A comprehensive review of health benefits of Qigong and Tai Chi

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Abstract:

Objective. Research examining psychological and physiological benefits of Qigong and Tai Chi is growing rapidly. The many practices described as Qigong or Tai Chi have similar theoretical roots, proposed mechanisms of action, and expected benefits. Research trials and reviews, however, treat them as separate targets of examination. This review examines the evidence for achieving outcomes from randomized controlled trials (RCTs) of both. **Data Sources.** The key words Tai Chi, Taiji, Tai Chi Chuan, and Qigong were entered into electronic search engines for the Cumulative Index for Allied Health and Nursing (CINAHL), psychological literature (PsycINFO), PubMed, Cochrane database, and Google Scholar. **Study Inclusion Criteria.** RCTs reporting on the results of Qigong or Tai Chi interventions and published in peer-reviewed journals from 1993 to 2007. **Data Extraction.** Country, type and duration of activity, number/type of subjects, control conditions, and reported outcomes were recorded for each study. **Synthesis.** Outcomes related to Qigong and Tai Chi practice were identified and evaluated. **Results.** Seventy-seven articles met the inclusion criteria. The nine outcome category groupings that emerged were bone density (n = 4), cardiopulmonary effects (n = 19), physical function (n = 16), falls and related risk factors (n = 23), quality of life (n = 17), self-efficacy (n = 8), patient-reported outcomes (n = 13), psychological symptoms (n = 27), and immune function (n = 6). **Conclusions.** Research has demonstrated consistent, significant results for a number of health benefits in RCTs, evidencing progress toward recognizing the similarity and equivalence of Qigong and Tai Chi.

Article:

INTRODUCTION

A substantial body of published research has examined the health benefits of Tai Chi (also called Taiji), a traditional Chinese wellness practice. In addition, a strong body of research is also emerging for Qigong, an even more ancient traditional Chinese wellness practice that has similar

characteristics to Tai Chi. Qigong and Tai Chi have been proposed, along with yoga and pranayama from India, to constitute a unique category or type of exercise referred to currently as meditative movement.[1] These two forms of meditative movement, Qigong and Tai Chi, are close relatives, having shared theoretical roots, common operational components, and similar links to the wellness and health-promoting aspects of Traditional Chinese Medicine (TCM). They are nearly identical in practical application in the health-enhancement context and share much overlap in what TCM describes as the ''three regulations'': body focus (posture and movement), breath focus, and mind focus (meditative, mindful components).[1,2]

Because of the similarity of Qigong and Tai Chi, this review of the state of the science for these forms of meditative movement will investigate the benefits of both forms together. In presenting evidence for a variety of health benefits, many of which are attributable to both practices, we will point to the magnitude of the combined literature and suggest under what circumstances Qigong and Tai Chi may be considered as potentially equivalent interventions, with recommendations for standards and further research to clarify this potential.

OBJECTIVES

Previously published reviews have reported on specific outcomes of either Tai Chi or Qigong, mostly addressing only one of these practices, and rarely taking into account the similarity of the two forms and their similar outcomes. These reviews have covered a wide variety of outcomes, with many focused on specific diseases or symptoms, including hypertension,[3] cardiovascular disease,[4,5] cancer,[6–8] arthritic disease,[9] stroke rehabilitation,[10] aerobic capacity,[11] falls and balance,[12,13] bone mineral density,[14] and shingles-related immunity,[15] with varying degrees of support noted for outcomes in response to Qigong or Tai Chi.

Other reviews have addressed a broad spectrum of outcomes to demonstrate how Qigong[16–19] or Tai Chi[20–26] has demonstrated improvements for participants with a variety of chronic health problems or with vulnerable older adults. Although many of these reviews have utilized selection criteria that restrict their focus to rigorous empirical studies, others have used less stringent criteria. The purpose of this review is to evaluate the current evidence for a broad range of health benefits for both Qigong and Tai Chi using only randomized controlled trials (RCTs), and to evaluate the potential of treating these two forms of meditative movement as equivalent forms. A complete description of Qigong and Tai Chi is presented and the equivalence of their theoretical roots and their common elements of practice are established. Then, the body of evidence for outcomes in response to Qigong and Tai Chi is reviewed to examine the range of health benefits. Finally, to more critically evaluate similarities across studies of the two practices, we discuss the potential of treating them as equivalent interventions in research and the interpretation of results across studies.

Research question 1: What health benefits are evidenced from RCTs of Qigong and Tai Chi?

Research question 2: In examining the Qigong and Tai Chi practices incorporated in research, and the evidence for health benefits commensurate with each, what claims can be made for equivalence of these two forms of practice/exercise that have typically been considered to be separate and different?

Overview of Qigong and Tai Chi

Qigong is, definitively, more ancient in origin than Tai Chi, and it is the overarching, more original discipline incorporating widely diverse practices designed to cultivate functional integrity and the enhancement of the life essence that the Chinese call Qi. Both Qigong and Tai Chi sessions incorporate a wide range of physical movements, including slow, meditative, flowing, dance-like motions. In addition, they both can include sitting or standing meditation postures as well as either gentle or vigorous body shaking. Most importantly, both incorporate the purposeful regulation of both breath and mind coordinated with the regulation of the body. Qigong and Tai Chi are both based on theoretical principles that are inherent to TCM.[1] In the ancient teachings of health-oriented Qigong and Tai Chi, the instructions for attaining the state of enhanced Qi capacity and function point to the purposeful coordination of body, breath, and mind (paraphrased here): ''Mind the body and the breath, and then clear the mind to distill the Heavenly elixir within.'' This combination of self-awareness with self-correction of the posture and movement of the body, the flow of breath, and mindfulness, are thought to comprise a state that activates the natural self-regulatory (self-healing) capacity, stimulating the balanced release of endogenous neurohormones and a wide array of natural health recovery mechanisms that are evoked by the intentful integration of body and mind.

Despite variations among the myriad forms, we assert that health-oriented Tai Chi and Qigong emphasize the same principles and practice elements. Given these similar foundations and the fashion in which Tai Chi has typically been modified for implementation in clinical research, we suggest that the research literature for these two forms of meditative movement should be considered as one body of evidence.

Qigong

Qigong translates from Chinese to mean, roughly, to cultivate or enhance the inherent functional (energetic) essence of the human being. It is considered to be the contemporary offspring of some of the most ancient (before recorded history) healing and medical practices of Asia. The earliest forms of Qigong make up one of the historic roots of contemporary TCM theory and practice.[2] Many branches of Qigong have a health and medical focus and have been refined for well over 5000 years. Qigong purportedly allows individuals to cultivate the natural force or energy (Qi) in TCM that is associated with physiological and psychological functionality. Qi is the conceptual foundation of TCM in acupuncture, herbal medicine, and Chinese physical therapy. It is considered to be a ubiquitous resource of nature that sustains human well-being and assists in healing disease as well as (according to TCM theory) having fundamental influence on all life and even on the orderly function of celestial mechanics and the laws of physics. Qigong exercises consist of a series of orchestrated practices including body posture/movement, breath practice, and meditation, all designed to enhance Qi function (that is, drawing upon natural forces to optimize and balance energy within) through the attainment of deeply focused and relaxed states. From the perspective of Western thought and science, Qigong practices activate naturally occurring physiological and psychological mechanisms of self-repair and health recovery.

Also considered part of the overall domain of Qigong is ''external Qigong,'' wherein a trained medical Qigong therapist diagnoses patients according to the principles of TCM and uses ''emitted Qi'' to foster healing. Both internal Qigong (personal practice) and external Qigong (clinician-emitted Qi) are seen as affecting the balance and flow of energy and enhancing functionality in the body and the mind. For the purposes of our review, we are focused only on the individual, internal Qigong practice of exercises performed with the intent of cultivating enhanced function, inner Qi that is ample and unrestrained. This is the aspect of Qigong that parallels what is typically investigated in Tai Chi research.

There are thousands of forms of Qigong practice that have developed in different regions of China during various historic periods and that have been created by many specific teachers and schools. Some of these forms were designed for general health-enhancement purposes and some for specific TCM diagnostic categories. Some were originally developed as rituals for spiritual practice, and others to empower greater skill in the martial arts. An overview of the research literature pertaining to internal Qigong yields more than a dozen forms that have been studied as they relate to health outcomes (e.g., Guo-lin, ChunDo-SunBup, Vitality or Bu Zheng Qigong, Eight Brocade, Medical Qigong).[2,27–29]

The internal Qigong practices generally tested in health research (and that are addressed in this review) incorporate a range of simple movements (repeated and often flowing in nature) or postures (standing or sitting) and include a focused state of relaxed awareness and a variety of breathing techniques that accompany the movements or postures. A key underlying philosophy of the practice is that any form of Qigong has an effect on the cultivation of balance and harmony of Qi, positively influencing the human energy complex (Qi channels/pathways) that functions as a holistic, coherent, and mutually interactive system.

Tai Chi

Tai Chi translates to mean ''Grand Ultimate,'' and in the Chinese culture, it represents an expansive philosophical and theoretical notion that describes the natural world (i.e., the universe) in the spontaneous state of dynamic balance between mutually interactive phenomena including the balance of light and dark, movement and stillness, waves and particles. Tai Chi, the exercise, is named after this concept and was originally developed both as a martial art (Tai Chi Chuan or taijiquan) and as a form of meditative movement. The practice of Tai Chi as meditative movement is expected to elicit functional balance internally for healing, stress neutralization, longevity, and personal tranquility. This form of Tai Chi is the focus of this review.

For numerous complex sociological and political reasons,[2] Tai Chi has become one of the best-known forms of exercise or practice for refining Qi and is purported to enhance physiological and psychological function. The one factor that appears to differentiate Tai Chi from Qigong is that traditional Tai Chi is typically performed as a highly choreographed, lengthy, and complex series of movements, whereas health-enhancement Qigong is typically a simpler, easy-to-learn, more repetitive practice. However, even the longer forms of Tai Chi incorporate many movements that are similar to Qigong exercises. Usually, the more complex Tai Chi routines include Qigong exercises as a warm-up, and emphasize the same basic principles for practice,

that is, the three regulations of body focus, breath focus, and mind focus. Therefore Qigong and Tai Chi, in the health promotion and wellness context, are operationally equivalent.

Tai Chi as Defined in the Research Literature

It is especially important to note that many of the RCTs investigating what is described as Tai Chi (for health enhancement) are actually not investigating the traditional, lengthy, complex practices that match the formal definition of traditional Tai Chi. The Tai Chi used in research on both disease prevention and used as a complement to medical intervention is often a ''modified'' Tai Chi (e.g., Tai Chi Easy, Tai Chi Chih, or ''short forms'' that greatly reduce the number of movements to be learned). The modifications generally simplify the practice, making the movements more like most health-oriented Qigong exercises that are simple and repetitive, rather than a lengthy choreographed series of Tai Chi movements that take much longer to learn (and, for many participants, reportedly delay the experience of ''settling'' into the relaxation response). A partial list of examples of modified Tai Chi forms from the RCTs in the review is: balance exercises inspired by Tai Chi,[30] Tai Chi for arthritis, five movements from Sun Tai Chi,[31] Tai Chi Six Form,[32] Yang Eight Form Easy,[33,34] and Yang Five Core Movements.[34]

In 2003, a panel of Qigong and Tai Chi experts was convened by the University of Illinois and the Blueprint for Physical Activity to explore this very point.[35] The expert panel agreed that it is appropriate to modify (simplify) Tai Chi to more efficiently disseminate the benefits to populations in need of cost-effective, safe, and gentle methods of physical activity and stress reduction. These simplified forms of Tai Chi are very similar to the forms of Qigong used in health research.

For this reason, it is not only reasonable but also a critical contribution to the emerging research dialogue to review the RCTs that explore the health benefits resulting from both of these practices together, as one comprehensive evidence base for the meditative movement practices originating from China.

METHODS

Data Sources

The following databases were used to conduct literature searches for potentially relevant articles: Cumulative Index for Allied Health and Nursing (CINAHL), psychological literature (PsycINFO), PubMed, Google Scholar, and the Cochrane database. The key words included Tai Chi, Taiji, Tai Chi Chuan, and Qigong, combined with RCT or with clinical research terms. Additional hand searches (based on word-of-mouth recommendations) completed the search for articles.

Study Inclusion Criteria

Criteria for inclusion of articles required that they (1) were published in a peer-reviewed English-language journal between 1993 and December 2007; (2) were cited in nursing, medical, or psychological literature; (3) were designed to test the effects of Tai Chi or Qigong; and (4) used

an RCT research design. The literature search resulted in the identification of 576 articles to be considered for inclusion. The full texts of 158 articles appearing to meet initial criteria 1 through 4 were retrieved for further evaluation and to verify which ones were, in fact, RCTs, resulting in a final set of 77 articles meeting all of our inclusion criteria.

Data Abstraction

Articles were read and results were entered into a table according to criteria established by the authors for categorization and evaluation of the studies and outcomes. Included in Table 1 for review and discussion are type and number of patients randomized, duration and type of intervention and control condition, measured outcomes, and results. As the information was entered into the table, it became apparent that some of the authors reported results from the same study in more than one article. Thus, the 77 articles selected actually represented 66 unique studies, with one study reporting a range of outcomes across five articles, and five other studies' results published in two articles each. An additional two articles were not entered into the table[36,37] because the same results were reported in newer articles. Other than these two dropped articles, multiple articles are entered into the table as representing one study (see Table 1) so that the full range of outcomes reported across the articles can be reported without inflating the number of studies.

Table 1. Randomized Controlled Trials Testing Health Benefits of Qigong and Tai Chi
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Synthesis

Three authors independently reviewed the articles selected for inclusion and considered categorizing studies by type of patient or disease outcome. Many of the studies drew participants from a general, healthy population (n = 16), so a category schema based on patient type or disease would not have included all of the studies. The authors revisited the long list of health benefits and outcomes assessed across the studies and generated broad categories that combined related health outcomes into larger groups. These initial categories were defined based on identifying the most frequently measured primary outcomes, and then refining the groups to develop an investigation framework that accommodated all of the research outcomes into at least one of the categories. These categories of outcomes related to Qigong and Tai Chi practice were discussed and continually reworked until we had clear, nonoverlapping boundaries for each category based on similar symptoms or health indicators related to a common function or common target organ system. These groupings are not intended to be conclusive taxonomies but rather are used for this review as convenient and meaningful tools for evaluating similar groups of outcomes. In this way, examining health outcomes across a variety of study designs and populations (including healthy, diseased, or at-risk patients) was possible.

RESULTS

Study Description

A total of 6410 participants were included across these reported studies. Although some of the studies compared Qigong or Tai Chi to other forms of exercise (n = 13), many compared Qigong or Tai Chi to a nonexercise treatment control group such as education or usual care (n = 43) and some used both exercise and nonexercise comparison groups to evaluate effects of Qigong or Tai Chi interventions (n = 11). Many studies included healthy adults (n = 16 studies), while other studies included participants based on specific risk factors or diagnosis of disease, including arthritis (n = 5), heart disease (n = 6), hypertension (n = 5), osteoporosis risk (e.g., perimenopausal status; n = 3), fall risk determined by age and sedentary lifestyle or poor physical function and balance (n = 18), breast cancer (n = 1), depression (n = 2), fibromyalgia (n = 2), immune dysfunction, including human immunodeficiency virus/acquired immune deficiency syndrome and varicella history or vaccine response (n = 3), muscular dystrophy (n = 1), Parkinson's disease (n = 1), neck pain (n = 1), sleep complaints (n = 1), chronic disease (n = 1), and traumatic brain injury (n = 1). Some of the studies (n = 9) monitored adverse effects during the interventions and none reported an adverse event.

The studies originated from 13 countries (USA, n = 34; China [including Hong Kong], n = 9; Korea, n = 4; Australia and New Zealand, n = 5; Sweden, n54; Great Britain, n53; Italy and Taiwan, each n = 2; Netherlands, Israel, Poland, and Spain, each n = 1).

Outcomes

From all of the studies, 163 different physiological and psychological health outcomes were identified. Many of the studies assessed outcomes across more than one category (e.g., physical function as well as a variety of psychosocial and fitness outcomes), so some studies are discussed in more than one section in the review of categories that follows. The nine outcome category groupings that emerged are bone density (n = 4); cardiopulmonary effects (n = 19); physical function (n = 16); falls, balance, and related risk factors (n = 23); quality of life (QOL; n = 17); self-efficacy (n = 8); patient-reported outcomes (PROs; n = 13); psychological symptoms (n = 27); and immune and inflammation-related responses (n = 6). Within each category of outcomes, there were both Qigong and Tai Chi interventions represented.

Bone Density

Resistance training and other weight-bearing exercises are known to increase bone formation[38] and have been recommended for postmenopausal women for that purpose.[39] Interestingly, most Qigong and Tai Chi practices involve no resistance and only minimal weight bearing (such as gentle knee bends), yet the four RCTs (total sample size = 427) included in this review reported positive effects on bone health. One study examined the effect of Qigong[40] and three examined Tai Chi.[41–43] Bone loss was retarded and numbers of fractures were less among postmenopausal women practicing Tai Chi compared to usual care.[41] In another study, bone loss was less pronounced for postmenopausal females practicing Tai Chi or resistance training compared to no-exercise controls, but this effect was not found in the older men participating in the study.[43] Shen et al.[42] compared Tai Chi to resistance training and reported significant changes in biomarkers of bone health in both groups. Bone mineral density increased for women following Qigong exercises as compared to no-exercise controls.[40] In summary, current research suggests a favorable effect on bone health for those practicing Tai Chi or Qigong.

Cardiopulmonary

Nineteen studies (Qigong, n = 7; Tai Chi; n = 12) reported favorable cardiovascular and/or pulmonary outcomes. Participants in this grouping of studies were generally older adults (mean age = 61.02) and inclusion criteria varied from history of disease to reported sedentary behavior. Measures of cardiopulmonary function were representative of cardiopulmonary fitness and cardiovascular disease risk and included blood pressure, heart rate, ejection fraction rates, blood lipids, 6-minute walk distance, ventilatory function, and body mass index (BMI).

One of the most consistent findings was the significant reduction in blood pressure reported in multiple studies, especially when Qigong[44,45] or Tai Chi[46,47] were compared to inactive control groups such as usual care, educational classes, or wait-list controls. Even when compared to active control groups such as aerobic exercise or balance training, Tai Chi showed a significant reduction in blood pressure in two studies.[48,49] Other studies, however, that utilized active control interventions expected to reduce blood pressure (e.g., low to moderate physical activity interventions) showed positive changes for both groups, but without significant differences between Qigong[28] or Tai Chi[50,51] and the comparison group, thus providing preliminary evidence that these meditative movement practices achieve similar results to conventional exercise.

Other indicators of cardiac health have been evaluated. Reduced heart rate is reported[49,51,52] as well as increases in heart rate variability.[53] These reported changes in blood pressure, heart rate, and heart rate variability suggest that one or several of the key components of Tai Chi and Qigong—body, breath, and mind—may affect sympathetic and parasympathetic balance and activity.

Biomarkers of heart health have been shown to improve in response to Qigong or Tai Chi practice. Yeh et al.[34] reported significantly improved serum B-type natriuretic peptide levels in response to Tai Chi compared to usual-care controls, indicating improved left ventricular function. Lipid profiles improved in two studies[44,46] comparing Qigong and Tai Chi to inactive controls, whereas another study of Qigong[54] reported no change in cholesterol levels compared to inactive (waitlist) controls. Pippa et al.[54] also reported no change in ejection fraction rates following a 16-week study of Qigong among participants with a history of chronic atrial fibrillation. Urine catecholamine levels were significantly decreased in participants practicing Tai Chi compared to wait-list controls,[45] but a similar trend did not reach significance in another study with only 15 participants per treatment condition.[34]

A variety of cardiopulmonary fitness indicators have been examined for both Qigong and Tai Chi. Participants with a history of heart failure reported significant improvements in the incremental shuttle walk following a combined Tai Chi/Qigong intervention implemented in two studies incorporating inactive control groups.[34,55] Women treated for breast cancer achieved significantly increased distances in the 6-minute walk test in response to Tai Chi compared to a psychosocial support control intervention56 and VO_{2max} increased significantly more following a Tai Chi intervention compared to resistance training and usual-care control groups.[53] In contrast to these consistent findings for cardiopulmonary benefits, one study found no significant improvement in response to Qigong, whereas aerobic training did achieve significant changes. In

this small (n = 11 in each arm of study) crossover study of patients with Parkinson's disease, participants practiced Qigong or aerobic training in random order for 7 weeks (with 8 weeks' rest in between intervention periods); results on the 6-minute walk test, VO_{2peak}, and $VO_{2/Kg}$ ratio were significantly improved for those who completed the aerobic exercise protocol, but no significant effects were found for those practicing Qigong.[57]

Most of the nonsignificant findings have been found in studies with participants with some form of chronic illness or recovery from cancer at study entry. For example, respiratory function improved clinically, but not significantly, for patients with chronic heart failure practicing Tai Chi compared to usual care,[34] and, as described above, was relatively unchanged for the Qigong group with a history of Parkinson's disease compared to an aerobic training control group.[57] A group of patients with muscular dystrophy[58] showed a trend for improvement that did not reach significance compared to a wait-list control. Further, no change in cardiovascular function was reported for sedentary participants with a history of osteoarthritis.[59] Aerobic capacity was shown to improve with Tai Chi, though not significantly more so than with inactive controls, in a small study of breast cancer survivors.[52,53,56] It is important to point out that of these five studies that failed to demonstrate significant improvements following Qigong or Tai Chi, four had 31 or fewer participants. It is difficult to discern whether nonsignificant findings in cardiopulmonary fitness are because of some pattern of ineffectiveness with chronic and debilitating illness or whether they are a result of the limited statistical power.

One of the key risk factors for cardiac disease is obesity. Qigong has demonstrated a greater reduction in BMI as compared to an exercise control group in two studies,[28,47] but this difference was not significant. Another study demonstrated a marked but nonsignificant reduction in waist circumference with Tai Chi compared to usual care for older adults.[52] Conversely, one study using Qigong and two with Tai Chi (respectively)[48,54,59] reported no change in BMI compared to usual care and another implementing a Qigong intervention[60] failed to maintain weight loss, suggesting the data are inconclusive at this point as to whether or not these practices may consistently affect weight.

A few studies of both Qigong and Tai Chi have examined level of intensity, indicating that some forms of these practices fall within the moderate intensity level,[11,61] but for the most part, level of exercise intensity is not reported. Cardiopulmonary benefits of Qigong and Tai Chi may partially be explained as a response to aerobic exercise, but with the wide range of speeds with which these exercises are executed, it would be important to assess this factor for a better understanding of the elements that contribute to outcomes. Regardless of the mechanisms, the preponderance of studies on cardiopulmonary outcomes show that Qigong and Tai Chi are effective compared to inactive controls, or at least approximately equal to the expected benefits of conventional exercise.

Physical Function

Decreased physical activity is related to declining physical function in all populations, and that decline is compounded by the natural process of aging.[62,63] Changes in physical function were assessed in 16 studies (Qigong, n = 2; Tai Chi, n = 14). Most of the studies were conducted with older adults (i.e., studies in which mean age = 55 years or older, n = 13) and several recruited

specifically for participants with chronic pain (e.g., osteoarthritis, neck pain, or fibromyalgia, n = 5). A number of behavioral measures of physical function performance were included in this category of outcomes, which also includes self-reported responses on scales representing physical function. Although fitness outcomes, such as the 6-minute walk test, might also be seen as assessing overall physical function, we did not include tests already discussed in the cardiopulmonary fitness category, but rather focused on functional tests that are usually used to assess capacity for daily living. Studies that assessed changes in overall physical activity levels are also included as an outcome pertaining to physical function.

Physical function measured with a wide variety of performance indicators, including chair rise, 50-ft walk, gait speed, muscle contraction strength, hand grip, flexibility, and function as measured on the Western Ontario and McMaster Universities Osteoarthritis Index (an osteoarthritis-specific assessment for function, stiffness, and pain), were variously found to be significantly improved in five studies comparing Tai Chi to minimal activity (usual or stretching activity, psychosocial support, or education) comparison groups[56,64–66] and one study of Tai Chi compared to an exercise therapy control intervention.[64] One of these studies combined functional walking with Tai Chi to achieve significant improvements with prefrail elders compared to usual care.[30]

In contrast, in seven studies including participants with osteoarthritis or multiple comorbidities, some of the physical function measures were not significantly different for Tai Chi or Qigong in comparison to inactive controls. This was the case for gait speed,[47] timed up and go, 50-ft walk and stair climb[31] and 50-ft walk and chair stand.[67,68] In one study of 30 patients with osteoarthritis practicing Tai Chi twice per week[67] and another with 36 participants with fibromyalgia that utilized hand grip and chair stand to test a 20-minutes-per-week Qigong intervention,[69] neither achieved significant improvements compared to usual care. In one exception to this trend, one measure of functional performance, time to complete chair rise, was significantly improved in transitionally frail elders in the Tai Chi group compared to a wellness education control group.[47]

Studies using self-report measures consistently show positive results for Tai Chi. Self-reported improvement in physical function for sedentary older adults was demonstrated for Tai Chi compared to wait-list controls[68,70] and a stretching exercise control.[33]

Results in this category of outcomes are inconsistent, with a preponderance of studies recruiting sedentary or chronically ill or frail elder participants. Even so, a handful of these studies successfully demonstrated potential for Qigong and Tai Chi to build performance, even with health-compromised individuals. Further studies are needed to examine the factors that are important to more critically evaluate these interventions (such as power considerations or dose and frequency of the interventions), or learn if there are particular states of ill health that are less likely to respond to this form of exercise.

Falls and Balance

Another large grouping of studies focused primarily on falls prevention, balance, and physical function tests related to falls and balance (such as one-leg stance). Although there may be some

crossover of implied benefits to the more general physical function measures reported above, this separate category was established to report on the studies of interventions primarily targeting falls and related measures. Fear of falling is reported with the psychological outcomes and falls self-efficacy is reported in the self-efficacy outcomes rather than in this category of falls and balance.

Outcomes related to falls such as balance, fall rates, and improved strength and flexibility were reported in 24 articles (Qigong, n = 2; Tai Chi, n = 20; and two studies that included both practices). Scores directly assessing balance (such as one-leg stance) or other closely related measures were consistently, significantly improved in 16 Tai Chi studies that included only participants who were sedentary or deemed at risk for falls at baseline.[33,43,49,53,59,65,71–81]

Qigong has been less studied in relationship to balance-related outcomes; however, results suggest that there was a trend to maintain balance using Qigong in a population of patients with muscular dystrophy.[58] In two studies that used both Qigong and Tai Chi, several measures of balance were significantly improved with sedentary women[82] and with elderly healthy adults (mean age 80.4 years) compared to wait list controls.[83]

Another set of studies shows the effect of Tai Chi on balance to be similar to that of conventional exercise or physical therapy control interventions aimed at improving physical function related to balance[53,72,84] or vestibular rehabilitation.[85,86] On the other hand, in a study of stroke survivors comparing Tai Chi to balance exercises, significant improvements in balance were achieved in the exercise control group, but not for Tai Chi.[87] Although knee extension was significantly improved, balance was not improved significantly in a Tai Chi intervention with sedentary women compared to a flexibility training control group.[74]

Mechanisms of gait performance, which are important to understanding how Tai Chi affects balance, were also studied. Reported improvements were found in four studies.[80,85,86,88] Strength and flexibility are also important to fall prevention. Four studies found significant improvements in these factors when Tai Chi was compared to an active control (brisk walking)[33,53,59,73,81] or inactive controls.[59,73,81]

Eight studies directly monitored fall rates. Studies that incorporate educational or less active control interventions (e.g., stretching) variously demonstrated significant falls reduction for Tai Chi[30,75,78,79] or nonsignificant reductions compared to control.[43,49] In a study comparing Tai Chi to an active physical therapy intervention designed to improve balance, results were similar (nonsignificant differences) between the two groups.[84] The results are difficult to interpret because some participants may fall more because their level of activity has increased and some interventions are not monitored long enough to detect changes in fall rates.[73]

This category of outcomes has a large body of research supporting the efficacy of Tai Chi on improving factors related to falls, and growing evidence that falls may be reduced. Longer-term studies to examine fall rates, and parallel studies that utilize Qigong as the intervention, may further clarify the potential of these forms of exercise to affect falls and balance.

Quality of Life

QOL outcomes were reported in 17 articles (Qigong, n = 4; Tai Chi, n = 13). QOL is a broad-ranging concept derived in a complex process from measures of a person's perceived physical health, psychological state, personal beliefs, social relationships, and relationship to relevant features of the person's environment.[89] In 13 studies of a wide range of participants (including healthy adults, patients with cancer, poststroke patients, patients with arthritis, etc.) at least one of the components of QOL was reported to be significantly improved by Tai Chi compared to inactive[34,66,67,71,90–93] or active controls,[87] and by Qigong compared to inactive[94,95] or active control groups.[72] Qigong also showed improvements in QOL compared to an exercise intervention, but not significantly so.[72]

Conversely, two studies reported no change in QOL, both with severely health-compromised individuals. One was of short duration (6 weeks), conducted with patients with traumatic brain injury.[96] Some improvement in coping was shown with muscular dystrophy patients in response to a Qigong intervention[58]; however, this finding was not significant, and direct QOL measures remained unchanged. One study reported no change in QOL when Tai Chi was compared to balance training and an education control among healthy older adults.[97]

With a few exceptions, the preponderance of studies indicate that Qigong and Tai Chi hold great potential for improving QOL in both healthy and chronically ill patients.

Self-Efficacy

Self-efficacy is the confidence a person feels in performing one or several behaviors and the perceived ability to overcome the barriers associated with the performance of those behaviors.[98] Although this is not a health outcome itself, it is often associated directly with health behaviors and benefits (e.g., falls self-efficacy associated with reduced falls) or with psychological health. Significant improvements in this outcome were reported in eight studies (Qigong, n = 2; Tai Chi, n = 6). Self-efficacy was generally assessed in the RCTs as a secondary outcome and reflected the ''problem'' area under investigation, such as falls self-efficacy (i.e., feeling confident that one will not fall) or efficacy to manage a disease (arthritis, fibromyalgia) or symptom (pain). Self-efficacy for falls was significantly increased as a result of participation in Tai Chi in three studies with adults at risk for falls compared to wait-list or usual-care, sedentary control groups.[68,73,99,123] In studies with clinical populations, persons with arthritis experienced improvements in arthritis self-efficacy[67] and fibromyalgia patients experienced improvements in the ability to manage pain100 after participating in Tai Chi as compared to inactive control groups that provided social interaction (telephone calls and relaxation therapy, respectively). Lastly, the perceived ability to handle stress or novel experiences[95,101] and exercise self-efficacy[97,101] were enhanced relative to inactive control groups as a function of participation in Qigong or Tai Chi.

Patient-Reported Outcomes

PROs include reports of symptoms related to disease as perceived by the patient. The definition of PROs as ''a measurement of any aspect of a patient's health status that comes directly from the patient, without the interpretation of the patient's responses by a physician or anyone

else,''[102] has developed over the past decade as an important indicator of treatment outcomes that matter to the patient, including an array of symptoms such as pain, fatigue, and nausea. Although PRO lists often include factors such as anxiety and depression, these are not included here, but rather in a separate section to address a range of psychological effects.

Thirteen studies are included in this category (Qigong, n = 3; Tai Chi, n = 10). Arthritic pain[31,71,103,104] decreased significantly in response to Tai Chi compared to inactive (health education or usual-care) controls. Self-reported neck pain and disability[64] improved to a similar degree for Qigong and an exercise comparison intervention, but the difference between groups was not significant. Fibromyalgia symptoms improved significantly in one study comparing Tai Chi to a relaxation intervention,[100] whereas another study reported slight improvements in symptoms for both Qigong and a usual-care control group with no significant difference between the groups.[69] Perceived symptoms of heart failure,[55] disability,[30] and sickness impact scores[32] decreased in response to Tai Chi interventions as compared to inactive controls (either usual care or educational interventions) and sleep quality improved for Tai Chi even as compared to an exercise intervention.[105] With Tai Chi, dissociative experiences and symptoms improved clinically, but were not statistically different from gains achieved by a support group among male veterans.[106] Parkinson's disease symptoms and disability were not significantly changed following a 7-week session of Qigong compared to aerobic training sessions.[57]

With the wide range of symptoms and irregular outcomes of these PROs studies, it is difficult to draw meaningful conclusions about this category. Pain consistently responded to Tai Chi in four studies, but other symptoms were not uniformly assessed.

Psychological

Twenty-seven articles (Qigong, n = 7; Tai Chi, n = 19; and one study using both Qigong and Tai Chi) reported on psychological factors such as anxiety, depression, stress, mood, fear of falling, and self-esteem. Most of these studies examined psychological factors as secondary goals of the study, and consequently, they often did not intentionally recruit participants with appreciable psychological distress. Nevertheless, a number of substantial findings dominate this category.

Anxiety decreased significantly for participants practicing Qigong compared to an active exercise group.[28,46,107] Depression was shown to improve significantly in studies comparing Qigong to an inactive control, newspaper reading,[95] and for Tai Chi compared to usual-care, psychosocial support, or stretching/education controls.[56,71,108] General measures of mood (e.g., Profile of Mood States) were improved significantly for participants practicing Tai Chi compared to usual-care controls.[66,96,101,109]

Depression improved, but not significantly, for both Qigong and exercise comparison groups[28,94] and for Tai Chi compared to an educational intervention.[110] One study reported improved depression, anxiety, and stress among patients with osteoarthritis for both Tai Chi and hydrotherapy groups compared to a wait-list control, but only significantly so for hydrotherapy.[31]

Nonsignificant changes in anxiety were reported in a study of Tai Chi compared to a relaxation intervention[100] and two other studies did not detect significant differences in depression in

response to Tai Chi[55,100] or Qigong[58] compared to usual-care or inactive controls. Fear of falling decreased significantly in most studies[49,80,81,99,111] except for one that showed no change.[82] Reports of self-esteem significantly improved in tests of Tai Chi compared to usual care[91,112] and psychosocial support,[93] but the increase in self-esteem compared to exercise and education controls was not significant.[97]

Jin[109] specifically created a stressful situation and measured the response in mood, self-reported stress levels, and blood pressure across four interventions, including Tai Chi, meditation, brisk walking, and neutral reading. Significant improvements were shown in adrenaline, heart rate, and noradrenaline in Tai Chi compared to a neutral reading intervention, and all groups showed improvements in cortisol. In another study examining blood markers related to stress response, norepinephrine, epinephrine, and cortisol blood levels were significantly decreased in response to Qigong compared to a wait-list control group.[117]

This category of symptoms, particularly anxiety and depression, shows fairly consistent responses to both Tai Chi and Qigong, especially when the control intervention does not include active interventions such as exercise. In particular, with a few studies indicating that there may be changes in biomarkers associated with anxiety and/or depression in response to the interventions, this category shows promise for examining potential mechanisms of action for the change in psychological state.

Immune Function and Inflammation

Immune-related responses have also been reported in response to Qigong (n = 3) and Tai Chi (n = 3) studies. Manzaneque et al.[113] reported improvements in a number of immune-related blood markers, including total number of leukocytes, number of eosinophils, and number and percentage of monocytes, as well as complement C3 levels, following a 1-month Qigong intervention compared to usual care. Antibody levels in response to flu vaccinations were significantly increased among a Qigong group compared to usual care.[114] Varicella zoster virus titers and T cells increased in response to vaccine among Tai Chi practitioners.[110] An earlier study conducted by Irwin et al.[90] reported an increase in varicella zoster virus–specific cell-mediated immunity among those practicing Tai Chi compared to wait-list controls.

Immune function and inflammation are closely related, and are often assessed using a variety of blood markers, particularly certain cytokines and C-reactive protein. Interleukin-6, an important marker of inflammation, was found to be significantly modulated in response to practicing Qigong, compared to a no-exercise control group.[40] On the other hand, C-reactive protein and erythrocyte sedimentation rates remained unchanged among a group of rheumatoid arthritis patients who participated in a Tai Chi class compared to stretching and wellness education.[71]

A number of studies not utilizing an RCT design have examined blood markers prior to and after Tai Chi or Qigong interventions, providing some indication of factors that might be important to explore in future RCTs (and not reported in the table). For example, improvements in thyroid-stimulating hormone, follicle-stimulating hormone, triiodothyronine,[115] and lymphocyte production[116] have been noted in response to Tai Chi compared to matched controls. Pre-post Tai Chi intervention designs have also shown an improvement in immunoglobulin G[117] and natural

killer cells,[118] and similar non-RCTs have suggested that Qigong improves immune function and reduces inflammation profiles as indicated by cytokine and T-lymphocyte subset proportions.[119–121]

As with the category of psychological outcomes, these immune- and inflammation-related parameters fairly consistently respond to Tai Chi and Qigong, while also providing potential for examining mechanisms of action.

DISCUSSION

In answering research question 1, we have identified nine categories of health benefits related to Tai Chi and Qigong interventions, with varying levels of support. Six domains of health-related benefits have dominated the research with 16 or more RCTs published for each of these outcomes: psychological effects (27), falls/balance (23), cardiopulmonary fitness (19), QOL (17), PROs (18), and physical function (16). These areas represent most of the RCTs reviewed, with many of the studies including multiple measured outcomes spanning across several categories (n = 42). Substantially fewer RCTs have been completed in the other three categories, including bone density (4), self-efficacy (8), and studies examining markers of immune function or inflammation (6).

The preponderance of studies showed significant, positive results on the tested health outcomes, especially when comparisons were made with minimally active or inactive controls (n = 52). For some of the outcomes addressed in this review, there were studies that did not demonstrate significant improvements for the Tai Chi or Qigong intervention as compared to the control condition. For the most part, however, these nonsignificant findings occurred in studies in which the control design was actually a treatment type of control expected to produce similar benefits, such as an educational control group intervention producing similar outcomes to Tai Chi for self-esteem,[97] aerobic exercise showing similar results to Qigong in reducing depression,[28,57] an acupressure group successfully maintaining weight loss compared to no intervention effect for Qigong,[60] or resistance training producing similar (nonsignificant) effects as Tai Chi for muscle strength, balance, and falls.[43,66] It is important to note that although the Tai Chi and Qigong interventions did not produce larger benefits than these active treatment controls, in most cases substantial improvements in the outcome were observed for both treatment groups.

Other studies in which the improvements did not significantly differ between the treatment group and the control group suffered from (1) study designs of shorter duration (4–8 weeks, rather than the usual 12 or more weeks),[51,96] although there were some exceptional studies with significant results after only 8 weeks[44,81,101]; (2) selection of very health-compromised participants or individuals with conditions that do not generally respond to other conventional treatments or medicines, such as muscular dystrophy,[58] multiple morbidities,[47] fibromyalgia,[69] or arthritis;[71] or (3) the outcome measured was not noted as particularly problematic nor set as an eligibility criteria for poor starting levels at baseline (n = 5).[28,94]

On the other hand, in the areas of research that address outcomes typically associated with physical exercise, such as cardiopulmonary health or physical function, results are fairly consistent in showing that positive, significantly larger effects are observed for both Tai Chi and

Qigong when compared to no-exercise control groups and similar health outcomes are found when compared to exercise controls. Even with the very wide range of study design types and strength of control interventions, and the entry level of the health status of study participants, there remains a number of remarkable and persistent findings of health benefits in response to both Qigong and Tai Chi.

In response to research question 2, we have noted in earlier sections the ways in which Qigong and Tai Chi are considered equivalent, and now address how studies identifying similar outcomes in response to these practices may provide additional evidence for equivalence. On the surface, research that examines the effects of Qigong on health outcomes appears to be of lesser magnitude than the research on what is typically called Tai Chi. For each category of outcomes described above, we noted how many RCTs had been conducted for each, Tai Chi and Qigong, and for the most part, there were many fewer reports on Qigong than for what is named Tai Chi for any given outcome examined. Nevertheless, across the outcomes examined in RCTs, the findings are often similar, with no particular trends indicating that one has different effects than the other.

As noted earlier, however, it is not unusual for the intervention used in a study or trial to be named Tai Chi, but to actually apply a set of activities that is more a form of Qigong, that is, easy-to-learn movements that are simple and repeatable rather than the long complex sequences of traditional Tai Chi movements that can take a long time to learn. For example, a large number of studies examining Tai Chi effects on balance use a modified, repetitive form of Tai Chi that is more like Qigong. Thus, although it appears that fewer studies have been conducted to test what is called Qigong, it is also clear that when a practice called Tai Chi is modified to focus especially on balance enhancement, for example, it actually may be Tai Chi in name only.

Given the apparent similarity of practice forms utilized in research, the discussion of equivalence of Tai Chi and Qigong extends beyond the earlier observation that they are similar in practice and philosophy. Because research designs often incorporate blended aspects of both Qigong and Tai Chi, it is unreasonable to claim that the evidence is lacking for one or the other and it becomes inappropriate not to claim their equivalence. We suggest that the combined current research provides a wider base of growing evidence indicating that these two forms produce a wide range of health-related benefits.

The problem with claiming equivalence, then, does not lie within the smaller number of studies using a form called Qigong, but rather in the lack of detail reported across the studies regarding whether or not the interventions contain the key elements philosophically and operationally thought to define meditative movement practices such as Tai Chi and Qigong. In previous publications, and in this review, we note that the roots of both of these TCM-based wellness practices require that the key elements of meditative movement be implemented: focus on regulating the body (movement/posture); focus on regulating the breath; and focus on regulating the mind (consciousness) to achieve a meditative state. Given the equivalence noted in foundational principles and practice, the differences among interventions and resultant effects on outcomes would perhaps more purposefully be assessed for intervention fidelity (i.e., adherence to the criteria of meditative movement).

Beyond the meditative movement factors that tie the practices and expected outcomes together, other, more conventional factors would be important to assess, each potentially contributing to variations in outcomes achieved. For example, dosing (i.e., frequency, duration, and level of intensity, including estimate of aerobic level or metabolic equivalents) may be important in whether or not benefits accrue. Or a focus on particular muscle groups may be critical to understanding changes relative to certain goals (e.g., how many of the exercises chosen for a study protocol develop quadriceps strength likely to produce results for specific physical function tests?). Beyond the important similarities of movement and a focus on breath and mind to achieve meditative states, there are other aspects that vary greatly within the wide variety of both Tai Chi and Qigong exercises, including speed of execution, muscle groups used, and range of motion, all of which may provide differences in the physio logically oriented outcomes (similar to the differences that could be noted in the wide variety of exercises considered under the aerobic umbrella).

While equivalence of Qigong and Tai Chi is established for philosophy and practice, there is still work to be done to test for similarity of effects. With consistent reporting on adherence to the above mentioned aspects of practice, not only could a level of standardization be implemented, but also measures that control for variation of interventions could be used to better understand differences and similarities in effects.[1]

LIMITATIONS

For purposes of this review, a study was selected if it was designed as an RCT and compared the effects of either Tai Chi or Qigong to those of a control condition on a physical or psychological health outcome. However, there was no further grading of the quality of the research design. As a result of this relatively broad inclusion criterion, the studies represent a wide variety in methods of controlling for balanced randomization and intent to treat analyses, in the specific methods of implementing Tai Chi and Qigong, in the outcomes assessed, in the measurement tools used to ascertain the outcomes, and in the populations being studied.

One difficulty in examining such a broad scope of studies is that the large number of studies required that we logically, but artificially, construct categories within which to discuss each group of outcomes. However, by choosing to categorize by health outcomes, rather than participant, patient, or disease types, we have provided one particular view of the data, and may have obscured other aspects. For example, in a recently published review, the authors analyzed studies that were conducted with community-dwelling adults over the age of 55.[122] Results showed that interventions utilizing Tai Chi and Qigong may help older adults improve physical function and reduce blood pressure, fall risk, depression, and anxiety. Another view of these data may emerge if only studies of chronically ill participants are evaluated. Thus, there may be other ways to examine the RCTs reported in the current review such that specific diseases or selected study populations may reveal more consistent findings (positive or negative) for certain outcomes that are clearly tied to entry level values.

CONCLUSION

Our intent has been to recognize the common critical elements of Qigong and Tai Chi, based on their similarities in philosophy and principles as well as common practice components. With this established, we thoroughly explore the range of findings for similar health outcomes and treat the two as equivalent aspects of one form of mind-body practice.

The preponderance of findings are positive for a wide range of health benefits in response to Tai Chi, and a growing evidence base for similar benefits for Qigong. As described, there are foundational similarities between Qigong and Tai Chi intervention protocols, as traditional Tai Chi is typically modified and adapted for ease of dissemination to more closely resemble forms of Qigong. This supports the rationale that outcomes can be tabulated across both types of studies, further supporting claims of the equivalence of Qigong and Tai Chi.

A compelling body of research emerges when Tai Chi studies and the growing body of Qigong studies are combined. The strongest, most consistent evidence is demonstrated for effects on bone health, cardiopulmonary fitness, some aspects of physical function, QOL, self-efficacy, and factors related to falls prevention, while findings are mixed for effects of Tai Chi or Qigong on psychological factors and PROs. Study design factors that appear to yield mixed findings are (a) the frequent choice of physical activity as a control group intervention, resulting in limited power to detect significant differences, (b) selection of participants who do not demonstrate deficiencies in baseline levels of the outcomes to be assessed, and (c) the use of study participants with severe, chronic, progressive illnesses who may be slower to respond or may not respond at all to the practices. Other studies, however, suggest that Tai Chi or Qigong may improve or slow the progression of such illnesses. This may be especially likely when the practices are implemented early as an aspect of wellness, prevention, or disease management in a proactive, risk reduction context. In a recent review addressing Tai Chi and Qigong research among older adults, it was pointed out that no adverse events were reported across studies.[122] The substantial potential for achieving health benefits, the minimal cost incurred by this form of self-care, the potential cost efficiencies of group delivered care, and the apparent safety of implementation across populations, points to the importance of wider implementation and dissemination.

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Table 1. Randomized Controlled Trials Testing Health Benefits of Qigong and Tai Chi

Source	Subjects: No. (Male/Female), Description, Mean Age	Exercise Duration	Exercise Group	Control Group	Reported Outcomes
Audette et al.[53]	27 (0/27), sedentary, 71.4 y	12 wk (60 min 3 × d/wk)	TC 10-movement Yang (n = 11)	BW (n = 8); UC later recruited and not randomized (n = 8)	Cardiopulmonary: VO_{2max} ↑ in TC more than BW and UC*; heart rate variability, high frequency ↑ and low frequency ↓ in TC only* no between group difference Falls and balance: strength, hand grip and knee extension ↑ TC only* and left knee extension ↑ in TC more than BW*; flexibility, only toe touch flexibility ↑ in TC more than BW*; balance, only nondominant OLS with eyes closed ↑ in TC more than BW*
Barrow et al.[55]	52 (42/10), older adults with history of chronic heart failure, 69.5 y	16 wk (55 min × 2 d/wk)	TC with Chi Kung (n = 25)	UC (n = 27)	Cardiopulmonary: incremental shuttle walk ↑ in TC more than UC ns Patient-reported outcomes: perceived symptoms of heart failure ↓ in TC more than UC* Psychological: depression (SCL-90-R) ↓ in TC more than UC ns; anxiety ↓ in both groups ns
Brismee et al.[103]	41 (7/34), history of knee osteoarthritis, 70 y	12 wk TC and 6 wk no training (40 min 3 × d/wk, 6 wk group training, 6 wk home training, 6 wk detraining)	TC Yang 24-form simplified (n = 18)	6 wk of HL followed by no activity same as exercise group (n = 13)	Physical function: WOMAC ↑ in TC more than HL* with ↓ for detraining period Patient-reported outcomes: pain ↓ in TC more than HL*; adverse outcomes ns
Burini et al.[57]	26 (9/17), history of Parkinson's disease, 65.2 y	7 wk each of aerobics (45 min 3 × d/wk) and QG (50 min 3 × d/wk) 20 sessions each with 8 wk between intervention periods	OG (n = 11)	AT sessions (n = 11)	Cardiopulmonary: 6-min walk and Borg scale for breathlessness ↑ and spirometry and cardiopulmonary exercise test ↓ for AT more than QG* Patient-reported outcomes: Parkinson's Disease Questionnaire ns for both; Unified Parkinson's Disease Rating Scale ns; Brown's Disability Scale ns Psychological: Beck Depression Inventory ns
Chan et al.[41]	132 (0/132), history of postmenopausal and sedentary, 54 y	12 mo (45 min × 5 d/wk)	TC Chuan Yang style (n = 54)	UC (n = 54)	Bone density: fractures (1 TC and 3 UC) BMD measured by dual energy x-ray absorptiometry in femoral neck, ↓ in TC less than UC ns and trochanter ↓ both ns; peripheral quantitative computed tomography of distal and ultradistal tibia ↓ less in TC than UC*
Channer et al.[51]	126 (90/36), history of MI, 56 y	8 wk (2 d/wk × 3 wk, then 1 d/wk × 5 wk)	TC Wu Chian-Ch'uan (n = 31)	AE (n = 30) or cardiac SG (n = 4) discussed risk factor modification and problems in rehabilitation	Cardiopulmonary: immediate SBP and DBP ↓ TC and AE ns and HR ↑ in AE more than TC*; over time, SBP ↓ both ns and DBP and resting HR↓ in TC more than AE*; SG too small for comparison
Chen et al.[40]	87 (0/87), history of BMD T ≥ -2.5, 45 y	12 wk (studied for 2 wk, then 3 d/wk)	QG Baduanjin (n = 44)	NQ (n = 43)	Bone density: BMD maintained in QG and ↓ in NQ*; Immune/inflammation: interleukin-6 ↓ in QG and ↑ in NQ*
Cheung et al.[28]	88 (37/51), older adults in community with history of hypertension, 54.5 y	16 wk (120 min × 2 d/wk × 4 wk then monthly and encouraged to practice 60 min in	QG Guolin (n = 47)	E (n = 41)	Cardiopulmonary: BP, HR, waist circumference, BMI, total cholesterol, renin, and 24-h urinary protein excretion ↓ QG and E ns; ECG QG and E nc/ns QOL: SF-36 ↓ E ns

		A.M. and 15 min in P.M. × 7 d/wk)			Psychological: Beck Anxiety Inventory ↓ and Beck Depression Inventory ↑; QG and E ns
Choi et al.[73]	59 (15/44), living in care facility, ambulatory with history of at least 1 fall risk factor, 77.8 y	12 wk (35 min × 3 d/wk)	TC Sun style (n = 29)	UC (n = 30)	Falls and balance: FALLS ns, but falls efficacy for TC ↑ and ↓ UC*; knee and ankle strength, OLS eyes open, and toe reach ↑ and 6-m walk ↓ more than UC*; OLS eyes open nc Self-efficacy: falls efficacy for TC ↑ and ↓ UC*
Chou et al.[108]	14 (7/7), community-dwelling Chinese, history of depression from a psychogeriatric clinic, 72.6 y	3 mo (45 min × 3 d/wk)	TC Yang style 18 form (n = 7)	WL (n = 7)	Psychological: Center for Epidemiological Studies Depression Scale ↓ TC more than WL*
Elder et al.[60]	92 (13/79), history of completing 12-wk weight loss intervention and loss of at least 3.5 kg, 47.1 y	24 wk (10 h overall with 28-min QG sessions)	QG Emie Zhen Gong (n = 22)	TAT (n = 27) and SDS (n = 24)	Cardiopulmonary: weight loss maintenance for TAT and ↑ QG and SDS*
Faber et al.[30]	238 (50/188) frail (51%) or prefrail (48.9%) older adults living in care facility, 85 y	20 wk (60 min exercise and 30 min social time × 1 d/wk × 4 wk for socialization, then × 2 d/wk for 16 wk)	TC (BE inspired by TC) (n = 80)	FW (n = 66) or UC (92)	Falls and balance: falls lower for TC more than FW and UC ns; when FW and TC combined, fall risk ↓ and physical function (6-m walk, timed chair stand, TUG, and FICSIT-4) ↑ compared to UC in prefrail,* frail ns, also TC compared to FW ns Patient-reported outcomes: Performance-Oriented Mobility Assessment ↑ for TC and FW and exercise groups combined more than UC* and prefrail,* frail ns; Groningen Activity Restriction Scale ↓ for FW more than control* TC vs. UC ns
Fransen et al.[31]	152 (40/112) older adults, history of chronic symptomatic hip or knee osteoarthritis, 70.8 y	12 wk (60 min × 2 d/wk)	TC for Arthritis by Dr. Lam from Sun Style 24 forms (n = 56)	H (n = 55) and WL control (n = 41)	Physical function: WOMAC: pain and function ↓ TC and H ns with treatment effect for physical function moderate*; pain score ↓ for H compared to WL,* TC ns; physical performance: TUG, 50-foot walk, and stair climb ↓ more for H than WL*; timed stair climb for ↓ TC and H ns QOL: SF-12 Physical ↑ H more than WL* and TC more than WL borderline*; SF-1 Mental ns Patient-reported outcomes: pain and function ↓ TC and H ns Psychological: Depression Anxiety & Stress 21 ↓ in H* and TC ns
Galantino et al.[66]	38 (38/0), history of long term care of HIV/AIDS, between 20 and 60 y	8 wk (60 min × 2 d/wk)	TC (n = 13)	AE (n = 13) and UC (n = 12)	Physical function: FR, SR, sit-up, and physical performance test all improved more than UC* and TC compared to AE nc QOL: Medical Outcomes Short Form-HIV improved TC and AE more than control*; spiritual well-being improved TC AE and UC ns Psychological: Profile of Mood States improved TC and AE more than control*
Gatts and Woollacott[65]	19 (2/17), balance-impaired seniors, 77.5 y	3 wk (90 min × 5 d/wk)	TC Twelve Classical TC Postures (n = 11)	TC-based and axial mobility program; same group practiced TC after control time (n = 8)	Falls and balance: TUG ↓ more for TC than control*; FR ↑ for TC and control; OLS and tandem stance both legs ↑ more TC than control*; tibialis anterior more ↑ for TC than control*; gastrocnemius ↑ only TC after control time*

Study	Participants	Duration	Intervention	Comparison	Outcomes
Gemmell and Leathem[96]	18 (9/9), history of traumatic brain injury symptoms, 45.7 y	6 wk (45 min × 2 d/wk)	TC Chen style (n = 9)	WL UC (n = 9)	QOL: SF-36 and Rosenberg Self-Esteem Scale no different ns except role emotional ↑ TC more than UC* Psychological: Visual Analogue Mood Scales improved TC more than UC*; Rosenberg Self-Esteem Scale nc, ns
Greenspan et al.[32]	269 (0/269), congregate independent living, transitionally frail with at least 1 fall in past year, >70 y and 50% over 80 y	48 wk (60 increasing to 90 min × 2 d/wk)	TC 6 simplified forms (n = 103)	WE (n = 102)	Physical function: Sickness Impact Profile for physical function and ambulation ↓ more TC than WE* Patient-reported outcomes: Sickness Impact Profile and physical and ambulation perceived health status ↓ TC more than WE*; self-reported health nc TC and WE ns
Hammond and Freeman[100]	133 (13/120), history of fibromyalgia from a rheumatology outpatient department, 48.53 y	10 wk (45 min × 1 d/wk)	TC for arthritis (part of patient ED group including fibromyalgia information, postural training, stretching, and weights) (n = 52)	RG (n = 49)	Self-efficacy: Arthritis Self-Efficacy Scale ↑ TC more than RG at 4 mo*; at 8 mo ns Patient-reported outcomes: Fibromyalgia Impact Questionnaire ↓ TC more than RG* at 4 mo*; at 8 mo ns Psychological: Anxiety and depression TC and RG ns
Hart et al.[87]	18 (16/2), history of stroke, community-dwelling, 54.77 y	12 wk (60 min × 2 d/wk)	TCC (n = 9)	BE (n = 9)	Falls and balance: BBS, OLS, Emory Fractional Ambulation Profile, Romberg, TUG improved in BE,* not TCC ns QOL: Duke Health Profile improved TC,* not BE ns
Hartman et al.[67]	33 (5/28), community-dwelling with lower extremity osteoarthritis, 68 y	12 wk (60 min × 2 d/wk)	TC 9-form Yang (n = 18)	UC with phone calls every 2 wk to discuss issues related to osteoarthritis (n = 15)	Physical function: OLS, 50-ft walk, and chair rise TC and UC ns with small to moderate effect size for TC only QOL: Arthritis Impact Measurement Scale II (satisfaction with life) ↑ and tension ↓ more for TC than UC*; pain and mood both ns Self-efficacy: arthritis self-efficacy ↑ TC more than UC*
Hass et al.[88]	28 (not reported), older adults transitioning to frailty, 79.6 y	48 wk (60 × 2 d/wk)	TC 8 of 24 simplified forms (n = 14)	WE (n = 14)	Falls and balance: center of pressure during S1 and S2 improved for TC more than WE*; S3 for both ns
Irwin et al.[110]	112 (41/71), healthy older adults, 70 y	16 wk (40 min × 3 d/wk)	TC Chih (n = 59)	HE (n = 53)	QOL: SF-36 improved for physical functioning, bodily pain, vitality, and mental health for TC more than HE*; role emotional ↓ for HE more than TC*; role physical, general health, and social functioning both groups ns Psychological: Beck Depression Score ↑ TC and HE ns Immune/inflammation: varicella zoster virus responder-cell frequency ↑ TC more than HE*
Irwin et al.[90]	36 (5/13), healthy older adults, 70.5 y	15 wk (45 min × 3 d/wk)	TC Chih (n = 14)	WL (n = 17)	QOL: SF-36 only role physical and physical functioning improved more for TC than WL* Immune/inflammation: varicella zoster virus cell–mediated immunity ↑ more for TC than WL*
Jin et al.[109]	96 (48/48), TC practitioners, 36.2 y	History of TC 46.4 mo males/34 mo females 2 sessions of exposure to	TC long form or Yang style (n = 24)	BW (n = 24), TC M (n = 24), and NR (n = 24)	Psychological: Profile of Mood States improved all treatments* with state anxiety ↓ in TC more than reading*; BP and HR ↑ under stress for TC and BW more than M and NR*; adrenaline ↓ more for TC

		stress followed by respective treatment			than M*; noradrenaline ↑ more for TC than NR*; salivary cortisol ↑ all groups*
Judge et al.[74]	21 (0/21), sedentary, 68 y	6 mo (20 min walking plus other exercise × 3 d/wk for TC and no exercise for 12 wk, then 30 min × 1 d/wk for FT)	TC simple with strength training and walking (n = 12)	FT (n = 9)	Falls and balance: OLS ↑ more for TC than FT ns; knee extension ↑ more for TC than FT*; sitting leg press improved TC and FT ns
Kutner et al.[97]	130 (?/?), TC BT and control, mostly women, healthy older adults, 76.2 y	15 wk (45 min total × 2 d/wk TC and 1 d/wk BT and ED)	TC 10 modified forms from 108 (n = 51)	BT (n = 39) and ED control (n = 40)	QOL: SF-36 all groups nc Self-efficacy: self-confidence ↑ more for TC and BT than EC* Psychological: Rosenberg self-esteem ↑ more TC than BT or EC ns
Lansinger et al.[64]	122 (36/86) history of long term nonspecific neck pain, 43.8 y	3 mo (1 h × 1–2 d/wk × 10–12 sessions)	QG Biyun (n = 60)	ET (n = 62)	Physical function: grip strength and cervical ROM ↑ both groups ns Patient-reported outcomes: neck pain and Neck Disability Index ↓ both groups ns
Lee et al.[44,101]	36 (14/22), history of hypertension, 53.4 y	8 wk (30 min × 2 d/wk)	QG Shuxinpingxuegong (n = 17)	WL (n = 19)	Cardiopulmonary[44]: (2004a) BP ↓ more in QG than WL*; HDL and APO-A1 ↑ more in QG than WL*; high-density lipoprotein and apolipoprotein A1 ↑ and total cholesterol ↓ in QG pre-post*; triglycerides ↓ in QG and ↑ in WL ns Self-efficacy[101]: Self-efficacy and perceived benefits ↑ in QG and ↓ in WL* Psychological[101]: emotional state ↑ in QG and ↓ in WL*
Lee et al.[45,107]	58 (not reported), history of hypertension, 56.2 y	10 wk (30 min × 3 d/wk)	QG Shuxinpingxuegong (n = 29)	UC WL (n = 29)	Cardiopulmonary[107]: HR ↓ more in QG than WL*; epinephrine and norepinephrine ↓ for QG and ↑ for WL*; cortisol ↓ for QG and ↑ for WL ns Psychological[107]: Self-report stress ↓ QG more than WL*; epinephrine and norepinephrine ↓ for QG and ↑ for WL*; cortisol ↓ for QG and ↑ for WL ns Cardiopulmonary[45]: BP and catecholamines ↓ for QG and ↑ for UC*; ventilatory function ↑ more for QG than UC*
Lee et al.[91]	139 (45/96), resident of care facility, ambulatory Chinese, 82.7 y	26 wk (60 min × 3 d/wk)	TC (n = 66)	UC (n = 73)	QOL: health-related QOL ↑ TC more than UC* Psychological symptoms: self-esteem ↑ TC more than UC*
Li et al.[33]	48 (not reported), older adults, 68.88 y	3 mo (3 d/wk)	TC Yang 8-form easy TC (n 5 26)	SC (n = 22)	Falls and balance: OLS improved TC more than SC* Physical function: SF-12 physical, instrumental activities of daily living, 50-ft walk, and chair rise all improved TC more than SC* Psychological: SF-12 mental ↑ more TC than SC*
Li et al.[105]	118 (22/96), history of moderate sleep complaints and community-dwelling adults, 75.4 y	24 wk (60 min 3 × d/wk)	TC Yang (n = 62)	EC (n = 56)	Physical function: OLS and SF-12 physical ↑ and chair rise and 50-ft walk ↓ TC more than EC* Patient-reported outcomes: sleep duration and efficiency ↑ and sleep quality, latency, duration, and disturbances, Epworth Sleepiness Scale, and Pittsburg Sleep Quality Index ↓ more for TC than EC*; sleep dysfunction both and medication ↓ TC only ns Psychological: SF-12 mental ↑ both ns

Study	Sample (M/F), population, age	Duration	Intervention	Comparison	Outcomes
Li et al.[75,99]	256 (77/179), sedentary 77.48 y	6 mo (60 min × 2 d/wk)	TC Yang style 24 forms (n = 125)	SC (n = 131)	Falls and balance[75]: fewer falls and fewer injurious falls for TC than SC*; and BBS, Dynamic Gait Index, FR, and OLS ↑ and 50-ft walk and TUG ↓ more for TC than SC* all sustained at 6 mo follow-up Falls and balance[99]: activities-specific balance ↑ more for TC than SC* Self-efficacy[99]: falls self-efficacyq (mediator) and fear of falling (SAFFE) ↓ more for TC than SC* Psychological: fear of falling (SAFFE) ↓ more for TC than SC*
Li et al.[68,70,92,112,123]	6401 (9/85), sedentary, 72.8 y	6 mo (60 min × 2 d/wk)	TC Yang style 24 forms (n = 49)	WL (n = 45)	Physical function[68]: SF-20 physical function ↑ among TC more than WL over time* r scores Self-efficacy[68]: self-efficacy ↑ among TC more than WL over time* r scores QOL[92]: SF-20 (general health survey) ↑ more for TC than WL*; TC with lower levels of health perception, physical function, and high depression at baseline and movement confidence ↑ = ↑ physical function* Psychological[112]: Physical function self-esteem and Rosenberg self-esteem ↑ more for TC than WL* Self-efficacy[123]: barrier and performance self-efficacy ↑ TC more than WL*; exercise adherence ↑ TC than WL*; and SE conditions related to adherence for TC
Maciaszek et al.[76]	49 (49/0), sedentary, history of osteopenia or osteoporosis, 70.2 y	18 wk (45 min × 2 d/wk)	TC 24 form (n = 25)	UC (n = 24)	Falls and balance: Posturographic Platform (time ↓; % task performance and total length of path ↑ for TC*; and % task performance and total length of path ↑ more for TC than UC*
Mannerkorpi and Arndorw[69]	36 (0/36), history of fibromyalgia, 45 y	3 mo (20 min × 1 d/wk)	QG with Body Awareness (n = 19)	UC (n = 17)	Physical function: chair stand and hand grip TC and UC ns Patient-reported outcomes: body awareness ↑ TC more than UC*; fibromyalgia symptoms TC and UC ns
Manzaneque et al.[113]	29 (14/15), healthy young adults, 18–21 y	1 mo (30 min × 5 d/wk)	QG Eight Pieces of Brocade (low intensity) (n = 16)	UC (n = 13)	Immune/inflammation: leukocytes, eosoinophils, monocytes, and C3 levels ↓ TC than UC*; trend for neutrophils; total lymphocytes, T lymphocytes, t helper lymphocytes, concentrations of complement C4 or immunoglobulins ns
McGibbon et al.[85]	36 (16/20), history of vestibulopathy, 59.5 y	10 wk (70 min × 1 d/wk)	TC Yang (n = 19)	VR (n = 17)	Falls and balance: gait speed ↑ TC more than VR*; step length ↑ for TC and VR*; stance duration ↓ VR* more than TC; step width ↑ VR and TC ns: mechanical energy expenditure (hip ↓ TC more than VR*; ankle ↑ more for TC than VR*; knee and leg both ns); peak trunk forward velocity ↑ TC more than VR*; forward velocity range and peak or range of lateral trunk velocity TC and VR ns; peak trunk angular velocity ↑ more for VR than TC*; trunk angular velocity in frontal plane and change in peak and range TC and VR ns; trunk velocity peak and range positively correlated with change in leg mechanical energy expenditure for TC* and VR negative relationship
McGibbon et al.[86]	26 (11/15), history of vestibulopathy, 56.2 y	10 wk (70 min × 1 d/wk)	TC Yang (n = 13)	VR (n = 13)	Falls and balance: gaze stability ↑ more for VR than TC*; whole-body stability and foot fall stability ↑ more for TC than VR*; correlation between change in gaze stability and whole-body stability , and

				footfall stability and gaze stability for VR not TC*; correlation between foot-fall stability and whole-body stability for VR and TC*
Motivala et al.[50]	32 (14/18), out of 63 who completed RCT for herpes zoster risk in aging study, 68.5 y	37 wk TC (? min × 1 d/wk)	TC Chih (n = 19)	PR and slow moving physical movement (n = 13)	Cardiopulmonary: pre-ejection period ↑ posttask more for TC than PR*; BP and HR TC and PR ns
Mustian et al.[56,93]	21 (0/21), history of breast cancer 52 y	12 wk (60 min × 3 d/wk)	TC Yang and Chi Kung (n = 11)	PS (n = 10)	Cardiopulmonary[56]: 6-min walk ↑ for TC and ↓ for PS*; aerobic capacity ↑ for TC and ↓ for PS ns Physical function[56]: (2006) muscle strength (hand grip ↑ for TC and ↓ for PS*); and flexibility (abduction ↑ TC and PS, flexion, extension, horizontal adduction and abduction ↑ more for TC than PS*; and body fat mass ↓ for TC and ↑ for PS ns QOL[93]: health-related QOL ↑ for TC* and ↓ PS ns Psychological[93]: Self-esteem ↑ for TC and ↓ for PS*
Norwalk et al.[84]	110 (15/95), long term care residents, 84 y	13–28 mo (3 d/wk)	TC with behavioral component (n = 38)	Physical therapy weight training (n = 37) and ED Control (n = 35)	Falls and balance: falls no difference between groups
Pippa et al.[54]	43 (30/13), history of stable chronic atrial fibrillation, 68 y	16 wk (90 min × 2 d/wk)	QG (n = 22)	WL control (n = 21)	Cardiopulmonary: 6-min walk ↑ for QG and ↓ for WL*; Ejection fraction, BMI, cholesterol ns
Sattin et al.[77]	311 (20/291), transitionally frail with history of 1 or more falls in past year (55 African Americans), 80.1 y	48 wk (60–90 min × 2 d/wk)	TC 6 of 24 Simplified (n = 158)	WE (n = 153)	Falls and balance: activities-specific balance ↑ more among TC than WE* Psychological: Falls Efficacy Scale ↓ more among TC than WE*
Shen et al.[42]	28 (7/21), sedentary from a senior living facility, 79.1 y	24 wk (40 min × 3 d/wk)	TC Yang Style Simplified 24 forms (n = 14)	RT (n = 14)	Bone density: sedentary older adults on bone metabolism (serum bone-specific alkaline phosphatase/urinary pyridinoline) ↑ more for TC than RT at 6 wk* and TC returned to baseline and RT less than baseline*; parathyroid hormone ↑ more for TC than RT at 12 wk*; serum 1,25-vitamin D3 TC and RT ns; serum calcium ↑ more for TC than RT at 12 wk compared to 6 wk*; urinary calcium ↓ for TC* not RT; serum and urinary Pi TC and RT ns
Song et al.[59,104]	43 (0/72), history of osteoarthritis and no exercise for 1 y prior, 63 y	12 wk (60 min × 3 d/wk for 2 wk then × 1 d/wk for 10 wk)	TC Sun Style modified for arthritics (n = 22)	UC (n = 21)	Cardiopulmonary[59]: BMI, 13-min ergometer TC and UC ns Falls and balance[59]: OLS, trunk flexion and sit-ups ↑ more for TC than UC*; flexibility and knee strength TC and UC ns Patient-reported outcomes[104]: pain and stiffness ↓ and perceived benefits ↑ more for TC than UC*; TC performed more health behaviors than UC*
Stenlund et al.[82]	95 (66/29), history of coronary artery disease, 77.5 y	12 wk (60 min QG and 120 min discussion on various themes)	QG (TC & Medicinsk QG) (n = 48)	UC (n = 47)	Falls and balance: Falls Efficacy Scale, tandem standing, OLS left, climb boxes left TC and UC ns; OLS right and climb boxes right ↑ more for TC than UC*; and coordination ↓ more for UC than TC*; and self-reported activity level ↑ for TC more than UC* Psychological: fear of falling between TC and UC ns

Study	Sample	Duration	Intervention	Control	Outcomes
Thomas et al.[52]	207 (113/94), healthy, community-dwelling, 68.8 y	12 mo (60 min × 3 d/wk)	TC Yang style 24 forms (n = 64)	PS (n = 65) or UC (n = 78)	Cardiopulmonary: energy expenditure ↑ for TC and RT more than UC ns; waist circumference and HR ↓ more TC and RT than UC ns; insulin sensitivity ↓ more for RT than UC* and more for TC than UC ns; BMI, body fat, BP, cholesterol, and glucose TC, RT, and UC ns
Tsai et al.[46]	76 (38/38), sedentary with prehypertension or stage I, 52 y	12 wk (50 min × 3 d/wk)	TC Yang (n = 37)	UC (n = 39)	Cardiopulmonary: BP and total cholesterol ↓ for TC* and ↑ for UC ns; BMI and HR TC and UC ns; triglyceride ↓ TC* and ↑ UC*; LDL ↓ TC* and ↑ UC ns; high-density lipoprotein ↑ TC* and ↓ UC ns Psychological: trait and state anxiety ↓ TC* more than UC ns
Tsang et al.[95]	82 (16/66), history of depression and chronic illness, 82.4 y	16 wk (30–45 min × 3 d/wk)	QG Baduanjin (n = 48)	NR group with same intensity (n = 34)	QOL: personal well-being ↑ for QG and ↓ NR*; general health questionnaire ↓ QG and ↑ NR*; and self-concept ↓ more TC than NR* Self-efficacy: Chinese General Self-Efficacy and Perceived Benefits Questionnaire ↑ more for QG than NR* Psychological: Geriatric Depression Scale ↓ more for QG than NR*
Tsang et al.[94]	50 (26/24), history of chronic disease, 74.6 y	12 wk (60 min × 2 d/wk)	QG Eight-Section Brocades (n = 24)	BR activities (n = 26)	QOL: physical health, activities of daily living psychological health and social relationships improved for QG*; self-concept and WHOQOL-BREF QG and BR ns Psychological: Geriatric Depression Scale ↓ TC and BR ns
Tsang et al.[72]	38 (8/30), sedentary, community-dwelling, type 2 diabetics, 65.4 y	16 wk (45 min × 2 d/wk)	TC for diabetes (12-movement hybrid from Yang and Sun) (n = 17)	Sham exercise (seated calisthenics and stretching) (n = 20)	Physical function: 6-min walk, habitual and maximal gait speed, muscle strength, and peak power ↑ TC more than SE ns; endurance ↓ more for SE than TC ns; and habitual physical activity ↑ TC and ↓ SE* Falls and balance: balance index ↓ TC and SE ns; OLS open ↑ TC and nc SE ns; OLS closed and tandem walk ↓ TC and SE ns; Falls 0–2 TC and SE ns QOL: SF-36 (except Social Function ↑ for TC and ↓ SE*) and Diabetes Integration Scale TC and SE ns
Voukelatos et al.[78]	702 (112/590) community dwelling, 69 y	16 wk (60 min × 1 d/wk)	TC 38 programs mostly Sun-style (83%) Yang (3%) (n = 271)	WL (n = 256)	Falls and balance: sway on floor and foam mat, lateral stability, coordinated stability, and choice stepping reaction time improved TC more than WL*; maximal leaning balance range ↑ TC more than WL ns; fall rates less for TC (n = 347) than WL (n = 337)*
Wang et al.[71]	20 (5/15), community-dwelling with rheumatoid arthritis class I or II, 49.5 y	12 wk (60 min × 2 d/wk)	TC Yang style (n = 10)	Stretching and WE (n = 10)	Physical function: chair stand and 50-ft walk ↑ TC and WE ns; American College of Rheumatology 20 ↓ TC more than WE*; hand grip not reported; Health Assessment Questionnaire ↑ more TC than WE*; ESR and C-reactive protein ns QOL: SF-36 ↑ more TC than WE with only vitality* Patient-reported outcomes: pain ↓ TC and ↑ WE ns Psychological: Center for Epidemiological Studies Depression Scale ↑ more TC than WE* Immune/inflammation: ESR and C-reactive protein ns (note TC higher level at baseline)
Wenneberg et al.[58]	36 (19/17), history of muscular dystrophy, 55.3 y	12 wk (weekend immersion, then 45–50 min × 1 d/wk for 4 wk,	QG (n = 16)	WL control (n = 15)	Cardiopulmonary: Forced vital capacity and expiratory volume ↓ QG and WL ns

		then every other week for 8 wk)			Falls and balance: BBS unchanged for QG and ↓ WL ns for intervention period; subgroup A QOL: SF-36 general health unchanged for QG and ↓ WL* and other dimensions ns; Ways of Coping positive reappraisal coping ↓ for QG and unchanged for WL,* confrontative coping ↑ QG and ↓ WL ns, and other dimensions ns Psychological: Montgomery Asberg Depression Rating Scale QG and WL ns
Winsmann[106]	47 (47/0), veterans. 49.55 y	4 wk (75 min × 2 d/wk)	TC Chuan Yang Style (n = 23)	UC included group therapy (n = 24)	Patient-reported outcomes: Dissociative Experiences and Symptom Checklist 90 ↓ TC more than UC ns
Wolf et al.[47]	311 (20/291), transitionally frail with average of 5.6 comorbidities, 80.9 y	48 wk (60–90 min × 2 d/wk)	TC 6 of 24 simplified forms (n = 158)	WE (n = 153)	Cardiopulmonary: BMI ↓ TC and ↑ WE*; SBP and HR ↓ TC and ↑ WE*; DBP ↓ TC more than WE* Physical function: gait speed and FR ↑ TC and WE ns; chair stands ↓ 12.3% TC and q13.7% WE*; 360° turn and pick up object similar change TC and WE ns; OLS nc
Wolf et al.[79]	286 (17/269), transitionally frail with average of 5.6 comorbidities, 80.9 y	48 wk (60–90 min × 2 d/wk)	TC 6 of 24 simplified forms (n = 145)	WE (n = 141)	Falls and balance: TC lower risk for falls from mo 4 to 12; RR falls TC and WE 0.75 (CI = 0.52–1.08) ns
Wolf et al.[80]	72 (12/60), sedentary, 77.7 y	15 wk (60 min × 2 d/wk TC group)	TC 108 forms simplified to 10 forms (n = 19)	BT (n = 16) and ED control (n = 19)	Falls and balance: balance: dispersion for OLS (eyes open), toes up (eyes open and closed), center of balance X with toes up (eyes open) and center of balance Y (OLS eyes open and closed) ↓ more BT than ED and TC*; dispersion for toes up (eyes open), center of balance X OLS (eyes open and closed) and toes up (eyes closed), and center of balance Y for toes up (eyes open and closed) TC, BT, and ED ns Psychological: fear of falling ↓ more for TC than BT and ED*
Wolf et al.[49]	200 (39/161), community-dwelling, 76.2 y	15 wk (45 min × 1 d/wk in class plus 15 min 2 × daily)	TC (n = 72)	BT (n = 64) and ED control (n = 64)	Cardiopulmonary: BPQ more for TC than BT and ED*; 12-min walkq0.01 mile for BT and ED andQ0.02 for TC*; body composition changes for TC, BT and ED ns Physical function: left hand grip strength ↓ more in BT and ED than TC*; strength of hip, knee and ankle via Nicholas MMT 0116 muscle tester, lower extremity ROM changes TC, BT, and ED ns Falls and balance: intrusiveness ↓ more for TC than ED ns; RR for falls in TC 0.632 (CI 0.45–0.89)* using FICSIT fall definition; for BT and other fall definitions ns Psychological: fear of falling ↓ more for TC than BT and ED*
Woo et al.[43]	180 (90/90), community-dwelling, 68.91 y	12 mo (? min × 3 d/wk)	TC Yang style 24 forms (n = 58)	RT (n = 59) and UC (n = 59)	Falls and balance: muscle strength (grip strength and quadriceps) ns; balance (SMART Balance Master, stance time, gait velocity, and bend reach) and falls for TC, RT and UC ns Bone density: women: BMD loss at hip less for TC and RT than UC*; BMD loss at spine less for TC and RT than UC ns; men: no difference in % change in BMD
Yang et al.[83]	49 (10/39), healthy adults, 80.4 y	6 mo (60 min × 3 d/wk)	QG (sitting and standing) and Taiji Chen style	WL (n = 16)	Falls and balance: Sensory Organization Test vestibular ratios and base of support measures ↑ more for TC than WL*q; Sensory

					Organization Test visual ratios and feet opening angle for TC and WL nc
			Essential 48 form (n = 33)		
Yang et al.[114]	50 (13/37), history of received flu immunization and sedentary, 77.2 y	20 wk (60 min × 3 d/wk)	QG (sitting and standing) and Taiji Chen style Essential 48 form (n = 27)	WL (n = 23)	Immune/inflammation: hemagglutination inhibition assayq109% for QG compared to ~10% for WL*
Yeh et al.[34]	30 (19/11), history of chronic stable heart failure, 64 y	12 wk (60 min × 2 d/wk)	TC Yang-style 5 core movements (n = 15)	UC including pharmacologic therapy and dietary and exercise counseling (n = 15)	Cardiopulmonary: peak O2 uptake ↑ TC and ↓ UC ns; 6-min walk ↑ TC and ↓ UC*; serum B-type natriuretic peptide ↓ TC and ↑ UC*; plasma norepinephrine ↑ TC more than UC ns; no differences in incidence of arrhythmia between groups QOL: Minnesota Living with Heart Failure ↓ TC and ↑ UC*
Young et al.[48]	62 (13/49), history of BP between 130 and 159 and not taking medications for hypertension or insulin (45.2% black), 66.7 y	12 wk (60 min × 2 d/wk class with goal of 30–45 min × 4–5 d/wk)	TC Yang style 13 movements (n = 31)	AE class at 40%–60% HR reserve (n = 31)	Cardiopulmonary: BPQ TC and AE*; BMI ↑ slightly TC and AE ns; time in moderate activity, weekly energy expenditure, and leisurely walking ↑ for AE more than TC ns
Zhang et al.[81]	47 (25/22), history of poor balance, 70.4 y	8 wk (60 min × 7 d/wk)	TC simplified 24 forms Zhou (n = 24)	UC (n = 23)	Falls and balance: OLS, trunk and flexion more TC than UC*; 10-min walk ↓ TC and UC ns Psychological symptoms: Falls Efficacy Scale ↑ more TC than UC*

† TC indicates Tai Chi; BW, brisk walking; UC, usual care; ↑, increase in score; ↓, decrease in score; OLS, 1-leg stance; ns, scores not significantly different between groups; HL, health lecture; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; QG, Qigong; AT, aerobic training; BMD, bone marrow density; AE, aerobic exercise; SG, support group; MI, myocardial infarction; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; NQ, no Qigong; E, exercise; BP, blood pressure; BMI, body mass index; ECG, electrocardiogram up; nc, no change in scores; QOL, quality of life; WL, wait list; TAT, Tapas acupressure technique; SDS, self-directed support; BE, balance exercises; FW, functional walking; TUG, timed up and go; FICSIT, Frailty and Injuries: Cooperative Studies on Intervention Techniques; H, hydrotherapy; HIV/AIDS, human immunodeficiency virus/acquired immunodeficiency syndrome; FR, functional reach; SR, sit and reach; WE, wellness education; ED, education; RG, relaxation group; BBS, Berg Balance Scale; TCC, Tai Chi chuan; HE, health education; M, meditation; NR, neutral reading; FT, flexibility training; BT, balance training; ET, exercise therapy; ROM, range of motion; HDL, high-density lipoprotein; APO-A1, apolipoprotein A1; SC, stretching control; EC, exercise Control; SAFFE, Survey of Activities and Fear of Falling in the Elderly; VR, vestibular rehabilitation; RCT, randomized controlled trial; PR, passive rest; PS, psychosocial support; RT, resistance training; NR, newspaper reading; BR, basic rehabilitation; WHOQOL-BREF, World Health Organization Quality of Life: Abbreviated Version; ESR, erythrocyte sedimentation rate.

* $p \leq 0.05$ between groups.