

The Effect of Tai Chi on Health Outcomes in Patients With Chronic Conditions. A Systematic Review

Chenchen Wang, MD, MSc; Jean Paul Collet, MD, PhD; Joseph Lau, MD

Arch Intern Med. 2004;164:493-501.

ABSTRACT

Objective To conduct a systematic review of reports on the physical and psychological effects of Tai Chi on various chronic medical conditions.

Data Sources Search of 11 computerized English and Chinese databases.

Study Selection Randomized controlled trials, nonrandomized controlled studies, and observational studies published in English or Chinese.

Data Extraction Data were extracted for the study objective, population characteristics, study setting, type of Tai Chi intervention, study design, outcome assessment, duration of follow-up, and key results.

Data Synthesis There were 9 randomized controlled trials, 23 nonrandomized controlled studies, and 15 observational studies in this review. Benefits were reported in balance and strength, cardiovascular and respiratory function, flexibility, immune system, symptoms of arthritis, muscular strength, and psychological effects.

Conclusions Tai Chi appears to have physiological and psychosocial benefits and also appears to be safe and effective in promoting balance control, flexibility, and cardiovascular fitness in older patients with chronic conditions. However, limitations or biases exist in most studies, and it is difficult to draw firm conclusions about the benefits reported. Most indications in which Tai Chi was applied lack a theoretical foundation concerning the mechanism of benefit. Well-designed studies are needed.

INTRODUCTION

Tai Chi is a traditional Chinese martial art that has been practiced in China for many centuries. It combines deep diaphragmatic breathing and relaxation with many fundamental postures that flow imperceptibly and smoothly from one to the other through slow, gentle, graceful movements.¹⁻⁵ It has been advocated for development of mind-body interaction, breathing regulation with body movement, hand-eye coordination, and tranquilization.⁶⁻¹¹

Tai Chi has evolved into many different styles during its development, including Chen, Wu, Sun, and Yang style. Among these styles, Chen is the oldest, while Yang is the most popular. Despite the lack of rigorous evidence regarding its benefits, Tai Chi is widely practiced in many countries as a form of exercise for health and fitness.

Tai Chi is practiced as an exercise to promote good health, memory, concentration, digestion, balance, and flexibility and is also thought to improve psychological conditions such as anxiety, depression, and declines associated with aging and inactivity. It is also practiced to improve quality of life.⁹⁻¹¹ However, despite its popularity, the biological mechanism and clinical effects of Tai Chi are not well understood. The purpose of this systematic review is to summarize the studies that have examined the effect of Tai Chi on

patients with a variety of chronic conditions and to identify and describe the limitations and biases of these published clinical studies.

METHODS

A total of 743 abstracts pertaining to the practice of Tai Chi were obtained from 11 sources: (1) MEDLINE search from 1966 through April 2002 (87 abstracts); (2) SPORTDiscus Database search from 1949 to December 2000 (419 abstracts); (3) Social Sciences Abstracts search from 1984 to December 2000 (19 abstracts); (4) Health Star search from 1975 to 2000 (22 abstracts); (5) PsycINFO search from 1887 to May 2001 (39 abstracts); (6) ERIC search from 1966 to May 2001 (13 abstracts); (7) AIDSLINE search from 1980 to December 2000 (4 abstracts); (8) Biological Abstracts search from 1980 to March 2001 (30 abstracts); (9) Sociological Abstracts search from 1963 to December 2000 (3 abstracts); (10) CINAHL search from 1982 to May 2001 (28 abstracts); and (11) Chinese Medical Database from 1976 to June 2000 (obtained from Nanjing Medical University Library) (79 abstracts). The search strategies used the text word "Tai Chi." This includes English and Chinese articles and all types of studies.

Original studies were included in the systemic review if they evaluated Tai Chi for treatment of a chronic condition and reported outcome data. Randomized controlled trials (RCTs), nonrandomized controlled studies (NRSs), and observational studies qualified.

The following criteria were used to evaluate study quality: (1) well-defined study question; (2) explicit and/or appropriate eligibility criteria; (3) proper allocation of intervention groups; (4) use of groups with similar baseline characteristics; (5) confounders accounted for; (6) interventions and outcomes adequately described; (7) blinded outcomes assessment; (8) valid outcome measurements and statistical methods; (9) adequate follow-up rate; dropout rate reported; and (10) conclusions supported by the findings. Two investigators extracted data.

Articles were categorized into clinical domains. For each clinical domain, we summarized information from each study. The summary tables described the interventions of Tai Chi, the outcomes measured, and the authors' main conclusions when appropriate. Included studies for each clinical domain were also assessed to determine the strengths and limitations of the most important studies following a detailed rationale for the appraisal of study characteristics related to quality. Because of the heterogeneity of outcomes, study designs, and settings, we did not perform a meta-analysis on the outcomes.

RESULTS

All abstracts were reviewed to identify the relevant studies related to the effects of Tai Chi. Of the 743 abstracts initially identified, 679 were excluded because they were review articles, case reports, letters or comments, conference proceedings, information about Tai Chi classes or training programs, theses or dissertations, newspaper articles, announcements, or duplicate publications.

After the initial screening, 64 articles were retrieved and reviewed. Seventeen studies were eliminated because they were duplicate publications, English translations of original Chinese articles, or contained major methodologic flaws such as study populations that did not meet the eligibility criteria, measurement tools that lacked rigorous validity and had not been tested with the population under consideration, and inadequately reported outcomes.

Ultimately, 47 studies (9 RCTs, 23 NRSs, and 15 observational studies) related to the clinical issues were identified for data abstraction and critical appraisal (Table 1). The

characteristics of the original research articles were assessed for each of 7 conditions.¹²⁻⁵⁷ Our reported results correspond to the data on each condition and are summarized below.

Table 1. Summary of the Tai Chi Studies Reviewed*

| Study Characteristic | No. of Studies |
|---|-----------------------|
| Date of publication | |
| Before 1990 | 9 |
| After 1990 | 38 |
| Group study site | |
| China (8 Taiwan, 2 Hong Kong) | 24 |
| United States | 19 |
| Canada | 2 |
| Australia | 2 |
| Language of study | |
| Chinese | 16 |
| English | 31 |
| Study design* | |
| Randomized controlled trials (United States) | 9 |
| Nonrandomized controlled studies (9 before-and-after trials and 14 external comparison) | 23 |
| Observational studies (3 cohort, 10 cross-sectional, 2 case-control studies) | 15 |
| Clinical domain | |
| Cardiovascular and respiratory function | 17 |
| Balance | 11 |
| Blood pressure | 4 |
| Musculoskeletal | 4 |
| Psychological effects | 6 |
| Endocrine and immune systems | 2 |
| Other | 3 |

*In randomized controlled trials, the investigator manipulates use of the procedure by offering it to one group of people (the exposed group) and offering nothing, a placebo, or some other procedure(s) to another group (the control group) by random allocation. Both groups are then evaluated to determine the rates of various outcomes. In nonrandomized controlled studies, the investigator causes some subjects to be exposed to the procedure but does not use random allocation to determine the exposure; these studies include both an "internal comparison (before and after)" and an "external comparison (unexposed group)." In observational studies, the investigator does not manipulate use of the procedure but merely observes and interprets the outcomes; observational studies include 3 main types: cohort, cross-sectional, and case-control.

BALANCE CONTROL AND FALLS

The evidence on balance comprised 11 studies¹²⁻²³ (Table 2): 2 RCTs of 24 and 200 subjects, respectively; 5 NRSs of 125 subjects in total; 3 cross-sectional studies with a total of 104 subjects; and 1 follow-up study of 110 subjects. Balance control, maximal voluntary extension, strength, flexibility, cardiovascular endurance, and postural stability were measured in these studies.

Table 2. Effects of Tai Chi on Balance

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|--|---------------|------------------|----------------------|--------------------------|---|---|---|
| Wolf et al, ^{12,13} 1996, 1997 | United States | 200 | 76 | RCT | 15 wk (1 h, 2 times/wk) 108 forms of Yang | Balance, strength, flexibility, cardiovascular fitness, stability | Reduced the risk of multiple falls and lowered blood pressure |
| Jacobson et al, ¹⁴ 1997 | United States | 24 | 20-45 | RCT | 12 wk (3 times/wk) 108 forms of Yang | Balance, strength, stability | Improved balance function, kinesthetic sense, and strength |
| Hain et al, ¹⁵ 1999 | United States | 22 | 20-76 | NRS (before-after trial) | 8 wk (1 h/wk) Selected from Yang, Pa-Kua, and Wu | Balance, stability, quality of life and others | Improved balance |
| Forrest, ¹⁶ 1997 | United States | 8 | 37 | NRS (before-after trial) | 16 wk (1 h, 2 times/wk) Simplified form | Balance, stability | Improved the ability to use the elasticity of the peripheral tissues for postural stabilization |
| Shih, ¹⁷ 1997 | United States | 11 | 31 | NRS (before-after trial) | 16 wk (50 min, 3 times/wk) Beijing 24 forms | Balance, stability | Increased postural stability |
| Schaller, ¹⁸ 1996 | United States | 46 | 70 | NRS | 10 wk (1 h/wk) Simplified 24 forms | Balance, flexibility, quality of life and others | Improved balance in community-dwelling elders |
| Yan, ¹⁹ 1998 | United States | 38 | 79 | NRS | 8 wk (45 min, 3 times/wk) Simplified 24 forms | Balance, stability | Improved dynamic balance control and smoothness in rapid-aiming arm movements |
| Wolfson et al, ²⁰ 1996 | United States | 110 | 80 | Cohort study | 6 mo (1 h/wk) No data for style | Balance, strength, stability | Improved balance and strength |
| Lin et al, ²¹ 2000 | Taiwan, China | 28 | 71 | Cross-sectional | 2-35 y No data for style | Balance, stability | Improved postural stability |
| Tse and Bailey, ²² 1992 | United States | 18 | 65-86 | Cross-sectional | 1-20 y No data for style | Balance, stability | Improved postural control |
| Hong et al, ²³ 2000 | United States | 58 | 68 | Cross-sectional | 13.2 y Classical Yang | Balance, flexibility, cardiovascular fitness | Long-term regular practice has favorable effects on the promotion of balance control, flexibility, and cardiovascular fitness in older adults |

Abbreviations: NRS, nonrandomized controlled study; RCT, randomized controlled trial.
*Includes control group.

Seven clinical trials¹²⁻¹⁹ (2 RCTs and 5 NRSs) reported that 8 to 16 weeks of Tai Chi training significantly improved balance, flexibility, and strength of knee extension and reduced the occurrence of falling in community-dwelling elders. One follow-up study²⁰ of 110 community-dwelling persons (mean age, 80 years) that combined strengthening and weight-training programs for 3 months, then 6 months of Tai Chi training, found a favorable impact on a variety of balance measures. Three cross-sectional studies²¹⁻²³ of individuals with 1 to 35 years of Tai Chi practice experience revealed that long-term Tai Chi practitioners had greater lower extremity flexibility than nonpractitioners and that Tai Chi was effective in improving normal gait velocity and producing a trend toward improved maximal gait velocity in elders. Overall, these studies reported that long-term Tai Chi practice had favorable effects on the promotion of balance control, flexibility, and cardiovascular fitness and reduced the risk of falls in elders.

However, most studies were NRSs,¹⁵⁻¹⁹ had no comparison group,¹⁵⁻¹⁷ or had relatively small sample sizes.^{14-17,21-22} Other studies lacked detailed information on health status and eligibility criteria,¹⁵⁻¹⁷ and blinding assessment of outcomes were not well reported in some studies.^{17, 19-20,23} In others, potential selection bias¹⁵⁻¹⁷ and uncontrolled confounding factors such as age, body mass index, sex, exercise time, and a large discrepancy in Tai Chi practitioner experience might also have existed.^{14, 20-23} Furthermore, the cross-sectional studies were too limited to explain the cause-effect relationships.²¹⁻²³ The differences between styles of Tai Chi exercise, especially between the traditional Chinese styles (Chen, Yang, and Wu) and self-modified as well as westernized Tai Chi forms, were not made clear. The personalities of participants and the abilities of different Tai Chi instructors may vary. Several studies reported a wide range of Tai Chi exercise experience,

spanning from 1 year to 35 years, making it difficult to relate the amount of benefit to the duration of exercises.²¹⁻²³

MUSCULOSKELETAL CONDITIONS

Four studies²⁴⁻²⁷ evaluated Tai Chi effects on musculoskeletal conditions (Table 3). One RCT²⁴ of 33 patients with osteoarthritis reported that 12 weeks of Tai Chi practice significantly improved arthritis symptoms, self-efficacy, level of tension, and satisfaction with general health status. Functional capacity (1-leg standing balance, 50-foot (15-m) walking speed, and time to rise from a chair), arthritis self-efficacy, and quality of life (Arthritis Impact Measurement Scale) were measured.

Table 3. Effects of Tai Chi on Musculoskeletal Condition

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|--|---------------|-----------------------------|----------------------|--------------------------|--|---|---|
| Hartman et al, ²⁴ 2000, osteoarthritis | United States | 33 | 68 | RCT | 12 wk (1 h, 2 times/wk) 9 forms from Yang | Arthritis scale, clinical symptom, quality of life, functional, balance and flexibility | Enhanced arthritis self-efficacy, quality of life, and functional mobility among older adults with osteoarthritis |
| Kirsteins et al, ²⁵ 1991, rheumatoid arthritis | United States | Study 1, 47; Study 2, 28 | 37-70 38-72 | NRS | 10 wk (90 min, 1 time/wk in study 1) (90 min, 2 times/wk in study 2) A series of 15 movements extracted from the Yang style Tai Chi short form | Clinical symptom, † strength and endurance, functional | No significant exacerbation of joint symptoms |
| Lan et al, ²⁶ 2000, community-dwelling subjects | Taiwan, China | 41 | 62 | NRS (before-after trial) | 6 mo (54 min/d) 108 forms of Yang style | Strength and endurance | Enhanced muscular strength and endurance of knee extensors in elderly individuals |
| Husted et al, ²⁷ 1999, multiple sclerosis | United States | 19 | NR | NRS | 8 wk (1 h, 2 times/wk) No data | Quality of life, functional, balance and flexibility | Maximized independence and improved quality of life for people with chronic disabling conditions |

Abbreviations: NR, not reported; NRS, nonrandomized controlled study; RCT, randomized controlled trial.

*Includes control group.

†Outcomes not well defined in the original article.

One publication²⁵ reported 2 NRSs of 47 and 28 patients with rheumatoid arthritis, respectively, who underwent 10 weeks of Tai Chi training. Disease activity (joint tenderness and number of swollen joints) and exacerbation of joint symptoms were measured; 50-foot (15-m) walk and handgrip strength were measured; and a written functional assessment was performed. The study showed no significant differences between the Tai Chi and control groups in disease activity. The authors suggested that Tai Chi appeared to be safe for patients with rheumatoid arthritis and might serve as a weight-bearing exercise with additional potential advantages of stimulating bone growth and strengthening connective tissue.

Another NRS²⁶ described 41 community-dwelling subjects (mean age, 62 years) who participated in a 6-month Tai Chi training course. The researchers found that concentric knee extensor peak torque increased by 15% to 20%, and eccentric peak torque increased by 15% to 24% in men. The women also showed increases, ranging from 14% to 22% in concentric peak torque and 18% to 24% in eccentric peak torque. In addition, the knee extensor endurance ratio increased by 10% to 19% in men and 10% to 15% in women.

Therefore, the study concluded that Tai Chi training may enhance muscular strength and endurance of knee extensors in elderly individuals.

An NRS study²⁷ of 19 patients with multiple sclerosis involved an 8-week Tai Chi training course that measured walking speed, hamstring flexibility, and psychosocial well-being using the Medical Outcomes Study 36-Item Short-Form General Health Survey. The results revealed that Tai Chi increased walking speed and hamstring flexibility. Patients experienced improvements in vitality, social functioning, mental health, and ability to carry out physical activities and emotional roles. The study concluded that Tai Chi maximized independence and improved quality of life for people with chronic disabling conditions.

The limitations of these studies included small sample size,²⁴⁻²⁷ lack of randomization,²⁵⁻²⁷ loss to follow-up,²⁵⁻²⁶ potential selection bias, uncontrolled confounding factors,²⁵⁻²⁷ unclear statistical analysis,²⁵⁻²⁷ lack of standardized outcome measures,²⁵⁻²⁷ and lack of blinded assessment of outcome.²⁵⁻²⁷

HYPERTENSION

We found 2 RCTs,²⁸⁻²⁹ and 2 NRSs³⁰⁻³¹ with a total of 401 patients with hypertension (Table 4). The duration of Tai Chi training for the studies was 8 to 12 weeks^{28-29,31} and 3 years.³⁰ Blood pressure, maximal oxygen uptake, and heart rate (HR) were recorded before and after each session. A reduction of mean blood pressure was found for regular Tai Chi practice in all the studies. Young et al²⁸ found adjusted mean (SE) changes in systolic blood pressure during the 12-week intervention period of -8.4 (1.6) mm Hg and -7.0 (1.6) mm Hg in the aerobic exercise and Tai Chi groups, respectively (within-group $P < .001$; between-group $P = .56$). Corresponding changes for diastolic blood pressure were -3.2 (1.0) mm Hg in the aerobic exercise group and -2.4 (1.0) mm Hg in the Tai Chi group (within-group $P < .001$; between-group $P = .54$). Channer et al²⁹ reported that over 11 sessions of exercise, both aerobic and Tai Chi exercise were associated with reduction in systolic blood pressure ($P < .05$), and Tai Chi was also associated with a reduction in diastolic blood pressure ($P < .01$) in patients recovering from acute myocardial infarction. Similar findings were also reported in 2 NRSs³⁰⁻³¹ conducted in China.

Table 4. Effects of Tai Chi on Hypertension

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|-----------------------------------|---------------|------------------|----------------------|--------------|---|---|---|
| Young et al, ²⁸ 1999 | United States | 62 | 69-80 | RCT | 12 wk (1 h, 2 times/wk) Yang style | Blood pressure, maximal oxygen uptake, physical activity, cardiorespiratory fitness | Decreased blood pressure in both Tai Chi and aerobic groups |
| Channer et al, ²⁹ 1996 | United States | 126 | 56 | RCT | 8 wk (1 h, 2 times/wk for 3 wk and 1 time/wk for 5 wk) Wu style short form | Blood pressure,† cardiorespiratory fitness† | Decreased blood pressure in both Tai Chi and aerobic groups in patients recovering from acute myocardial infarction |
| Chou and Li, ³⁰ 1994 | China | 143 | 54 | NRS | 3 y (every morning) No data for style | Blood pressure,† cardiorespiratory fitness† | Decreased blood pressure |
| Fang and Wang, ³¹ 1985 | China | 70 | 40-70 | NRS | 12 wk (40 min, 2 times/wk) Simplified 24 forms | Blood pressure† | Decreased blood pressure |

Abbreviations: NRS, nonrandomized controlled study; RCT, randomized controlled trial.

*Includes control group.

†Outcomes were not well defined in the original article.

These studies included biases due to volunteer effect, confounding factors, and loss to follow-up.^{28, 30-31} The eligibility criteria were not clearly specified,²⁹⁻³¹ and several studies lacked standardized outcome measurements and appropriate statistical analysis.³⁰⁻³¹

CARDIOVASCULAR AND RESPIRATORY SYSTEM

Numerous studies have evaluated the effects of Tai Chi on cardiovascular and respiratory function.³²⁻⁴⁸ Since 1993, three observational studies and 2 NRSs³²⁻³⁶ were conducted by Taiwan groups to evaluate the cardiovascular effect of regular Tai Chi practice (Table 5). Two cohort studies³²⁻³³ of 90 and 84 subjects with 6.3 and 6.7 years' experience of Tai Chi, respectively, were reported. Cardiopulmonary exercise testing using incremental cycle ergometry and HR measurements were performed in these studies. The researchers found that the oxygen uptake ($\dot{V}O_2$) and work rate in the Tai Chi group were significantly higher than in the control group. Tai Chi practitioners had a smaller decline in the maximum oxygen uptake than their sedentary counterparts.

Table 5. Effects of Tai Chi on Cardiorespiratory Condition

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|---|---------------|------------------|----------------------|--------------------------|---|--|--|
| Lai et al, ³² 1993 | Taiwan, China | 90 | 58 | Cohort study | 6.3 y (54 min, 4 times/wk) 108 forms of Yang | Incremental cycle ergometry, cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | Tai Chi practitioners had superior cardiorespiratory function compared with their sedentary counterparts |
| Lai et al, ³³ 1995 | Taiwan, China | 84 | 65 | Cohort study | 6.7 y (54 min, 5 times/wk) 108 forms of Yang | Cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | May delay the decline of cardiorespiratory function in older individuals |
| Lan et al, ³⁴ 1996 | Taiwan, China | 76 | 69 | Case-control† | 11.8 y (4.3 times/wk) 108 forms of Yang | Cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | Long-term practice may benefit cardiorespiratory function, flexibility, and body composition in the elderly |
| Lan et al, ³⁵ 1998 | Taiwan, China | 38 | 58-70 | NRS | 12 mo (54 min, 4.6 times/wk) 108 forms of Yang | Cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | Improved health fitness of the elderly |
| Lan et al, ³⁶ 1999 | Taiwan, China | 20 | 57 | NRS | 1 y (54 min, 3.8 times/wk) 108 forms of Yang | Incremental cycle ergometry, cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | Enhanced cardiorespiratory function for low-risk patients with coronary artery bypass surgery |
| Schneider and Leung, ³⁷ 1991 | United States | 20 | 30-35 | NRS | 81.6 mo No data for style | Cardiopulmonary function, oxygen uptake, heart rate and electrocardiography | Tai Chi is of low to moderate intensity and may not be suitable for improving cardiorespiratory fitness |
| Brown et al, ³⁸ 1989 | China | 6 | 34 | Cross-sectional | 8.3 y Long form of Yang | Incremental cycle ergometry, cardiopulmonary function, oxygen uptake | Tai Chi leads to a more efficient use of the ventilatory volume than cycle ergometry |
| Gong et al, ³⁹ 1981 | China | 100 | 41-80 | Cross-sectional | 1-30 y No data for style | Heart rate and electrocardiography | Tai Chi represents a lighter load than other forms of physical training |
| Zhuo et al, ⁴⁰ 1984 | China | 11 | 24-35 | Cross-sectional | 5 y No data for style | Heart rate and electrocardiography‡ | The metabolic intensity of the activity seems insufficient to generate improvements in cardiorespiratory fitness in healthy young adults |
| Zhang et al, ⁴¹ 1979 | China | 22 | 7-12 | NRS (before-after trial) | 18 mo (30 min, 6 times/wk) Simplified 24 forms | Cardiopulmonary function,‡ clinical symptom, heart rate and electrocardiography | Improved clinical symptoms and cardiorespiratory function |
| Chang and Gao, ⁴² 1998 | China | 110 | 61 | Cross-sectional | 6-24 mo No detailed data | Cardiopulmonary function,‡ clinical symptom, heart rate and electrocardiography | Enhanced cardiorespiratory function |
| Cun and Lansimies, ⁴³ 1998 | China | 14 | 21 | Cross-sectional | No detailed data | Heart rate and electrocardiography | Changing heart rate variability and improved function of vegetative nervous system, especially increased parasympathetic nervous system |
| Wu and Ho, ⁴⁴ 1996 | China | 20 | 54 | NRS | 90 d (40 min, 2 times/d) Simplified 24 forms | Cardiopulmonary function,‡ oxygen uptake, heart rate and electrocardiography | Enhanced cardiorespiratory function |
| Kui et al, ⁴⁵ 1990 | China | 28 | 50-75 | NRS (before-after trial) | 90 d (3 times/wk) Simplified 24 forms | Cardiopulmonary function, oxygen uptake | Improved cardiorespiratory function compared with sedentary counterparts |
| Liu et al, ⁴⁶ 1993 | China | 55 | 58 | NRS (before-after trial) | 3 mo (60 min, 2 times/d) No data for style | Cardiopulmonary function, heart rate and electrocardiography | Improved cardiorespiratory function |
| Cun et al, ⁴⁷ 1998 | China | 14 | 64 | NRS (before-after trial) | 18 mo No data for style | Cardiopulmonary function, oxygen uptake | Improved cardiorespiratory function |
| Gao and Tan, ⁴⁸ 1997 | China | 60 | 60-70 | Cross-sectional | 3 y No detailed data for style | Cardiopulmonary function, heart rate and electrocardiography | Improved cardiorespiratory function compared with sedentary counterparts in the elderly |

Abbreviations: NRS, nonrandomized controlled study; RCT, randomized controlled trial.

*Includes the control group.

†The case-control study design was defined by the authors.

‡Outcomes were not well defined in the original article.

One case control study³⁴ of 76 subjects with 11.8 years of Tai Chi practice (mean age, 69 years) evaluated cardiovascular function, flexibility, and body composition. The researchers found that the long-term Tai Chi practitioners showed higher $\dot{V}O_2$ scores in the stand-and-reach test and a lower percentage of body fat than their sedentary counterparts. Two NRSs³⁵⁻³⁶ evaluated the training effect of Tai Chi for 38 community-dwelling subjects (aged 58-70 years) and 20 low-risk patients who underwent coronary artery bypass surgery (mean age, 57 years). After 1 year of 4-times-weekly Tai Chi training, the Tai Chi group showed significantly enhanced cardiorespiratory function, strength and flexibility, and increased $\dot{V}O_2$ and work rate compared with the control group who performed self-adjusted exercises.

One NRS³⁷ with 20 subjects (aged 30-35 years) examined the metabolic and cardiorespiratory responses to continuous performance of Tai Chi and Wing Chun (rapid forceful striking and kicking movements with forced expirations timed with punching and kicking in an attempt to achieve maximum power). The exercise values corresponded to 52.4% of maximum oxygen uptake values ($\dot{V}O_{2max}$) and 70.5% of maximum HR (HR_{max}) for Wing Chun and only 36.4% of $\dot{V}O_{2max}$ and 59.8% of HR_{max} for Tai Chi. The ventilatory equivalent for $\dot{V}O_2$ obtained during Tai Chi (21.7) was significantly lower than for Wing Chun exercise (24.2). The authors concluded that Tai Chi practitioners use efficient breathing patterns during exercise. However, because Tai Chi is a low- to moderate-intensity form of exercise, it might not be suitable for improving cardiorespiratory fitness.

Results related to the effect of Tai Chi on cardiovascular and pulmonary function have been reported in 11 publications by Chinese researchers since 1979.³⁸⁻⁴⁸ Although 1 study⁴⁰ reported that the metabolic intensity of the activity seemed insufficient to generate improvements of cardiorespiratory fitness in healthy young adults, all other studies suggested that regularly practiced Tai Chi might delay the decline of cardiorespiratory function in older individuals and might be prescribed as a suitable exercise for older adults.

No RCTs were identified in this area, and the overall study quality was very poor, especially among the studies conducted in China. Many limitations were found in the Chinese studies, such as unclear study designs,^{32, 34, 36-48} small sample sizes,^{36-38,40-41,43-45,47} poorly reported baseline health status and eligibility criteria of the subjects,³⁸⁻⁴⁸ lack of comparison groups,^{41, 45-47} lack of detailed information about the types of Tai Chi exercise and duration of the trial,^{37, 39-40,42-43,46-48} lack of accounting of subjects lost to follow-up,³⁸⁻⁴⁸ and no blinding of outcome assessors.³⁸⁻⁴⁸ In addition, study limitations included potential selection bias,^{32-33,37-48} confounding factors,^{32-33,37-48} inconsistent measurement intervals,^{33-35,39-42,44-48} and large differences in Tai Chi practitioner experience.^{33-35,39-42,44-48}

PSYCHOLOGICAL RESPONSES

The effect of Tai Chi on psychological responses were evaluated in 3 RCTs⁴⁹⁻⁵¹ and 3 NRSs⁵²⁻⁵⁴ (Table 6). Results from 2 RCTs indicated that 283 low-activity older adults participating in either a 16-week or a 6-month Tai Chi exercise program showed improvement compared with the control groups in several indices of psychological well-being that evaluated depression, psychological distress, positive well-being, life satisfaction, and perceptions of health.⁴⁹⁻⁵⁰

Table 6. Effects of Tai Chi on Psychological Measures

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|------------------------------------|---------------|------------------|-----------------------|--------------------------|---|--|--|
| Li et al. ⁴⁹ 2001 | United States | 148 | 73 | RCT | 6 mo (1 h, 2 times/wk) Classical Yang | Depression score; anxiety, mood, stress scales, storytelling; well-being scale; satisfaction scale; general health scale | Higher levels of health perceptions, life satisfaction, positive affect, and well-being; lower levels of depression, negative affect, and psychological distress |
| Brown et al. ⁵⁰ 1995 | United States | 135 | 51 | RCT | 16 wk (45 min, 3 times/wk) No data for style | Anxiety, mood, stress scales, storytelling; satisfaction scale; self-competence | No significant difference among 5 training groups on measures of mood, self-esteem, personality, or life satisfaction |
| Baron, ⁵¹ 1998 | Canada | 90 | Children (grades 4-6) | RCT | 12 wk (1 h, 2 times/wk) Yang style | Anxiety, mood, stress scales, storytelling; self-competence; visual-motor integration | Improved perceived self-competence and visual-motor integration |
| Jin, ⁵² 1992 | Australia | 96 | 36 | NRS | 46.4 and 36.4 mo (1-h meditation) Either the long form or Yang style or Wu style | Anxiety, mood, stress scales, storytelling† | Stress-reduction effect |
| Fu et al. ⁵³ 1995 | China | 90 | 18-68 | NRS | 1 mo (30 min, 6 times/wk) No data for style | Anxiety, mood, stress scales, storytelling† | Improved symptoms and reduced stress and anxiety |
| Gibb et al. ⁵⁴ 1997 | Australia | 9 | 79 (66-90) | NRS (before-after trial) | 7 wk (2 times/wk) No data for style | Anxiety mood, stress scales, story telling† | Structured reminiscence with Tai Chi facilitated thinking that was focused and insightful beyond the level normally manifested for this group of participants |

Abbreviations: NRS, nonrandomized controlled study; RCT, randomized controlled trial.

*Includes control group.

†Outcomes were not well defined in the original article.

Another RCT⁵¹ examined the psychological effect of a 12-week Tai Chi program on 90 schoolchildren, grades 4 to 6 (52 boys, 38 girls), who were pretested on measures of perceived self-competence, visual-motor integration, and anxiety. The Tai Chi group significantly improved their scores on the perceived self-competence and visual-motor integration tests.

Two NRSs⁵²⁻⁵³ with a total of 186 patients reported that 1 to 46 months of Tai Chi practice improved mood and reduced stress and anxiety. Nine elderly patients diagnosed with multiple-infarct dementia or Alzheimer disease participated twice weekly over 7 weeks in a before-and-after Tai Chi trial.⁵⁴ The authors concluded that "structured reminiscence with Tai Chi facilitated thinking that was focused and insightful, beyond the level normally manifested for this group of participants."

Although these 6 studies (including 3 RCTs) were conducted in 4 countries (United States, Canada, China, and Australia), the study populations were poorly defined. The Tai Chi interventions were not adequately described, and there was no blinding of outcome assessors to intervention in any of these studies.

ENDOCRINE AND IMMUNE SYSTEMS

Two studies⁵⁵⁻⁵⁶ evaluated the effects of Tai Chi practice on the endocrine or immune systems (Table 7). A cross-sectional Chinese study⁵⁵ of 98 elderly men reported that 10 years of Tai Chi practice might widely affect endocrine function, including the pituitary-

thyroid system and the pituitary-gonad system, and may strengthen pituitary metabolic reaction among elderly men. The conclusion of this study is questionable because cross-sectional studies are not designed to evaluate causality.

Table 7. Effects of Tai Chi on Endocrine and Immune Systems

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|--------------------------|---------|------------------|----------------------|-----------------|---|--|--|
| Wang, ⁵⁵ 1986 | China | 98 | 60-90 | Cross-sectional | 10-70 y (40 min/d) No data for style | T ₃ , T ₄ , testosterone; estradiol and cortisone; TSH and FSH; LH | Increased the blood level of T ₃ , T ₄ , testosterone, estradiol, cortisone, TSH, FSH, and LH compared with control groups |
| Sun, ⁵⁶ 1989 | China | 60 | 60 | NRS | ≥4 y No data for style | T cells (total and active T lymphocytes) | Increased total number of circulating T cells |

Abbreviations: FSH, follicle-stimulating hormone; LH, luteinizing hormone; NRS, nonrandomized controlled study; T₃, triiodothyronine (liothyronine); T₄, thyroxine; TSH, thyrotropin.

*Includes control group.

†Outcomes were not well defined in the original article.

An NRS of 60 elderly subjects⁵⁶ found that the total number of circulating T cells, including active T lymphocytes, were significantly higher in the Tai Chi group (30 healthy subjects, aged ≥60 years, who regularly practiced Tai Chi for 4 or more years) than in the untrained group (30 age-matched subjects).

Both studies lacked explicit and appropriate eligibility criteria. In both studies, the Tai Chi intervention was not well described, and the follow-up rate and statistical analysis were not adequately reported.

OTHER CONDITIONS

Several studies evaluated the beneficial effects of Tai Chi in other areas (Table 8).⁵⁷⁻⁵⁹ A recent RCT⁵⁷ found that a 60-minute Tai Chi practice session twice a week for 6 months using a classical Yang style could significantly enhance self-efficacy in older adults. Two aspects of self-efficacy were measured: barriers and performance. The study also suggested that changes in self-efficacy cognitions were significantly related to class attendance.

Table 8. Effects of Tai Chi on Other Areas

| Source | Country | No. of Subjects* | Mean Age or Range, y | Study Design | Practice Duration and Style | Outcome Measured | Main Conclusions |
|-------------------------------------|---------------|------------------|----------------------|--------------|--|--|---|
| Li et al, ⁵⁷ 2001 | United States | 94 | 73 | RCT | 6 mo (1 h, 2 times/wk) Classical Yang | Physical functioning (SF-20), self-efficacy | Enhanced the self-efficacy and functional status in healthy, physically inactive older adults |
| Wang et al, ⁵⁸ 2001 | China | 20 | 69 | Case-control | 11.2 y (54 min, 5 times/wk) Classical Yang | Bicycle ergometer; skin blood flow, cutaneous vascular conductance, and skin temperature | Higher cutaneous microcirculatory function during Tai Chi exercise than in sedentary counterparts in older adults |
| Slater and Hunt, ⁵⁹ 1997 | Canada | 22 | 21 | NRS | 20 d (5 min/d before bed) No data for style | Dream diary† | Significant decrease in nightmares |

Abbreviations: NRS, nonrandomized controlled study; RCT, randomized controlled trial; SF-20, Medical Outcomes Study Short-Form General Health Survey.

*Includes control group.

†Outcomes were not well defined in the original article.

A recent case-control study⁵⁸ of 20 elderly men revealed that 10 elderly men who practiced Tai Chi for 11.2 years had a 34% higher $\dot{V}O_2$ peak and higher skin blood flow, cutaneous vascular conductance, and skin temperature than the 10 sedentary men at rest and during exercise. Another NRS⁵⁹ of 22 young people (mean age, 21 years) found that 20 days of Tai Chi practice significantly decreased nightmares.

CONCLUSIONS

Most of the studies evaluated in this systematic review have been performed in China and the United States to examine the physiological and psychosocial benefits of Tai Chi for all age groups. Benefits were reported by the authors of these studies in cardiovascular and respiratory function in healthy subjects and in patients who had undergone coronary artery bypass surgery as well as in patients with heart failure, hypertension, acute myocardial infarction, arthritis, and multiple sclerosis. Benefit was also found for balance, strength, and flexibility in older subjects; falls in frail elderly subjects; and pain, stress, and anxiety in healthy subjects. Overall, Tai Chi appears to have physiologic and psychosocial benefits and appears to be safe and effective in promoting balance control, flexibility, and cardiovascular fitness for older adults with chronic conditions.

Unfortunately, many studies of Tai Chi lack rigorous scientific methods, and most investigations have been retrospective and have not used randomized control groups. It is also difficult to obtain overall quantitative estimates of treatment effects owing to the heterogeneity of inclusion criteria, patients, and outcome definitions and inadequate information on design, details of the intervention, and outcomes. It should also be noted that none of the studies from Asia were RCTs. In contrast to those published in the United States and other Western countries, almost all the studies published in mainland China, Hong Kong, and Taiwan reported positive results. Studies may have been conducted with different levels of methodologic rigor, and publication bias may be greater in some countries than in others.⁶⁰

In addition, the mechanisms of the benefits from practicing Tai Chi for any of the conditions studied are not well understood. There are only 9 RCTs in this review, and they examined only short-duration practice of Tai Chi (8-16 weeks). Therefore, long-term effects of Tai Chi practice are still unknown, and there is insufficient information to recommend Tai Chi to patients with chronic conditions. Well-defined study questions, adequate selection criteria, groups similar at baseline, valid statistical methods, accounted-for confounders, appropriate outcome, and adequate follow-up are needed for proper evaluation of the effects of Tai Chi. Patients and physicians who use Tai Chi intervention will be better informed by high-quality RCTs that report short- and long-term risks and benefits.

AUTHOR INFORMATION

Corresponding author and reprints: Chenchen Wang, MD, MSc, Institute for Clinical Research and Health Policy Studies, Tufts-New England Medical Center, 750 Washington St, No 63, Boston, MA 02111 (e-mail: Cwang@tufts-nemc.org).

Accepted for publication March 28, 2003.

This work was partially supported by the General Clinical Research Center, funded by the Division of Research Resources of the National Institutes of Health under grant No. M01-RR0054, and by funding from the Tufts-New England Medical Center (Dr Wang).

From the Center for Clinical Evidence Synthesis, Division of Clinical Care Research, Tufts-New England Medical Center, Boston, Mass (Drs Wang and Lau); and Center for Clinical

Epidemiology and Community Studies, Jewish General Hospital, McGill University, Montreal, Quebec (Dr Collet). The authors have no relevant financial interest in this article.

REFERENCES

1. Jin P. Changes in heart rate, noradrenaline, cortisol and mood during Tai Chi. *J Psychosom Res.* 1989;33:197-206. FULL TEXT | ISI | PUBMED
2. Xu S, Fan Z. Physiological studies of Tai Chi in China. In: Qu M, Yu C, eds. *China's Sports Medicine.* New York, NY: Karger; 1988:70-80.
3. Delza S. *Tai Chi Chuan.* Rev ed. Albany, NY: State University of New York Press; 1985.
4. Cheng J. Tai Chi Chuan: a slow dance for health. *Physician Sports Med.* 1999;27:109-110.
5. Yan JH. The health and fitness benefits of Tai Chi. *J Phys Educ Recreation Dance.* 1995;66:961-963.
6. Yan JH, Downing JH. Tai Chi. *J Aging Phys Activity.* 1998;6:350-362.
7. Li JX, Hong Y, Chan KM. Tai Chi. *Br J Sports Med.* 2001;35:148-156. **FREE FULL TEXT**
8. Kutner NG, Barnhart H, Wolf SL, McNeely E, Xi T. Self-report benefits of Tai Chi practice by older adults. *J Gerontol B Psychol Sci Soc Sci.* 1997;52:P242-P246. **ABSTRACT**
9. Jin P. Theoretical perspectives on a form of physical and cognitive exercise Tai Chi. In: Davidson G, ed. *Applying Psychology: Lessons From Asia-Oceania.* Carlton, Victoria: Australian Psychological Society Ltd; 1994:135-153.
10. Chen KM, Snyder M. A research-based use of Tai Chi/movement therapy as a nursing intervention. *J Holist Nurs.* 1999;17:267-279. **FREE FULL TEXT**
11. Wolf SL, Coogler C, Tingsen X. Exploring the basis for Tai Chi Chuan as a therapeutic exercise approach. *Arch Phys Med Rehabil.* 1997;78:886-892. FULL TEXT | ISI | PUBMED
12. Wolf SL, Barnhart HX, Ellison GL, Coogler CE. The effect of Tai Chi Quan and computerized balance training on postural stability in older subjects. *Phys Ther.* 1997;77:371-381. **FREE FULL TEXT**
13. Wolf SL, Barnhart HX, Kutner NG, et al. Reducing frailty and falls in older persons. *J Am Geriatr Soc.* 1996;44:489-497. ISI | PUBMED
14. Jacobson BH, Cheng CH, Cashel C, Guerrero L. The effect of Tai Chi Chuan training on balance, kinesthetic sense, and strength. *Percept Mot Skills.* 1997;84:27-33. ISI | PUBMED
15. Hain TC, Fuller L, Weil L, Kotsias J. Effects of T'ai Chi on balance. *Arch Otolaryngol Head Neck Surg.* 1999;125:1191-1195. **FREE FULL TEXT**

16. Forrest WR. Anticipatory postural adjustment and T'ai Chi Ch'uan. *Biomed Sci Instrum.* 1997;33:65-70. PUBMED
17. Shih J. Basic Beijing twenty-four forms of T'ai Chi exercise and average velocity of sway. *Percept Mot Skills.* 1997;84:287-290. ISI | PUBMED
18. Schaller KJ. Tai Chi Chih: an exercise option for older adults. *J Gerontol Nurs.* 1996;22:12-17. PUBMED
19. Yan JH. Tai Chi practice improves senior citizens' balance and arm movement control. *J Aging Phys Activity.* 1998;6:271-284.
20. Wolfson L, Whipple R, Derby C, et al. Balance and strength training in older adults: intervention gains and Tai Chi maintenance. *J Am Geriatr Soc.* 1996;44:498-506. ISI | PUBMED
21. Lin YC, Wong AM, Chou SW, Tang FT, Wong PY. The effects of Tai Chi Chuan on postural stability in the elderly: preliminary report. *Changeng Yi Xue Za Zhi.* 2000;23:197-204. PUBMED
22. Tse SK, Bailey DM. Tai Chi and postural control in the well elderly. *Am J Occup Ther.* 1992;46:295-300. ISI | PUBMED
23. Hong Y, Li JX, Robinson PD. Balance control, flexibility, and cardiorespiratory fitness among older Tai Chi practitioners. *Br J Sports Med.* 2000;34:29-34. **FREE FULL TEXT**
24. Hartman CA, Manos TM, Winter C, Hartman DM, Li B, Smith J. Effects of T'ai Chi training on function and quality of life indicators in older adults with osteoarthritis. *J Am Geriatr Soc.* 2000;48:1553-1559. ISI | PUBMED
25. Kirsteins A, Dietz F, Hwang SM. Evaluating the safety and potential use of a weight-bearing exercise, Tai-Chi Chuan, for rheumatoid arthritis patients. *Am J Phys Med Rehabil.* 1991;70:136-141. FULL TEXT | ISI | PUBMED
26. Lan C, Lai JS, Chen SY, Wong MK. Tai Chi Chuan to improve muscular strength and endurance in elderly individual: a pilot study. *Arch Phys Med Rehabil.* 2000;81:604-607. FULL TEXT | ISI | PUBMED
27. Husted C, Pham L, Hekking A, Niederman R. Improving quality of life for people with chronic conditions. *Altern Ther Health Med.* 1999;5:70-74. ISI | PUBMED
28. Young DR, Appel LJ, Jee S, Miller ER. The effects of aerobic exercise and Tai Chi on blood pressure in older people: results of a randomized trial. *J Am Geriatr Soc.* 1999;47:277-284. ISI | PUBMED
29. Channer KS, Barrow D, Barrow R, Osborne M, Ives G. 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. ABSTRACT
30. Chou WS, Li Z. The effect of Tai Chi Chuan training on blood pressure, ECG and microcirculation in older people. *Chin Sports Med.* 1995;14:249.
31. 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.

32. Lai JS, Wong MK, Lan C, Chong CK, Lien IN. Cardiorespiratory responses of Tai Chi Chuan practitioners and sedentary subjects during cycle ergometry. *J Formos Med Assoc.* 1993;92:894-899. PUBMED
33. Lai JS, Lan C, Wong MK, Teng SH. Two-year trends in cardiorespiratory function among older Tai Chi practitioners and sedentary subjects. *J Am Geriatr Soc.* 1995;43:1222-1227. ISI | PUBMED
34. Lan C, Lai JS, Wong MK, Yu ML. Cardiorespiratory function, flexibility and body composition among geriatric Tai Chi Chuan practitioners. *Arch Phys Med Rehabil.* 1996;77:612-616. FULL TEXT | ISI | PUBMED
35. Lan C, Lai JS, Chen SY, Wong MK. 12-Month Tai Chi training in the elderly: its effect on health fitness. *Med Sci Sports Exerc.* 1998;30:345-351. ISI | PUBMED
36. Lan C, Chen SY, Lai JS, Wong MK. The effect of Tai Chi on cardiorespiratory function in patients with coronary artery bypass surgery. *Med Sci Sports Exerc.* 1999;31:634-638. ISI | PUBMED
37. Schneider D, Leung R. Metabolic and cardiorespiratory responses to the performance of Wing Chun and Tai Chi Chuan exercise. *Int J Sports Med.* 1991;12:319-323. ISI | PUBMED
38. Brown DD, Mucci WG, Hetzler RK, Knowlton RG. Cardiovascular and ventilatory responses during formalized Tai Chi Chuan exercise. *Res Q Exerc Sport.* 1989;60:246-250. ISI | PUBMED
39. Gong LS, Qain J, Zhang J, et al. Changes in heart rate and electrocardiogram during Tai Chi Quan exercise. *Chin Med J.* 1981;94:589-592. PUBMED
40. Zhuo DH, Shephard RJ, Plyley MJ, Davis GM. Cardiorespiratory and metabolic responses during Tai Chi Chuan exercise. *Can J Appl Sport Sci.* 1984;9:7-10. PUBMED
41. Zhang GD. Effect of simplified Tai-Ji boxing and playing in water on the health of children with abnormal cardiovascular system. *Zhonghua Yu Fang Yi Xue Za Zhi.* 1979;13:136-138. PUBMED
42. Chang HL, Gao HH. Effect of Qigong and Tai Chi on cardiovascular function in the elderly. *J Chin Pharmacol.* 1988;3:16-18.
43. Cun XC, Lansimies E. The effect of simplified Tai Chi Chuan on heart rate variability. *J Chin Rehabil.* 1998;13:225-226.
44. Wu XP, Ho ZQ. Effect of Tai Chi on cardiorespiratory function among older people with chronic conditions. *Massage Instruct.* 1996;71:9-10.
45. Kui RQ, Lin YH, Cun YX, Chou N. The effect of Qigong and Tai Chi Quan on pulmonary function in the elderly. *J Chin Rehabil Med.* 1990;5:115-117.
46. Liu JC, Zen HY, Pong LL, Liu ZJ, Liu YF. Effect of Tai Chi on cardiorespiratory function. *J Chin Rehabil.* 1993;1:20-21.
47. Cun YX, Chou N, Wang XP, Yu XZ, Kui RQ, Lin YH. The effect of Qigong and Tai Chi Quan on pulmonary function. *J Chin Rehabil Med.* 1988;3:168-171.
48. Gao LZ, Tan AL. Effect of Tai Chi on cardiorespiratory function in the elderly. *Bo Bu Med School J.* 1997;22:436-437.

49. Li F, Duncan TE, Duncan SC, McAuley E, Chaumeton NR, Harmer P. Enhancing the psychological well-being of elderly individuals through Tai Chi exercise: a latent growth curve analysis. *Struct Equation Modeling*. 2001;8:53-83.
50. Brown DR, Wang Y, Ward A, et al. Chronic psychological effects of exercise and exercise plus cognitive strategies. *Med Sci Sports Exerc*. 1995;27:765-775. ISI | PUBMED
51. Baron LJ. Tai Chi practice in the elementary classroom. *J Can Res Early Childhood Educ*. 1998;6:341-352.
52. Jin P. Efficacy of Tai Chi, brisk walking, meditation, and reading in reducing mental and emotional stress. *J Psychosom Res*. 1992;36:361-370. FULL TEXT | ISI | PUBMED
53. Fu CY, Wong AF, Wang YZ. The effects of Tai Chi on psychological balance. *J Chin Rehabil*. 1996;11:88-89.
54. Gibb H, Morris CT, Gleisberg J. A therapeutic programme for people with dementia. *Int J Nurs Pract*. 1997;3:191-199. PUBMED
55. Wang W. The effects of practicing Tai Chi on endocrine function in aged males. *J Shanghai Chin Trad Med*. 1986;10:3-5.
56. Sun X, Xu Y, Xia YJ. Determination for E-rosette-forming lymphocytes in aged subjects with Taichiquan exercise. *Int J Sports Med*. 1989;10:217-219. ISI | PUBMED
57. Li F, McAuley E, Harmer P, Duncan TE, Chaumeton NR. Tai Chi enhances self-efficacy and exercise behavior in older adults. *J Aging Phys Activity*. 2001;9:161-171.
58. 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. FULL TEXT | ISI | PUBMED
59. Slater J, Hunt H. Postural-vestibular integration and forms of dreaming: a preliminary report on the effects of brief T'ai Chi Chuan training. *Percept Mot Skills*. 1997;85:97-98. ISI | PUBMED
60. Vickers A, Goyal N, Harland R, Rees R. Do certain countries produce only positive results. *Control Clin Trials*. 1998;19:159-166. FULL TEXT | ISI | PUBMED

RELATED LETTERS

Response to the Systematic Review of Tai Chi

Ruth E. Taylor-Piliae

Archives of Internal Medicine. 2004;164:2503.

EXTRACT | FULL TEXT

Response to the Systematic Review of Tai Chi—Reply

Chenchen Wang

Archives of Internal Medicine. 2004;164:2504.

EXTRACT | FULL TEXT

THIS ARTICLE HAS BEEN CITED BY OTHER ARTICLES

Tai Chi for Disease Activity and Flexibility in Patients with Ankylosing Spondylitis A Controlled Clinical Trial

Lee et al.

Evid Based Complement Alternat Med 2007;0:nem048v2-nem048.

ABSTRACT | FULL TEXT

A Randomized Controlled Trial of Tai Chi for Tension Headaches

Abbott et al.

Evid Based Complement Alternat Med 2007;4:107-113.

ABSTRACT | FULL TEXT

Tai Chi Chuan Exercise Decreases A1C Levels Along With Increase of Regulatory T-Cells and Decrease of Cytotoxic T-Cell Population in Type 2 Diabetic Patients

Yeh et al.

Diabetes Care 2007;30:716-718.

FULL TEXT

Group and home-based tai chi in elderly subjects with knee osteoarthritis: a randomized controlled trial

Brismee et al.

Clin Rehabil 2007;21:99-111.

ABSTRACT

Tai Chi Chih Acutely Decreases Sympathetic Nervous System Activity in Older Adults

Motivala et al.

J. Gerontol. A Biol. Sci. Med. Sci. 2006;61:1177-1180.

ABSTRACT | FULL TEXT

Community patient education and exercise for people with fibromyalgia: a parallel group randomized controlled trial.

Hammond and Freeman

Clin Rehabil 2006;20:835-846.

ABSTRACT

Tai chi chuan: mind-body practice or exercise intervention? Studying the benefit for cancer survivors.

Mansky et al.

Integr Cancer Ther 2006;5:192-201.

ABSTRACT

Tai Chi versus brisk walking in elderly women

Audette et al.

Age Ageing 2006;35:388-393.

ABSTRACT | FULL TEXT

The potential of a person-centered approach in caring for patients with cancer: a perspective from the UCLA center for East-west medicine.

Hui et al.

Integr Cancer Ther 2006;5:56-62.

ABSTRACT

Regular tai chi chuan exercise enhances functional mobility and CD4CD25 regulatory T cells.

Yeh et al.

Br. J. Sports. Med. 2006;40:239-243.

ABSTRACT | FULL TEXT

Risk Indices Associated with the Insulin Resistance Syndrome, Cardiovascular Disease, and Possible Protection with Yoga: A Systematic Review

Innes et al.

J Am Board Fam Med 2005;18:491-519.

ABSTRACT | FULL TEXT

Effect of Tai Chi in adults with rheumatoid arthritis

Wang et al. *Rheumatology (Oxford)* 2005;44:685-687.

FULL TEXT

Mind-Body, Ki (Qi) and the Skin: Commentary on Irwin's 'Shingles Immunity and Health Functioning in the Elderly: Tai Chi Chih as a Behavioral Treatment'

Kobayashi and Ishii. *Evid Based Complement Alternat Med* 2005;2:113-116.

FULL TEXT

Response to the Systematic Review of Tai Chi

Taylor-Piliae

Arch Intern Med 2004;164:2503-2503.

FULL TEXT

Response to the Systematic Review of Tai Chi--Reply

Wang. *Arch Intern Med* 2004;164:2504-2504.

FULL TEXT

Shingles Immunity and Health Functioning in the Elderly: Tai Chi Chih as a Behavioral Treatment

Irwin et al.

Evid Based Complement Alternat Med 2004;1:223-232.

ABSTRACT | FULL TEXT

23 Apr 2004 to 23 Jul 2004

Evid. Based Nurs. 2004;7:e4-e4.

FULL TEXT

Research on Complementary Therapies in Home Care

DePalma. *Home Health Care Management Practice* 2004;16:521-523.

Evidently...

Lehman

Evid. Based Med. 2004;9:104-105.

FULL TEXT

Other articles noted

Evid. Based Med. 2004;9:127-128.

FULL TEXT