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## Tai Chi and Rheumatic Diseases

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### SYNOPSIS

Many patients with chronic rheumatic diseases such as osteoarthritis, rheumatoid arthritis and fibromyalgia experience high levels of pain, psychological distress and negative emotions and have limited therapeutic options. Tai Chi is a complex multi-component mind-body exercise that increasing numbers of Americans are practicing, particularly those with musculoskeletal conditions. Clinical trials and observational studies have provided encouraging evidence that Tai Chi, both short and long-term, has benefits for patients with a variety of chronic disorders. As a form of physical exercise, Tai Chi enhances cardiovascular fitness, muscular strength, balance, and physical function. It also appears to be associated with reduced stress, anxiety and depression as well as improved quality of life. Thus, despite the noted limitations in the evidence, and the need for further methodologically rigorous studies, Tai Chi can be safely recommended to patients with osteoarthritis, rheumatoid arthritis and fibromyalgia as a complementary and alternative medical approach to affect patient well-being. This overview synthesizes the current body of knowledge about this ancient Chinese mind-body medicine to better inform clinical decision-making for our rheumatic patients.

### Keywords

Tai Chi; Mind-body Exercise; Osteoarthritis; Rheumatoid Arthritis; Fibromyalgia; Complementary and Alternative Medicine; Pain Management

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Tai Chi, a traditional Chinese mind-body exercise, has recently grown in popularity in the United States. According to the 2007 National Health Interview Survey, around 2.5 million Americans have practiced Tai Chi for health and that number is increasing.[1] Furthermore, individuals with musculoskeletal conditions are more likely to practice Tai Chi.[2] It is clear that our patients with rheumatic disease are interested in seeking this type of complementary and alternative treatment. Thus, it is important to examine evidence-based Tai Chi mind-body medicine to provide clinicians with an overview of these new sources of knowledge for the best care for our rheumatic patients.

As an original Chinese martial art, Tai Chi 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

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movements. It has been considered a complex, multi-component intervention integrating physical, psychosocial, emotional, spiritual, and behavioral elements and promoting the mind-body interaction.[3–5] Tai Chi evolved into many different styles during its development including Chen style, Wu style, Sun style, Yang style (classical long form style of 108 postures or simplified style of 24 postures) and other modified styles. Tai Chi can be practiced in almost any setting because it requires no equipment and a minimal amount of space.

In the past two decades, literature has consistently recognized the potential therapeutic benefits of Tai Chi for chronic conditions. Significant improvement has been reported in balance, strength, flexibility, cardiovascular and respiratory function, mood, depression and anxiety, self-efficacy, pain reduction and health-related quality of life in diverse eastern and western populations.[4] Several recent reviews have further suggested that Tai Chi appears to improve a variety of medical conditions.[6–10]

This article encompasses scientific evidence on the therapeutic benefits of Tai Chi for several major rheumatic disorders: osteoarthritis, rheumatoid arthritis and fibromyalgia. We also briefly review the role of Tai Chi on associated conditions including neuromuscular abnormalities, cardiovascular disease, osteoporosis, depression and sleep disturbance.

## Tai Chi and Osteoarthritis (OA)

Osteoarthritis, the most prevalent joint disorder, is an increasing problem in the elderly resulting in chronic pain, functional limitation, reduced quality of life and substantial health care costs worldwide.[11] The pathophysiological basis of OA is multifaceted and includes impaired muscle function, reduced proprioceptive acuity, and the psychological traits of chronic pain. Symptomatic OA is the most frequent cause of dependency in lower limb tasks, with substantial physical and psychosocial disability.[12–14] Few effective disease-modifying remedies for OA currently exist. Nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen, the most widely used agents, relieve pain levels by about 20%, and carry a hidden cost of serious adverse events in the elderly.[15] Furthermore, recent evidence indicates that arthroscopic surgery for knee OA provides no additional benefits over optimized physical and medical therapy.[16] Recommended core treatments for OA include physical therapy, such as aerobic and muscle strengthening exercises,[17,18] but current data suggest these have modest benefits for pain and physical function,[19,20] substantial costs,[21] and may not affect psychological outcomes.[19] In addition, reduced activity levels due to OA result in poor aerobic capacity and increased risk for cardiovascular disease, obesity, and other inactivity-related conditions.[22–24]

As a complementary mind-body approach, Tai Chi may be an especially applicable treatment for older adults with OA. The physical component provides exercise consistent with current recommendations for OA (muscle strength, balance, flexibility, and aerobic cardiovascular exercise)[17,18] and the mental component could address the chronic pain state through effects on psychological well-being, life satisfaction, and perceptions of health.[25] These effects may reduce pain, improve function, and retard disease progression and disability associated with OA.[26]

Several randomized, controlled studies have examined the effects of Tai Chi on symptomatic OA. Hartman and colleagues[27] were among the first to conduct a prospective, randomized, controlled clinical trial to test the efficacy of 12 weeks of Tai Chi for patients with OA. A total of 35 community-dwelling participants were randomly assigned to receive either two 1-hour Tai Chi classes per week for 12 weeks (a 9-form Yang style) or to a control group that received usual physical activities and routine care. The results of Tai Chi training significantly improved arthritis symptoms, arthritis self-efficacy,

level of tension, and satisfaction with general health status. In another study, Song and colleagues reported that among 72 patients with OA, patients receiving 12 forms of Sun-style Tai Chi over 12 weeks perceived significantly less pain and stiffness than patients receiving routine treatment. In addition, physical functioning, balance and abdominal muscle strength were significantly improved for the Tai Chi group.[28]

In a three-armed randomized, clinical trial of 152 older patients with chronic symptomatic hip and knee OA, Fransen and colleagues found that, when compared with a waiting list control group, both 12-week Tai Chi and hydrotherapy classes provided large and sustained improvements in physical function. All significant improvements were sustained at 24 weeks.[29] In a study by Brismee and colleagues, a 6-week group Tai Chi program followed by 6 weeks of home Tai Chi training showed significant improvement in knee pain and physical function compared with an attention control in 41 elderly patients with knee OA, however the benefits for knee pain (visual analogue scale) and the Western Ontario and McMaster Universities OA overall scores were not sustained throughout the follow-up detraining period (weeks 13–18). [30]

The author's research group has recently conducted a single-blind, randomized controlled trial testing the effectiveness of Tai Chi training in the treatment of knee OA symptoms in the elderly. Forty eligible individuals (age  $\geq 55$  yr; Body Mass Index  $\leq 40$  kg/m<sup>2</sup> with knee pain visual analog score  $> 40$  [range 0–100]; fulfillment of the American College of Rheumatology criteria for knee OA with radiographic Kellgren and Lawrence grade  $\geq 2$ ) were randomly assigned to 60 minutes of Tai Chi (10 modified forms from classical Yang style) or an attention control (stretching and wellness education) twice-weekly for 12 weeks. The outcomes of the Western Ontario and McMaster Universities OA (WOMAC) pain, WOMAC function, patient and physician global assessments, timed chair stand, depression, self-efficacy, and health-related quality of life were assessed at baseline, 12, 24 and 48 weeks. The results showed that participants in the Tai Chi arm exhibited significantly greater improvements in pain, physical function, depression, self-efficacy and health status compared to the controls. Patients who continued Tai Chi practice after 12 weeks reported durable benefits in pain and function.[31]

Another recent randomized controlled trial of 82 women with OA suggested that 6 months of 31 forms of Sun-style Tai Chi with qigong breathing exercise significantly improved knee extensor endurance and bone mineral density and decreased patients' fear of falling, compared with a self-help education program.[32] Similar positive findings of short and long term Tai Chi have been well documented on balance control, flexibility, muscular strength and endurance in the elderly,[4,33–36] which have important benefits for patients with symptomatic OA.

Neurologic deficits, especially quadriceps sensory dysfunction (i.e., decreased proprioceptive acuity) may precede clinically evident OA and are proposed to be a factor in its pathogenesis and progression. Studies examining the impact of knee-joint proprioception and neuromuscular activities have largely focused on older adults with long-term Tai Chi practice.[37–39] Tsang and Hui-Chan reported a longitudinal study investigating knee joint proprioception of 21 elderly individuals who practiced Tai Chi for at least 3 years compared with 21 non-Tai Chi controls. Using the passive knee joint repositioning test, the Tai Chi practitioners had better knee-joint proprioceptive acuity (less absolute angle errors than controls).[37] This research group further examined knee joint proprioception in 68 elderly subjects who practiced Tai Chi regularly for at least 4 years, long-term swimming-running exercisers, and sedentary controls. The Tai Chi practitioners showed significantly better knee joint proprioception than two other groups. In addition, the threshold for detection of passive motion improved in knee flexion and extension in the Tai Chi group.[38] Moreover,

in a cross-sectional study of 61 elderly individuals consisting of long-term Tai Chi practitioners, regular joggers, and sedentary counterparts, Xu and colleagues found that, when compared with a sedentary control, Tai Chi and Jogging groups had significant improvements in the neuromuscular reaction in the elderly. [39] Despite limited observational evidence, these results generally support that long-term Tai Chi practice led to better knee-joint proprioceptive acuity and neuromuscular activities in an older population.

In summary, the pathophysiological basis of OA is complex and multifaceted and symptomatic OA is diverse and heterogeneous. Tai Chi exercise, as a multi-component mind-body intervention, may modulate complex factors and improve health outcomes in OA. The evidence reviewed here is promising and suggests that Tai Chi training may provide an ideal form of exercise for older individuals with OA suffering from pain and poor function. As a form of physical exercise, Tai Chi may enhance cardiovascular function, muscular strengthening, proprioceptive acuity, neuromuscular activities, and integration of the mind and body, thereby reducing pain. Stronger muscles and better balance coordination can also improve the stability of joints and physical function. Increased periarticular muscle strength may protect joints from traumatic impacts. Improving self-efficacy, social function and depression can help people build confidence, get support and overcome fears of pain leading to improved physical, psychological and psychosocial well-being and overall quality of life.[40–42]

## Tai Chi and Rheumatoid Arthritis (RA)

Treatment of RA, a systemic, diverse and dynamic disorder, has made major progress over the past few decades. Early active treatment with disease-modifying anti-rheumatic drugs and biological agents can be highly beneficial for control of inflammatory activity and preventing disability in many patients.[43] However, the most effective new drugs can be too expensive and many patients with RA continue to suffer from pain, restricted mobility, reduced muscle strength and low endurance. In addition, it is increasingly recognized that comorbid conditions play a pivotal role in RA outcomes. For example, cardiovascular complications are the leading contributor to mortality in RA,[44] accounting for approximately one half of all deaths,[45] and osteoporosis resulting in bone fractures represents a major source of morbidity in RA.[46] Indeed, lifestyle behavioral modification is considered to be critical in preventing RA-associated comorbidities and their complications.[47] Tai Chi exercise may be beneficial to patients with RA as a result of its effects on muscle strength, stress reduction, cardiovascular and bone health as well as improved health-related quality of life.

One early publication by Kirsteins and colleagues,[48] reported on two non-randomized controlled trials of 47 and 28 RA patients with 10 weeks Tai Chi training. Disease activity (joint tenderness, number of swollen joints), time to walk 50 feet, handgrip strength and a written functional assessment, and exacerbation of joint symptoms were measured. The studies showed that Tai Chi appears to be safe for RA patients and may serve as a suitable weight-bearing exercise with the additional potential advantages of stimulating bone growth and strengthening connective tissue.

Two Korean randomized controlled trials were published recently. A study of 31 patients reported by Lee and colleagues showed that compared with a usual care group, 6-week Tai Chi training significantly improved mood and sleep disturbance.[49] Another trial of 61 patients showed that 50 minutes per week of Tai Chi training for 12 weeks significantly decreased pain and fatigue compared to usual care controls.[50]

To obtain preliminary data on the effects of Tai Chi on RA, the author's research group conducted a pilot randomized controlled trial.[51] Twenty patients with functional Class I or

II RA and mean disease duration of 14.5 years were randomly assigned to Tai Chi or attention control in twice-weekly sessions for 12 weeks. Patients continued routine medications such as NSAIDs, corticosteroids and DMARDs and maintained treatment visits with their primary care physician and rheumatologist throughout the conduct of the study. The American College Rheumatology 20 response criterion, functional capacity, health-related quality of life and the depression index were assessed. At 12 weeks, 5/10 patients (50%) randomized to Tai Chi achieved an ACR 20% response compared with 0/10 (0%) in the control ( $p = 0.03$ ). Tai Chi had greater improvement in the Disability Index ( $p = 0.01$ ), Vitality subscale of the SF-36 ( $p = 0.01$ ) and the Depression Index ( $p = 0.003$ ). Similar trends to improvement were also observed for disease activity, functional capacity and health related quality of life. No adverse events were observed and no patients withdrew from the study, suggesting that Tai Chi is safe and may be beneficial for Functional Class I or II RA.

A subsequent study of Tai Chi in RA patients by Uhlig and colleagues, however, produced inconsistent results. In a before and after comparison study involving 15 female patients with RA aged 40–70 years, participating in 8-week Tai Chi training, no improvements were seen in disease activity, muscle strength, flexibility, balance and health status despite the fact that the study suggested that Tai Chi was a safe and feasible exercise in RA.[52] The same group of investigators using the similar study design for another 15 patients found that a 12-week Tai Chi improved lower-limb muscle function and endurance at the end of 12 weeks.[53] A Cochrane review examined the evidence of 4 clinical trials in 206 participants and only two of which included exclusively Tai Chi from non-randomized controlled trials by Kirsteins and colleagues [48]. The other two trials were using multicomponent programs that include combinations of exercise and Tai Chi [54] [55] The review suggested that Tai Chi does not exacerbate symptoms of RA and has statistically significant benefits on lower extremity range of motion for people with RA, with ankle range of motion in particular.[56]

As a chronic disorder characterized by inflammation leading to joint destruction, RA has clinically important comorbidities, including cardiovascular complications and osteoporosis. Numerous studies have evaluated the effects of Tai Chi on cardiovascular and respiratory function.[57–61] Since 1979, results related to the effect of Tai Chi on cardiovascular and pulmonary function have been reported in 43 eastern and western publications.[4,8,62] Among them, one study[63] reported that the metabolic intensity of the activity seems insufficient to generate improvements of cardiorespiratory fitness in healthy young adults. Yet, other studies suggested that regular Tai Chi practice may preserve cardiorespiratory function in older individuals and may be prescribed as a suitable exercise for older adults. Recent systematic reviews of the literature have shown that Tai Chi can reduce blood pressure and increase cardiovascular exercise capacity.[8,62] Thus, encouraging evidence suggests that Tai Chi may be a safe and beneficial adjunctive therapy to conventional care for patients with RA-associated cardiovascular disease and its complications. Several large ongoing trials studying Tai Chi for patients with cardiac conditions will provide more information on the role of Tai Chi's benefits and mechanisms in the prevention and management of cardiovascular disease.

Evidence from several recent randomized controlled trials and observational studies have evaluated the potential beneficial effects of Tai Chi for osteoporosis, another common RA-associated comorbidity. In a recent randomized trial of three times per week Tai Chi or resistance exercise compared to a no intervention control in 180 community-living elders, Woo and colleagues reported that both Tai Chi and resistance exercise had less Bone Mineral Density (BMD) loss at total hip after 12 months, compared with the no intervention controls.[64] In a second randomized trial among 28 sedentary elderly adults, comparing the effects of Tai Chi and resistance training, Shen and colleagues found that treatment with 3



sessions per week of 24-week Tai Chi increased serum bone-specific alkaline phosphatase and parathyroid hormone compared with resistance training after 6 or 12 weeks. Results also revealed a reduction of the urinary calcium level with Tai Chi at 24 weeks and suggested that Tai Chi is beneficial for increased bone formation in the elderly.[65] A longitudinal randomized prospective trial also showed that 12 months of 108-form Tai Chi slowed bone loss in weight-bearing bones in 132 healthy postmenopausal woman compared to sedentary controls.[66] Among early postmenopausal Chinese women in Hong Kong, Qin and colleagues demonstrated that Tai Chi practitioners with more than 4 years experience had significantly higher BMD in the lumbar spine, proximal femur, and distal tibia than sedentary controls,[67] and that regular long-term Tai Chi practice was associated with higher BMD and better neuromuscular function.[68]

In summary, as a complex immunologically mediated disorder, RA is still a therapeutically challenging chronic condition to control. Emerging evidence from clinical trials reviewed here supports the concept that the development of better lifestyle modifying strategies such as Tai Chi could affect progression of disease and decrease morbidity among individuals with RA. While existing evidence regarding Tai Chi on RA remain limited and inconclusive, [69,70] these promising results suggest that Tai Chi may be a safe adjunctive therapy for RA and warrants further investigation.

### Tai Chi and Fibromyalgia (FM)

FM is a complex disorder characterized by widespread musculoskeletal pain, sleep disturbances, functional limitations and poor quality of life that can be best managed with multidisciplinary therapies.[71,72] Pharmacological therapies that are currently available for the treatment of FM are associated with numerous limitations, including side effects and addiction and tolerance issues, and patients are often left with unrelieved pain. Nonpharmacological approaches, including educational and exercise programs, have a role in pain management, but data from clinical trials on the use of these treatment modalities and knowledge of how to best incorporate them into the clinical care of patients are limited. [73]

Recent research testing Tai Chi mind-body interventions found considerable benefits for patients with FM. One nonrandomized study of Tai Chi in 39 individuals with FM suggested that 6-weeks of 1-hour, twice weekly Tai Chi led to statistically significant improvement in FM symptom management and health related quality of life.[74] The author's group recently conducted a single-blind, randomized controlled trial of classical Yang-style Tai Chi vs. as compared with a control intervention consisting of wellness education and stretching for the treatment of FM (defined by American College of Rheumatology 1990 criteria). Sessions lasted 60 minutes each and took place twice a week for 12 weeks for each of the study groups. The primary end point was a change in the FM Impact Questionnaire (FIQ) score (ranging from 0 to 100, with higher scores indicating more severe symptoms) at the end of 12 weeks. Secondary end points included patient and physician global assessments, sleep quality, 6-minute walk time, depression, chronic pain self-efficacy and summary scores on the physical and mental components of the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36). All assessments were repeated at 24 weeks to test durability of response. The study found that the 33 patients in the Tai Chi group had clinically important improvement in the FIQ score and in the measure used to assess pain, sleep quality, depression, and quality of life, compared with the control group. Improvements were maintained at 24 weeks. No adverse events were reported in the study participants. Notably, more subjects had discontinued medication used to treat FM in the Tai Chi group than in the control group, although the difference was not significant (11 of 31 patients vs. 4 of 26,  $P=0.09$ ). [75] Both studies suggested that Tai Chi may be a useful treatment in the

multidisciplinary management of this therapeutically challenging disorder. Similar positive findings were reported in a number of clinical trials supporting the benefits of other forms of mind-body practice or group exercise such as Qigong for symptom management in FM.[76–81]

### **Effect of Tai Chi on Psychological Health**

Chronic pain in FM is commonly accompanied by psychosocial stress, anxiety and depression.[82] Therapeutic approaches with psychological and behavioral impact such as Tai Chi mind-body therapy could better patients' emotional health outcomes.[83]

The author's group recently systematically reviewed the evidence of the effects of Tai Chi on stress, anxiety, depression and mood disturbance in various eastern and western populations.[6] Specifically, the results of 33 randomized and nonrandomized trials suggest that regular Tai Chi practice is significantly associated with improvements in psychological well-being including reduced stress (effect size, 0.66; 95% confidence interval [CI], 0.23 to 1.09), anxiety (effect size, 0.66; 95% CI, 0.29 to 1.03), depression (effect size, 0.56; 95% CI, 0.31 to 0.80), and mood disturbance (effect size, 0.45; 95% CI, 0.20 to 0.69) in healthy participants and patients with chronic conditions (Figure 1). Seven observational studies with relatively large sample sizes reinforced the beneficial association between Tai Chi practice and psychological health. Notably, the review found that Tai Chi tended to reduce depression compared to various controls among healthy adults, individuals with OA, RA and FM, depression disorders, sedentary obese women, and elderly participants with cardiovascular disease risk factors. This positive result was associated with improvement in symptoms and physical function in patients with OA, FM, RA and multiple sclerosis. Interestingly, the benefits were also associated with an improvement in the immune response with 50% improvement in varicella zoster virus-specific cell-mediated immunity (T cell-dependent response) after 15 and 25 weeks of Tai Chi in healthy elderly Americans. [84,85]

However, the vast majority of the studies suffer from less rigorous designs and were conducted on "healthy" populations with only two studies reporting results on participants diagnosed with clinical depression. Nevertheless, the potential mental health benefits of Tai Chi mind-body therapy support its inclusion as a key component of a multidisciplinary medical approach to promote psychological health, treat chronic pain, and better inform clinical decision-making for FM.

### **Effect of Tai Chi on Sleep Quality**

Sleep disturbances are common in FM and patients may derive greater benefits from mind-body interventions to improve sleep quality and reduce pain and fatigue. Several randomized, controlled studies have investigated the efficacy of Tai Chi interventions for sleep quality. In the first study, Li and colleagues randomized 118 older people with moderate sleep disturbance into one-hour sessions, three times per week of Tai Chi or low-impact exercise for 24 weeks. Tai Chi participants reported significant improvements in Pittsburgh Sleep Quality Index global scores and subscores (sleep quality, sleep-onset latency, sleep duration, sleep efficiency and sleep disturbances) in comparison with the low-impact exercise control group. The study concluded that Tai Chi appears to be effective as a nonpharmacological approach for sleep-disturbed elderly individuals.[86] A second randomized controlled trial was reported by Irwin and colleagues. One hundred and twelve healthy older adults were randomly assigned to 16 weeks of Tai Chi or health education followed by practice and assessment 9 weeks later. The main outcome measure was sleep quality, as assessed by the Pittsburgh Sleep Quality Index. Among adults with moderate sleep disturbance, subjects in the Tai Chi group showed significant improvements in Pittsburgh Sleep Quality Index global score ( $P < 0.001$ ), as well as habitual sleep efficiency

( $P<0.05$ ), sleep duration ( $P<0.01$ ), and sleep disturbance ( $P<0.01$ ).[87] In addition, Yeh and colleagues assessed the effects of a 12-week Tai Chi exercise program on sleep using the sleep spectrogram in a randomized controlled trial of 18 patients with chronic stable heart failure. Compared with the usual care group, the Tai Chi group had significant improvements in sleep stability.[88] Similarly, one observational study of 145 subjects reported that 1 to 14 years of Tai Chi practice significantly improved sleep and mood disturbance in elderly Chinese participants.[89]

### **Practicing Tai Chi for Chronic Rheumatic Conditions**

Overall, despite limited data, previous work has demonstrated that Tai Chi, a traditional Chinese mind-body exercise, may be highly suited to the management of symptoms of common chronic rheumatic conditions by reducing pain and improving physical and psychological health and wellbeing. Scientific research is under way to learn more about how Tai Chi affects rheumatic diseases and for which conditions it may be helpful. For patients who like to practice Tai Chi to improve their health and well-being, health care providers need to discuss complementary and alternative practices to help ensure coordinated and safe care. There is no evidence to support that Tai Chi can be a replacement for conventional care or can postpone seeing a doctor about a medical problem. Also, there is no current standard training for instructors, therefore providing patients with access to experienced Tai Chi instructors is essential.

### **Summary**

Osteoarthritis, rheumatoid arthritis and fibromyalgia consist of complex interplay between psychological and biologic aspects. Many patients with these chronic rheumatic illnesses experience high levels of pain and psychological distress that are incompletely relieved by current pharmacologic or physical interventions. Tai Chi, a complex multi-component mind-body therapy, may be particularly applicable for promoting overall quality of life for patients with these chronic rheumatic conditions.

Over the past two decades, clinical trials and observational studies have provided encouraging evidence that Tai Chi, both short and long-term, has great benefits for patients with a variety of chronic conditions. As a form of physical exercise, Tai Chi enhances cardiovascular fitness, muscular strength, balance, coordination, and physical function. In addition, Tai Chi appears to be associated with improvements in psychological well-being including reduced stress, anxiety, depression and mood disturbance, and increased self-esteem. Thus, despite the noted limitations in the evidence, and the need for further methodologically rigorous studies, Tai Chi mind-body exercise can be safely recommended to patients with OA and FM as a primary form of treatment, or an adjective therapy for RA and its comorbidities to promote both physical and psychological wellbeing. Further exploring the mechanisms of successful mind-body medicine is important to better inform clinical decision-making for our rheumatic patients.

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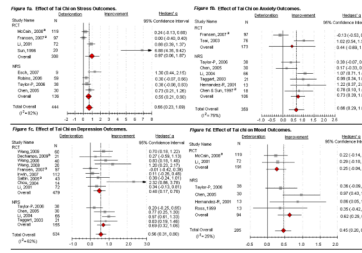
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**Figure 1. Effects of Tai Chi on stress, anxiety, depression and mood\***

\*The magnitude of the effect size (clinical effects) indicates: 0–0.19= negligible effect, 0.20–0.49=small effect, 0.50–0.79= moderate effect, 0.80+= large effect.

RCT= randomized controlled trial; NRS= nonrandomized comparison study (all the meta-analyzed NRS are self-comparison studies). N= number of participants.

<sup>a</sup> McCain, 2008, included only Tai Chi versus wait list control (n=119); Fransen 2007, included only Tai Chi versus control group (n=97); Chen & Sun 1997, included only participants in Tai Chi group as pretreatment, posttreatment (n=18); Sattin 2005, included only clinically depressed participants in Tai Chi and control arms (n=43). <sup>b</sup> Dechamps, 2009, used an active control compared to Tai Chi.

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