.8, 9.6)	0.005
RMDQ (0–24)	10.2 (9.1, 11.3)	7.01 (5.88, 8.14)	9.1 (8.0, 10.2)	8.1 (7.0, 9.3)	2.6 (1.1, 3.7)	0.000
QBPDS (20–100)	29.2 (25.7, 32.8)	22.0 (18.4, 25.6)	30.2 (26.6, 33.9)	29.6 (25.9, 33.3)	6.6 (2.4, 10.7)	0.002
PSFS (0–10)	3.5 (3.0, 4.0)	4.7 (4.2, 5.2)	4.0 (3.5, 4.5)	4.10 (3.6, 4.6)	−1.0 (−1.7, −0.4)	0.001
GPE (−5 to +5)	0.4 (−0.1, 0.8)	1.6 (1.2, 2.1)	−0.1 (−0.6, 0.8)	0.4 (−0.1, 0.8)	−0.8 (−1.5, −0.0)	0.05

* 95% CI = 95% confidence interval; PDI = Pain Disability Index; RMDQ = Roland-Morris Disability Questionnaire; QBPDS = Quebec Back Pain Disability Scale; PSFS = Patient-Specific Functional Scale; GPE = global perceived effect.
† Data are unadjusted baseline and followup outcomes and effects of tai chi from the linear mixed models.
‡ Bothersomeness is the primary outcome.

Table 3. Percentage in each group that had an observed 30% or greater improvement from their baseline score*

	Tai chi (n = 80), no. (%) improved by 30%	Control (n = 80), no. (%) improved by 30%	Attributable fraction ($N_{Tc} - N_{Con}/N_{Tc}$) × 100%, %†	NNT, $1/(\%_{Tc} - \%_{Con})$‡
Bothersome (0–10)§	40 (50)	14 (17.5)	65	4
Pain (0–10)	37 (46.3)	12 (15)	67.5	4
PDI (0–70)	36 (45)	14 (17.5)	61	4
RMDQ (0–24)	40 (50)	19 (23.8)	52.5	4
QBPDS (20–100)	32 (40)	6 (7.5)	81.2	4
PSFS (0–10)	35 (43.8)	13 (16.3)	62.8	4

* N_{Tc} = number of patients in the tai chi group who had an observed ≥30% improvement from their baseline score; N_{Con} = number of patients in the waitlist control group who had an observed ≥30% improvement from their baseline score; PDI = Pain Disability Index; RMDQ = Roland-Morris Disability Questionnaire; QBPDS = Quebec Back Pain Disability Scale; PSFS = Patient-Specific Functional Scale.
† The proportion of the observed improvement in the tai chi group that can be attributed to the tai chi intervention, i.e., the proportion of the observed 30% reduction in pain intensity that can be attributed to the intervention of tai chi.
‡ NNT = the number needed to undergo the treatment for 1 person to have the event; in this case, a 30% reduction in the clinical outcome. Number rounded up to the nearest whole number to represent an actual number of people.
§ Pain bothersomeness is the primary outcome.

reported in a recent meta-analysis of exercise compared to no exercise for chronic low back pain that included 5 moderate- to high-quality RCTs with pain outcomes and 9 moderate- to high-quality RCTs with disability outcomes (9). Additionally, these results are also consistent with the results found in a meta-analysis of tai chi exercise for people with arthritis pain (12).

Our study has a number of strengths, including the use of an RCT design, the trial was prospectively registered with the Australian New Zealand Clinical Trials Registry, and we followed a prespecified and published protocol that can be accessed online at http://www.biomedcentral.com/1471-2474/10/55 (18). We followed a well-described protocol for tai chi and used an experienced tai chi practitioner to deliver therapy. We minimized contamination in the usual care group by offering the participants the opportunity to participate in tai chi at trial conclusion. We measured outcome using instruments with good clinimetric properties, validated in samples similar to our own. Lastly, this is among the first trials to ask participants if they believe the results are worthwhile.

The study sample included participants who volunteered for the study via community advertisements and were not typically seeking or receiving care for their back pain problems. Therefore, it is unclear whether the conclusions are generalized to those who are seeking care for their back pain. However, the participant demographics of our sample are comparable in terms of mean age, pain, and disability to those reported in other physiotherapy-based trials of patients with chronic low back pain (26,27). Furthermore, these effects were observed at short-term followup directly after the 10-week treatment; therefore, the effects of treatment in the long-term remain unknown.

The exact mechanism(s) by which tai chi may elicit a beneficial outcome for people with low back pain is not clear and was not specifically studied in this trial. However, the design of the tai chi exercise intervention used in this study incorporated components of strengthening and stretching that previously have been associated with better outcomes for exercise therapy and back pain (10). The focus of the 10-week tai chi exercise program was postural and body awareness, lower extremity strengthening, static and dynamic balance, and gentle thoracic stretching. To date, lower extremity strengthening, improved balance, and postural control have been shown to help decrease loads in the lumbar spine (28), yet this has not been associated with decreased pain in clinical trials. It is also been hypothesized that complex interventions, such as tai chi or yoga, that include a body awareness and/or relaxation component may reduce pain and dysfunction through improved cognitive appraisal about back pain and/or the relief of psychological distress (29,30). With respect to cognitive appraisal regarding back pain, there is some preliminary evidence to suggest that chronic nonspecific pain may be associated with changes in body perceptions (31) and may be improved by increasing body awareness and cognitive appraisal (31); however, this has not yet been confirmed as a mechanism for persistent low back pain. Symptoms of psychological distress, however, have been associated with persistent low back pain and have recently been identified as potential mediators in the development of chronic low back pain (32). A recent systematic review of RCTs of tai chi interventions showed that it had a small to moderate effect for reducing symptoms of depression (33). While this effect was not specific to patients with low back pain, the findings lend support for relief of psychological distress as a possible mediator of tai chi on pain and disability. As yet, these potential mechanisms of tai chi for pain reduction lack formal testing and remain speculative. To establish the exact mechanisms of tai chi, further research is required.

While participants improved with tai chi, typically they did not fully recover. For example, with regard to pain bothersomeness, the group mean for the tai chi group was 3.7 (95% CI 3.2, 4.217) following the intervention. Likewise, the mean score of pain intensity was 3.4 (95% CI 2.91, 3.8). Although there is no consensus as to what cutoff scores best represent complete recovery for people with low back pain, a recent study found that a pain score of 0 most correctly classifies patients who report they were "completely recovered" (34). We recognize that "recovery" has been found to be a highly individual construct that encompasses more than just pain intensity (35), and the lack of an established definition presents many challenges

in interpreting patient-specific effects of treatments (36). However, it would be reasonable to conclude, on the basis of our results, that while tai chi provides benefits for pain reduction considered clinically worthwhile by patients and researchers, "complete recovery" of long-term low back pain with a 10-week course of tai chi exercise is unlikely.

While the study design of this first RCT to investigate the effectiveness of tai chi for long-term low back pain is rigorous and appropriate, we acknowledge there are limitations. First, the results presented in this study represent short-term effects and it is unknown at present whether these would be maintained over a longer duration. Second, this study focuses on the effectiveness of tai chi compared to usual care; therefore, the effects of tai chi compared to other interventions are unknown. Third, while in this study the outcomes focused on the major problems associated with persistent low back pain, i.e., pain bothersomeness and pain-related activity limitation, other aspects of interest for this population such as physical activity levels or psychological distress were not fully assessed. These could be important outcomes for future studies. Further, outcomes in this study were patient self-report, and patients were not blinded to treatment allocation at followup assessment, which may have introduced some bias into the results. Finally, while the generalizability of our results may extend to the broader community, they may not extend to a more clinical population presenting to primary care.

Future study designs of tai chi should 1) include a longer-term followup to determine if the observed effects in the current study are also demonstrated over a longer period of time, 2) use another intervention arm to investigate the effects of tai chi compared to other current treatments, 3) assess a broader range of outcomes important in the management of low back pain such as quality of life variables and in particular outcomes that could be assessed by a blinded assessor such as physical activity and function, 4) incorporate potential mediating and moderating variables, 5) replicate the study in other patient populations, such as those low back pain patients seeking treatment in primary care, and 6) replicate the results with the intervention delivered by other trained tai chi instructors. Interestingly, this was among one of the first studies to assess the patient's perspective on worthwhile effect of treatment by interviewing a small sample of included patients at the end of their treatment course. Future studies could interview an entire sample prior to them being randomized to treatment groups.

This is the first pragmatic RCT of tai chi for long-term low back pain. It showed that a 10-week tai chi program was an effective intervention for improving pain and disability outcomes. These effects were comparable to those observed with other forms of exercise therapy and provide evidence for the use of tai chi as an intervention for those who have persistent low back pain symptoms.

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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 published. 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, Lam, Ferreira, Latimer.

Acquisition of data. Hall, Ferreira.

Analysis and interpretation of data. Hall, Maher, Ferreira.

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