CLINICAL STUDY

# The Effect of Tai Chi Exercise on Blood Pressure: A Systematic Review

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*A systematic review of the literature on the effect of tai chi exercise on blood pressure (BP) was performed. The authors searched Medline, CAB, Alt HealthWatch, BIOSIS previews, Science Citation Index, and EMBASE systems (inception through January 2007); researched Chinese Medical, China Hospital Knowledge, China National Knowledge Infrastructure, and China Traditional Chinese Medicine databases (inception to June 2005); and performed hand searches at the medical libraries of Beijing and Nanjing Universities. Clinical studies of tai chi examining BP as an outcome published in English or Chinese were included. Studies reporting only acute exercise effects were excluded. Data were extracted in a standardized manner and 2 independent investigators assessed methodologic quality. Twenty-six studies examining patients with and without cardiovascular conditions met inclusion criteria: 9 randomized controlled trials, 13 nonrandomized studies, and 4 observational studies. Study heterogeneity precluded formal meta-analyses. Twenty-two studies (85%) reported reductions in BP with tai chi (3–32 mm Hg systolic and 2–18 mm Hg diastolic BP reductions). Five randomized controlled trials were of adequate quality (Jadad score ≥3). No adverse effects were reported.*

*Tai chi exercise may reduce BP and serve as a practical, nonpharmacologic adjunct to conventional hypertension management.* Prev Cardiol. *2008;11:82–89.* ©*2008 Le Jacq*

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*Manuscript received August 8, 2007; revised September 28, 2007; accepted October 9, 2007*



Hypertension is the most common primary office diagnosis in the United States, with more than 35 million visits per year. Despite pharmacologic advances and nationwide education campaigns, only one-third of adult patients with hypertension in 2000 had adequate blood pressure (BP) control, far below the Healthy People 2010 goal of 50%.[1] Clinical trials have consistently shown the benefits of lowering BP, with substantial reductions in cardiovascular risk, stroke, myocardial infarction, heart failure, and cardiovascular-related death.[2] While pharmacologic therapy is often emphasized, the critical importance of nonpharmacologic approaches and lifestyle modifications, including physical activity and exercise, has continued to be recognized by the most recent Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) report for both primary and secondary prevention of high BP.[1]

In recent years, with the popularity and prevalence of mind-body therapies, there has been a growing interest in tai chi exercise for patients with hypertension.[3–5] Tai chi (t'ai chi or taiji) has origins in ancient Chinese martial arts and combines gentle physical activity with elements of meditation, body awareness, imagery, and attention to breathing. The scientific literature describing tai chi is varied, with studies reporting benefits in a number of health conditions, from balance and reduction of falls in frail adults, to improvements in quality of life and symptoms of rheumatoid arthritis, the human immunodeficiency virus, cancer, and heart failure.[6,7] A substantial amount of research examines the cardiovascular effects of tai chi, including cardiorespiratory fitness and exercise capacity, although BP is the most commonly evaluated effect in these studies.[4,8]

To date, there have been no comprehensive systematic reviews examining long-term BP effects of

tai chi, and very little is known about what has been published in the Chinese language. Our objective was to conduct a systematic review of Chinese and English language literature on the effects of tai chi on BP and hypertension and to offer recommendations for future research.

## METHODS

### Literature Search

We conducted electronic literature searches of Medline (from 1966), CAB (from 1973), Alt HealthWatch, BIOSIS previews (from 1969), Science Citation Index (from 1945), and EMBASE systems (from 1991) through January 2007 using search terms "tai chi," "tai chi chuan," "ta'i chi," "tai ji," and "taijiquan." In addition, we performed searches of the Chinese Medical, China Hospital Knowledge, China National Knowledge Infrastructure, and China Traditional Chinese Medicine databases from inception to June 2005 and performed hand searches at the medical libraries of Beijing and Nanjing Universities in China. We also performed hand searches of retrieved articles for additional references.

### Eligibility Criteria

Available clinical studies published in English and Chinese that used human participants and examined long-term (nonacute) BP changes (>1 week) were included.

### Data Extraction and Synthesis

Two independent reviewers extracted data in a standardized manner. We extracted data from Chinese language articles with direct translation to English.

### Grading of Methodologic Quality

To assess methodologic quality of studies, we developed an "ABC" summary quality grading system adapted from methods used in evidence reports of the Agency for Healthcare Research and Quality (AHRQ) Evidence-Based Practice Centers.[9] Two independent investigators assessed methodologic quality, evaluating specific criteria for each study design type (randomized controlled trials [RCTs], prospective nonrandomized controlled and noncontrolled studies [NRSs], and observational controlled and noncontrolled studies [OBSs] and assigning an A, B, or C grade based on the potential for bias in the study. Any discrepancies between assessors were resolved through discussion. The summary quality grading system evaluates and rates studies within each of the study design strata. By design, it does not attempt to assess the comparative validity of studies across different design strata. Thus, in interpreting the methodologic quality of a study, one should note the quality grade that it received *and* the study design. For RCTs, in addition to the summary quality grade, we also indicate a modified Jadad score. Because double-blinding is impractical in tai chi studies, our modification gives 1 point for proper single-blinding of the outcome assessors. Summary quality grading criteria for each of the 3 design strata are listed in Table I.

## RESULTS

We screened 829 English language and 859 Chinese language abstracts and full text articles for potentially relevant data. A total of 26 studies (11 in English, 15 in Chinese) met the inclusion criteria and were analyzed. This includes 9 RCTs, 13 NRSs, and 4 OBSs.[10–35] Studies were conducted in patients with hypertension, coronary heart disease, varied cardiovascular conditions, and chronic rheumatologic and dermatologic conditions, as well as in "healthy volunteers." Within these studies, in addition to BP, other reported outcomes included heart rate, body mass index, exercise capacity, heart rate variability, lipids, pulmonary and cardiac function, functional measures, and quality of life. Table II details studies examining BP in patients with hypertension.[10–17] Table III details studies examining BP in other cardiovascular populations.[18–20] Table IV details studies examining BP in noncardiovascular populations and "healthy" patients.[21–35] Study heterogeneity precluded formal meta-analysis. No adverse events associated with tai chi were reported. Of the 9 RCTs, 4 received an A quality score and 2 received a B. Of the 13 NRSs, 11 received a B score. Of the 4 OBSs, 1 received an A and 3 received a B score. Of the English language studies, 5 received an A and 6 received a B. Of the Chinese studies, 1 received an A, 10 received a B, and 4 received a C. The significance of each rating is provided in Table I.

### Studies in Patients With Hypertension

Of the 8 studies that specifically evaluated patients with hypertension, all reported a statistically significant within-group reduction in mean BP after tai chi exercise. Three RCTs, 4 NRSs, and 1 OBS with a total of 524 patients with hypertension were found (Table II). The duration of tai chi training for the studies ranged from 12 weeks to 3 years. The magnitude of systolic BP (SBP) and diastolic BP (DBP) change in the tai chi group ranged from –7 to –32 mm Hg and –2.4 to –18 mm Hg, respectively.

The 3 RCTs specifically designed to study patients with hypertension varied in quality and study design. Young and colleagues[10] compared a light-intensity tai chi program that "emphasized physical movements rather that meditational aspects" to moderate-intensity walking and low-impact aerobic dance. The investigators reported comparable BP reductions (±SD) in both groups (–7.0 [±8.8] vs –8.4 [±8.8] mm Hg SBP; –2.4 [±5.5] vs –3.2 [±5.5] mm Hg DBP, respectively); however, there were no difference between groups. Of note, a higher compliance with home exercise was reported in the tai chi group. Tsai and colleagues[11] reported significant SBP and DBP

**Table I.** ABC Quality Grading Criteria for 3 Study Design Strata[a]

| |
|---|
| Randomized controlled trials |
| Adequate randomization, proper single-blinding of assessors, and reporting of dropouts (modification of Jadad score) |
| Adequate methods used to assess physical activity |
| No errors or discrepancies in reporting results |
| Clear inclusion/exclusion criteria |
| Sample size estimates/justification |
| Adequate description of tai chi intervention (eg, style, training schedule, frequency/duration of classes, instructor experience) |
| Adequate description of comparison groups |
| Prospective, nonrandomized studies (controlled and noncontrolled) |
| Unbiased selection of the cohort (prospective recruitment of patients) |
| Sufficiently large sample size |
| Adequate description of the cohort; clear inclusion/exclusion criteria |
| Adequate methods used to assess physical activity |
| Adequate description of tai chi intervention (eg, style, training schedule, frequency/duration of classes, instructor experience) |
| Adequate description of comparison groups |
| Use of validated method for ascertaining clinical outcomes |
| Adequate follow-up period |
| Completeness of follow-up |
| Analysis (multivariate adjustments) and reporting of results; use of appropriate statistical analyses |
| Observational studies (controlled and noncontrolled) |
| Valid ascertainment of cases |
| Unbiased selection of cases |
| Appropriateness of the control population (as applicable) |
| Clear inclusion/exclusion criteria |
| Comparability of cases and controls with respect to potential confounders |
| Adequate methods used to assess physical activity |
| Adequate description of tai chi intervention (eg, style, training schedule, frequency/duration of classes, instructor experience) |
| Adequate description of comparison groups |
| Appropriate statistical analyses |

ABC grades: A, Least bias; results are valid. B, Susceptible to some bias but not sufficient to invalidate the results. C, Significant bias that may invalidate the results. [a]ABC summary quality grading system adapted from methods used in evidence reports of the Agency for Healthcare Research and Quality.[9]

reductions, while there were no changes with usual care. They also reported significant improvements in lipids (total cholesterol, triglycerides, and low- and high-density lipoprotein), as well as improvements on the State-Trait Anxiety Inventory. The study by Shen and Su,[12] conducted in China, compared tai chi with antihypertensive agents (unspecified) and with no treatment. Although this study was poorly described and lacked detail, the investigators reported a significantly larger proportion of patients meeting "effective BP control" in the tai chi group (73% in tai chi vs 45% in the medication group, $P<.01$).

### Studies in Other Cardiovascular Populations

Of the 3 studies that examined patients with cardiovascular conditions, 2 studies examined patients with coronary heart disease discharged after an acute hospital stay (Table III). In the only RCT in this subset, Channer and colleagues[18] randomized patients recovering from an acute myocardial infarction to a mixed tai chi/qigong intervention, conventional aerobic exercise, or a cardiac support group. After 8 weeks, both aerobic exercise and tai chi were associated with significant reductions (±SD) in SBP (–4 [±7.5] and –3 [±3.3] mm Hg, respectively, both $P<.05$). DBP was improved in the tai chi group only (–2 [±2.7] mm Hg, $P<.01$). No between-group comparisons were made. This study also reported decreases in resting heart rate and greater compliance with the tai chi intervention. The prospective nonrandomized study by Zheng[19] showed decreases in DBP in patients with coronary artery disease who had a mean baseline BP that met current JNC 7 criteria for stage I hypertension.

### Studies in Noncardiovascular Populations and Healthy Patients

Of the 15 studies in this subset, most were conducted in middle-aged "healthy" patients, although the mean age ranged from 20 to 81 years (Table IV). Five RCTs, 7 NRSs, and 3 OBSs with a total of 1157 patients were included. The magnitude of BP decreases in these studies ranged from –4 to –18 mm Hg SBP and –2.3 to –7.5 mm Hg DBP. Most compared tai chi with usual activity, other forms of exercise, or education. Of note, patients in 4 of these studies had a mean baseline SBP >140 mm Hg, although a diagnosis of hypertension was not mentioned.

## DISCUSSION

Tai chi may have beneficial effects on BP, although studies have varied in methodologic quality. Each of the 8 studies specifically designed to evaluate patients with hypertension reported improvements in BP with tai chi, although sometimes showing no difference when compared with conventional exercise. Another 18 studies, including other cardiovascular populations and "healthy" patients, offer supportive evidence that tai chi can reduce BP and may play a role in primary prevention. More than one-half of the studies were published in Chinese and offer data that has historically been excluded from other reviews.

**Table II.** Studies of Tai Chi in Patients With Hypertension

| Reference (Author, Year, Country, Publication Language) | Study Design | Study Population Description, Mean Baseline BP, Mean Age | No.[a] | Intervention/ Control Details | BP Results/Magnitude of BP Change (SD if Available) in TC group[b] | Modified Jadad Score[c] and/ or ABC Quality Score |
|---|---|---|---|---|---|---|
| Young et al,[10] 1999, United States, English | RCT | High normal or stage I hypertension<br>140/76 mm Hg<br>67 y | 60 | Yang-style TC (13 movements) for 12 wk<br>Walking/aerobic dance | Decreased BP in both groups (between-group *P* value not significant)<br>SBP –7 (8.8) mm Hg<br>DBP –2 (5.5) mm Hg | +4[c]<br>A |
| Tsai et al,[11] 2003, Taiwan, English | RCT | High normal or stage I hypertension<br>145/87 mm Hg<br>51 y | 76 | Yang-style TC (108 postures) for 12 wk<br>Usual care | Decreased BP (compared with usual care)<br>SBP –16 (7.9) mm Hg<br>DBP –9 (7.4) mm Hg | +3[c]<br>B |
| Shen and Su,[12] 2000, China, Chinese | RCT | Essential hypertension<br>Baseline BP not reported<br>64 y | 60 | TC/Qigong (18 postures; unspecified duration)<br>Medication[d]<br>No treatment | Decreased BP (compared with medication and no treatment)<br>SBP –30 mm Hg<br>DBP –10 mm Hg | +2<br>C |
| Wang et al,[13] 2000, China, Chinese | NRS | Essential hypertension or high normal<br>(Men) 161/97 mm Hg (hypertension)<br>140/83 mm Hg (high normal)<br>66 y | 54 | Yang-style TC for 3 y | Decreased BP<br>SBP –14 mm Hg (hypertension); –10 mm Hg (high normal)<br>DBP –7 mm Hg (hypertension); –3 mm Hg (high normal) | B |
| Fang and Wang,[14] 1985, China, Chinese | NRS | Stage I/II hypertension<br>168/103 mm Hg<br>Range 40–70 y | 70 | Yang-style TC (simplified 24 forms) for 12 wk<br>Qigong breathing<br>Medication (tab hypotensor co-captopril)[d]<br>No treatment | Decreased BP all groups compared with no treatment (between-group *P* value not significant for active interventions)<br>SBP –13 mm Hg<br>DBP –8 mm Hg | B |
| Lu et al,[15] 1987, China, Chinese | NRS | Hypertension<br>180/99 mm Hg<br>66 y | 14 | TC (unspecified style)/Qigong/ relaxed slow running for 6 mo | Decreased BP<br>SBP –32 mm Hg<br>DBP –18 mm Hg | B |
| Taylor-Piliae,[16] 2006, United States, English | NRS | At least 1 CV risk factor (92% with hypertension)<br>150/86 mm Hg<br>66 y | 38 | Yang-style TC (24-posture short form) for 12 wk | Decreased BP<br>SBP –19 (2.8) mm Hg (at rest); –14 (4.0) mm Hg (after step-test)<br>DBP –9 (1.3) mm Hg (at rest); –17 (3.5) mm Hg (after step-test) | B |
| Liu and Li,[17] 2004, China, Chinese | OBS | Chronic hypertension<br>66 y | 113 | TC (unspecified style; unspecified duration)<br>No TC | Decreased BP,<br>TC vs control: SBP 159 vs 167 mm Hg | B |

[a]Number of study participants included in blood pressure (BP) analyses. [b]All within-group (tai chi [TC]) pre-post changes are significant ($P \leq .05$) unless otherwise noted. All results in controlled trials are reported in comparison with the control group(s) and are significant ($P \leq .05$) unless otherwise noted. [c]Modified Jadad score for randomized controlled clinical trials (RCTs) (which gives 1 point for proper single-blinding of outcome assessors). [d]No further details reported. Abbreviations: CV, cardiovascular; DBP, diastolic BP; NRS, prospective nonrandomized studies (that include an intervention), controlled and noncontrolled; OBS, observational, cross-sectional studies, controlled; SBP, systolic BP; SD, standard deviation.

**Table III.** Studies of Long-Term BP Effects in Other Cardiovascular Populations

| Reference (Author, Year, Country) | Study Design | Study Population Description, Mean Baseline BP, Mean Age | No.[a] | Intervention/ Control Details | BP Results/ Magnitude of BP Change in TC group[b] | Modified Jadad[c] and/or ABC Quality Score |
|---|---|---|---|---|---|---|
| Channer et al,[18] 1996, United Kingdom, English | RCT | Coronary artery disease (post-myocardial infarction)<br>133/84 mm Hg<br>56 y | 126 | Wu-style TC/Qigong for 8 wk<br>Exercise to music<br>Support group | Decreased BP both exercise groups (between-group *P* value not reported)<br>BP –3 (3.3) mm Hg<br>DBP –2 (2.7) mm Hg | +2<br>B |
| Zheng,[19] 2004, China, Chinese | NRS | Coronary artery disease<br>149/88 mm Hg<br>68 y | 24 | Yang-style TC (simplified 24 forms) for 3 mo | Decreased DBP<br>DBP –6 mm Hg | B |
| Zhou and Li,[20] 1994, China, Chinese | NRS | Various CV conditions (26% with hypertension)<br>Baseline BP not reported<br>54 y | 143 | TC (unspecified style) for 3 y<br>No TC | Decreased BP (compared with no TC)[d] | C |

[a]Number of study participants included in blood pressure (BP) analyses; [b]All within-group (tai chi [TC]) pre-post changes are significant ($P \leq .05$) unless otherwise noted. All results in controlled trials are reported in comparison with the control group(s) and are significant ($P \leq .05$) unless otherwise noted. [c]Modified Jadad score for randomized controlled clinical trials (RCTs) (which gives 1 point for proper single-blinding of outcome assessors). [d]No further details reported. Abbreviations: CV, cardiovascular; DBP, diastolic BP; NRS, prospective nonrandomized studies (that include an intervention), controlled and noncontrolled; OBS, observational, cross-sectional studies, controlled; SBP, systolic BP.

### Comparison With Nonpharmacologic Approaches to Hypertension

Traditionally, the role of exercise in the management of BP and hypertension has been discussed in combination with other lifestyle modifications, including weight loss, sodium restriction, the Dietary Approaches to Stop Hypertension (DASH) diet with increased potassium and calcium, moderation of alcohol, and smoking cessation.[36,37] With tai chi, we found reductions in SBP from 7 to 32 mm Hg. Studies of conventional physical activity have reported changes in SBP from 4 to 9 mm Hg and suggest that there may be an additive effect when used in combination with other nonpharmacologic strategies, lowering SBP up to 10 to 15 mm Hg.[38–40] Although it is difficult to compare magnitudes of BP reductions across studies, the available data suggest that tai chi may be as effective as other lifestyle approaches.

### Comparison With Other Mind-Body Approaches

Similar BP-lowering effects have been reported with other mind-body therapies, both nonexercise and exercise-based interventions (eg, transcendental meditation, mindfulness-based stress reduction, qigong, and yoga).[41–45] In one study, investigators reported a 3.4 mm Hg SBP reduction in patients with stable coronary disease who practiced 16 weeks of transcendental meditation, as compared with health education. The mechanisms by which mind-body interventions such as tai chi may contribute to reductions in BP are not well understood, although modulation of autonomic tone is often cited.[46–48] The role of stress in cardiovascular physiology and the relationship between stress, chronic sympathetic stimulation, and vasoconstriction is well described.[49] Although there is a component of aerobic exercise with tai chi, to what extent the meditation, imagery, breathwork, general relaxation, and stress reduction play active roles in the overall effects is unknown. Studies suggest that meditative and stress reduction techniques (eg, progressive muscle relaxation, biofeedback, or music therapy) alone can have measurable effects on BP.[50]

### Clinical Implications and Advantages of Tai Chi

Given the existing evidence, tai chi exercise may be a safe and effective alternative to conventional exercise programs. It may be appropriate for patients unable or unwilling to engage in other forms of physical activity or as a bridge to more rigorous activity in frail or deconditioned patients. Patients with borderline BPs may be reluctant to begin drug therapy and often welcome nonpharmacologic approaches. These lifestyle interventions have been recognized as important and effective strategies for both primary and secondary prevention, although they often require a high level of motivation from the patient.[39] Patients with either prehypertension or established hypertension, who otherwise feel well, may find it difficult to engage in and maintain a regular conventional exercise regimen. Finding an appropriate, nonthreatening, easy-to-perform activity that patients will maintain

**Table IV.** Studies of Long-Term BP Effects in Noncardiovascular and "Healthy" Patients

| Reference (Author, Year, Country) | Study Design | Study Population Description, Mean Baseline BP, Mean Age | No.[a] | Intervention/ Control Details | BP Results/Magnitude of BP Change (SD) in TC group[b] | Modified Jadad[c] and/ or ABC Quality Score |
|---|---|---|---|---|---|---|
| Wolf et al,[21] 1996, United States, English | RCT | Healthy<br>SBP post-walk 169 mm Hg<br>76 y | 167 | Yang-style TC for 15 wk<br>Computerized balance training<br>Education | Decreased SBP post-walk test (compared with balance training and education)<br>SBP –13 (27.4) mm Hg | +4[c]<br>A |
| Wolf et al,[22] 2006, United States, English | RCT | Transitionally frail<br>149/77 mm Hg<br>81 y | 311 | Yang-style TC for 48 wk<br>Wellness education | Decreased SBP (compared with education)<br>SBP –7 mm Hg<br>DBP –4 mm Hg | +4†<br>A |
| Thomas et al,[23] 2005, Hong Kong, English | RCT | Healthy<br>142/72 mm Hg<br>69 y | 207 | Yang-style TC (24 forms) for 12 mo<br>Resistance training<br>Usual activity | No change in BP (compared with resistance training and usual activity) | +3<br>A |
| Zhang and Yue,[24] 2004, China, Chinese | RCT | Healthy men<br>123/79 mm Hg<br>20 y | 20 | TC (unspecified style) for 8 wk<br>Running | Decreased BP (compared with running)<br>SBP –9 mm Hg<br>DBP –6 mm Hg | +2<br>C |
| Zhang et al,[25] 1997, China, Chinese | RCT | Healthy<br>Baseline BP not reported<br>Mean age not reported | 60 | TC (unspecified style and duration)<br>No exercise | Decreased BP (compared with no exercise)<br>Magnitude of change not reported | +1<br>C |
| Wu and Ho,[26] 1996, China, Chinese | NRS | Chronic rheumatic and dermatologic conditions<br>118/75 mm Hg<br>54 y | 20 | Yang-style TC (simplified 24 forms, 108 movements) for 3 mo | Increased SBP (+7 mm Hg) | A |
| Ko et al,[27] 2006, Hong Kong, English | NRS | Healthy women; hospital staff<br>114/69 mm Hg<br>41 y | 20 | TC (unspecified style) for 10 wk | Decreased SBP (–6 mm Hg) | B |
| Schaller[28] 1996, United States, English | NRS | Healthy<br>Mean BP not reported<br>70 y | 46 | Modified TC for 10 wk<br>Usual activity | No change in BP (compared with usual activity) | B |
| Thornton et al,[29] 2004, Hong Kong, English | NRS | Healthy women; community-dwelling)<br>122/80 mm Hg<br>48 y | 34 | Yang-style TC (108 postures) for 12 wk<br>Usual activity | Decreased BP (compared with usual activity)<br>SBP –10 mm Hg<br>DBP –8 mm Hg | B |
| Liu et al,[30] 2003, China, Chinese | NRS | Healthy women<br>130/83 mm Hg<br>64 y | 30 | Yang-style TC (simplified 24 form) for 6 mo | Decreased BP<br>SBP –18 mm Hg<br>DBP –11 mm Hg | B |
| Ni and Lei,[31] 2000, China, Chinese | NRS | Healthy<br>131/78 mm Hg<br>61 y | 39 | TC (42 styles) for 1 y | Decreased SBP (–4 mm Hg) | B |
| Zhang and Fu,[32] 1991, China, Chinese | NRS | Healthy<br>121/74 mm Hg (young men); 113/73 mm Hg (young women); 130/86 mm Hg (older men); 126/82 mm Hg (older women)<br>25 y (young)<br>41 y (old) | 90 | TC (unspecified style) for 12 mo | Decreased BP<br>SBP –7 mm Hg (young men); -11 mm Hg (young women); –12 mm Hg (older men); –8 mm Hg (older women)<br>DBP –5 mm Hg (young men); –9 mm Hg (young women); –12 mm Hg (older men); –9 mm Hg (older women) | B |
| Wang et al,[33] 2001, Taiwan, English | OBS | Healthy male TC practitioners<br>69 y | 20 | Yang-style TC (108 movements) for 11 y<br>Age and body size–matched sedentary control | No difference in BP<br>TC vs control<br>SBP 141 (28.5) vs 139 (22.1) mm Hg<br>DBP 72 (6.3) vs 77 (6.3) mm Hg | A |
| Gao and Tan,[34] 1997, China, Chinese | OBS | Healthy elders<br>Range 60–70 y | 60 | TC (unspecified style) for 3 y<br>No TC | Decreased BP<br>TC vs control:<br>SBP 123 (11.3) vs 145 (13.5) mm Hg<br>DBP 79 (13.5) vs 88 (9.0) mm Hg | B |
| Liang,[35] 2001, China, Chinese | OBS | Healthy elders<br>65 y | 33 | Long-term TC practitioners (unspecified style; unspecified duration)<br>Non-TC practitioners | Decreased BP<br>TC vs control:<br>SBP 137 (4.3) vs 148 (4.9) mm Hg<br>DBP 77 (2.5) vs 81 (3.1) mm Hg | B |

[a]Number of study participants included in blood pressure (BP) analyses. [b]All within-group (tai chi [TC]) pre-post changes are significant ($P \leq .05$) unless otherwise noted. All results in controlled trials are reported in comparison with the control group(s) and are significant ($P \leq .05$) unless otherwise noted. [c]Modified Jadad score for randomized controlled clinical trials (RCTs) (which gives 1 point for proper single-blinding of outcome assessors). Abbreviations: DBP, diastolic BP; NRS, prospective nonrandomized studies (that include an intervention), controlled and noncontrolled; OBS, observational, cross-sectional studies, controlled; SBP, systolic BP.

is critical to therapeutic success. Clinical trials have reported excellent compliance with tai chi interventions and suggest that tai chi may promote exercise self-efficacy. Several studies mention better adherence to tai chi, as compared with standard exercise. Other studies have provided qualitative data to support meaningful changes in social functioning and well-being with tai chi.[51,52]

### Safety

Collectively, these studies suggest that tai chi is likely to be safe for patients with hypertension. Two trials with higher-risk patients with coronary artery disease reported no adverse effects.[18,19] Another study appeared to be safe in frail elders.[22] The exercise intensity of tai chi can be easily modified. Many studies have reported metabolic equivalents of 1.5 to 4.0 (approximately low-moderate aerobic exercise), a reasonable intensity for even the more deconditioned cardiac patient.[53–55]

### Limitations

The quality of studies within this review varied significantly. Overall, quality was poorer in the Chinese language studies although adequate quality studies were found in both languages. Since the substantial majority of studies reported positive results, the possibility of publication bias certainly exists. Also, since most of the studies reported positive outcomes, it is difficult to determine whether there was an inverse relationship between study quality and positive findings (eg, lower quality studies reporting more positive results). It is, however, worth noting that 2 of the 3 studies that reported no change in BP received an A quality score.

In addition, we were unable to perform meta-analyses, and our synthesis of results was limited by study heterogeneity, with differences in design, and types of control, as well as protocol implementation, intervention style, intensity, and dose/duration. There were also inherent limitations in our use of the Jadad scale, given the nature of tai chi trials and the frequent difficulty and impracticality of double-blinding. Despite these limitations, this study provides a valuable synthesis of information on a therapy that has the potential to benefit a majority of our population. Further, this review includes the first comprehensive synthesis of both English and Chinese language literature describing long-term BP effects of tai chi.

## CONCLUSIONS

Further studies of tai chi exercise are needed. Future research should include prospective, adequately powered RCTs in carefully chosen and defined patient populations, with SBP and DBP as primary outcomes. Importantly, tai chi study interventions need to be well characterized and validated so that meaningful comparisons can be made across studies and practical inferences made regarding clinical use. Further research will help to define the potential role of tai chi exercise in both primary and secondary prevention of hypertension together with other nonpharmacologic approaches, lifestyle modifications, and conventional medications.

*Disclosures: Dr Yeh is supported by a K-23 Career Investigator Award from the National Institutes of Health (NIH) National Center for Complementary and Alternative Medicine (NCCAM), Bethesda, MD (1K23-AT002624). Dr Phillips is supported by a K-24 Career Investigator Award from the NIH NCCAM (1K24-AT00589). The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official views of NCCAM.*

## REFERENCES

1 Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA.* 2003;289:2560–2572.
2 Ogden LG, He J, Lydick E, et al. Long-term absolute benefit of lowering blood pressure in hypertensive patients according to the JNC VI risk stratification. *Hypertension.* 2000;35:539–543.
3 Wong SS, Nahin RL. National Center for Complementary and Alternative Medicine perspectives for complementary and alternative medicine research in cardiovascular diseases. *Cardiol Rev.* 2003;11:94–98.
4 Taylor-Piliae RE. Tai Chi as an adjunct to cardiac rehabilitation exercise training. *J Cardiopulm Rehabil.* 2003;23:90–96.
5 Luskin FM, Newell KA, Griffith M. A review of mind-body therapies in the treatment of cardiovascular diseases part 1: implications for the elderly. *Altern Ther Health Med.* 1998;4:46–61.
6 Wang C, Collet JP, Lau J. The effect of Tai Chi on health outcomes in patients with chronic conditions: a systematic review. *Arch Intern Med.* 2004;164:493–501.
7 Klein PJ, Adams WD. Comprehensive therapeutic benefits of Taiji: a critical review. *Am J Phys Med Rehabil.* 2004;83:735–745.
8 Verhagen AP, Immink M, van der Meulen A, et al. The efficacy of Tai Chi Chuan in older adults: a systematic review. *Fam Pract.* 2004;21:107–113.
9 EPC evidence reports. Agency for Healthcare Research and Quality Web site. http://www.ahrq.gov/clinic/epcindex.htm. Accessed February 15, 2008.
10 Young DR, Appel LJ, Lee SH. The effects of aerobic exercise and T'ai Chi on blood pressure in older people: results of a randomized trial. *J Am Geriatr Soc.* 1999;47:277–284.
11 Tsai JC, Wang WH, Chan P, et al. The beneficial effects of Tai Chi Chuan on blood pressure and lipid profile and anxiety status in a randomized controlled trial. *J Altern Complement Med.* 2003;9:747–754.
12 Shen ZS, Su XH. The effect of Tai Chi Qigong form 18 on hypertension. *Modern Rehabil.* 2000;4:33.
13 Wang ZY, Liu DN, Kong DZ. The effect of Tai Chi on lowering blood pressure. *Chinese Chi Gong.* 2000;10:4–5.
14 Fang Z, Wang ZY. Clinical comparison of simplified Taichiquan, breathing exercise, tab, hypotensor co, and simple convalescence in treatment of hypertension. *J Chin Phys.* 1985;2:96–97.
15 Lu JB, Wang YF, Hu M, et al. A Preliminary observation on the therapeutic effect of breathing exercise and shadow boxing training on hypertension in the elderly. *J WCUMSHua Xi Yi Ke Da Xue Xue Bao.* 1987;18:37–39.
16 Taylor-Piliae RE, Haskell WL, Froelicher ES. Hemodynamic responses to a community-based tai chi exercise intervention in ethnic Chinese adults with cardiovascular disease risk factors. *Eur J Cardiovasc Nurs.* 2006;5:165–174.
17 Liu TM, Li SX. Effect of shadow boxing on the cardiovascular excitability, adaptability and endurance in middle-aged and elderly patients with hypertension. *Chinese Journal of Clinical Rehabilitation.* 2004;8:7508–7509.

18 Channer KS, Barrow D, Barrow R. Changes in haemodynamic parameters following Tai Chi Chuan and aerobic exercise in patients recovering from acute myocardial infarction. *Postgrad Med J.* 1996;72:349–351.
19 Zheng JQ. The effect of Tai Chi on coronary heart disease rehabilitation in elderly. *Chin J Rehabilitation Theory Practice.* 2004;10:429.
20 Zhou WS, Li Z. The effect of Tai Chi Chuan training on blood pressure, ECG and microcirculation in older people. *Chin J Sports Med.* 1995;14:249.
21 Wolf SL, Barnhart HX, Kutner NG, et al. Selected as the best paper in the 1990s: Reducing frailty and falls in older persons: an investigation of tai chi and computerized balance training. *J Am Geriatr Soc.* 2003;51:1794–1803.
22 Wolf SL, O'Grady M, Easley KA, et al. The influence of intense tai Tai chi Chi training on physical performance and hemodynamic outcomes in transitionally frail, older adults. *J Gerontol A Biol Sci Med Sci.* 2006;61A:184–189.
23 Thomas GN, Hong AWL, Tomlinson B, et al. Effects of tai chi and resistance training on cardiovascular risk factors in elderly Chinese subjects: a 12-month longitudinal, randomized, controlled, intervention study. *Clin Endocrinol (Oxf).* 2005;63:663–669.
24 Zhang JH, Yue GF. The effect of Tai Chi and running exercise on blood pressure. *Chinese Journal of Clinical Rehabilitation.* 2004;8:2957.
25 Zhang Q, Wei X, Zhao SY, et al. The effect of Tai Chi on microcirculation system in elderly. *J of Binzhou Medical Institute.* 1997;20:11.
26 Wu XP, Ho ZQ. Effect of Tai Chi on cardiorespiratory function among older people with chronic conditions. *Massage Instruct.* 1996;71:9–10.
27 Ko GTC, Tsang PCC, Chan HCK. A 10-week tia Tai-Chi program improved the blood pressure, lipid profile and SF-36 scores in Hong Kong Chinese women. *Med Sci Monit.* 2006;12:CR196–CR199.
28 Schaller KJ. Tai Chi Chih: an exercise option for older adults. *J Gerontol Nurs.* 1996;22:12–17.
29 Thornton EW, Sykes KS, Tang WK. Health benefits of Tai Chi exercise: improved balance and blood pressure in middle-aged women. *Health Promot Int.* 2004;19:33–38.
30 Liu J, Chen PJ, Qiu PX, et al. The follow up investigation of long time effect of Tai Chi Chuan on heart-lung function in elder women. *Chin J Sports Med.* 2003;22:290–293.
31 Ni HY, Lei XS. The effect of performing 42-form Tai Chi exercise on hemodynamics and hemorheology in elderly. *Chin J Sports Med.* 2000;19:194–196.
32 Zhang WJ, Fu SY. The effect of performing Tai Chi on cardiovascular function. *J of Beijing Institute of Traditional Chinese Medicine.* 1991;14:46–47.
33 Wang JS, Lan C, Wong MK. Tai Chi Chuan training to enhance microcirculatory function in healthy elderly men. *Arch Phys Med Rehabil.* 2001;82:1176–1180.
34 Gao LZ, Tan AL. Effect of Tai Chi on cardiorespiratory function in the elderly. *Bo Bu Medical School J.* 1997;22:436–437.
35 Liang YW. The effect of Tai Chi on the heart-lung function in elderly. *Journal of Physical Education.* 2001;8:64–75.
36 Reisin E. Nonpharmacological approaches to hypertension. Weight, sodium, alcohol, exercise, and tobacco considerations. *Med Clin North Am.* 1997;81:1289–1303.
37 Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA.* 2003;289:20892083–2093.
38 Pinto A, Di Raimondo D, Tuttolomondo A, et al. Twenty-four hour ambulatory blood pressure monitoring to evaluate effects on blood pressure of physical activity in hypertensive patients. *Clin J Sport Med.* 2006;16:238–243.
39 Tejada T, Fornoni A, Lenz O, et al. Nonpharmacological therapy for hypertension: does it really work? *Curr Cardiol Rep.* 2006;8:418–424.
40 O'Shaughnessy KM. Role of diet in hypertension management. *Curr Hypertens Rep.* 2006;8:292–297.
41 Cheung BM, Lo JL, Fong DY, et al. Randomised controlled trial of qigong in the treatment of mild hypertension. *J Hum Hypertens.* 2005;19:697–704.
42 Sivasankaran S, Pollard-Quintner S, Sachdeva R, et al. The effect of a six-week program of yoga and meditation on brachial artery reactivity: do psychosocial interventions affect vascular tone? *Clin Cardiol.* 2006;29:393–398.
43 Paul-Labrador M, Polk D, Dwyer JH, et al. Effects of a randomized controlled trial of transcendental meditation on components of the metabolic syndrome in subjects with coronary heart disease. *Arch Intern Med.* 2006;166:1218–1224.
44 Walton KG, Schneider RH, Nidich SI, et al. Psychosocial stress and cardiovascular disease Part 2: effectiveness of the Transcendental Meditation program in treatment and prevention. *Behav Med.* 2002;28:106–123.
45 Mayer M. Qigong and hypertension: a critique of research. *J Altern Complement Med.* 1999;5:371–382.
46 Vaananen J, Xusheng S, Wang S, et al. Taichiquan acutely increases heart rate variability. *Clin Physiol Funct Imaging.* 2002;22:2–3.
47 Lu WA, Kuo CD. The effect of Tai Chi Chuan on the autonomic nervous modulation in older persons. *Med Sci Sports Exerc.* 2003;35:1972–1976.
48 Audette JF, Jin YS, Newcomer R, et al. Tai Chi versus brisk walking in elderly women. *Age Ageing.* 2006;35:388–393.
49 Esch T, Stefano GB, Fricchione GL, et al. Stress in cardiovascular diseases. *Med Sci Monit.* 2002;8:RA93–RA101.
50 Vogel JH, Bolling SF, Costello RB, et al. Integrating complementary medicine into cardiovascular medicine. A report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents (Writing Committee to Develop an Expert Consensus Document on Complementary and Integrative Medicine). *J Am Coll Cardiol.* 2005;46:184–221.
51 Morris Docker S. Tai Chi and older people in the community: a preliminary study. *Complement Ther Clin Pract.* 2006;12:111–118.
52 Kutner NG, Barnhart H, Wolf SL, et al. Self-report benefits of Tai Chi practice by older adults. *J Gerontol B Psychol Sci Soc Sci.* 1997;52:242P242–P246.
53 Lan C, Chou SW, Chen SY, et al. The aerobic capacity and ventilatory efficiency during exercise in Qigong and Tai Chi Chuan practitioners. *Am J Chin Med.* 2004;32:141–150.
54 Chao YF, Chen SY, Lan C, et al. The cardiorespiratory response and energy expenditure of Tai-Chi-Qui-Gong. *Am J Chin Med.* 2002;30:451–461.
55 Fontana JA, Colella C, Wilson BR, et al. The energy costs of a modified form of T'ai Chi exercise. *Nurs Res.* 2000;49:91–96.