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A Review of Clinical Trials of Tai Chi and Qigong in Older Adults

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Abstract

Initiation and maintenance of physical activity (PA) in older adults is of increasing concern as the benefits of PA have been shown to improve physical functioning, mood, weight and cardiovascular risk factors. Meditative movement forms of PA, such as Tai Chi and Qigong (TC&QG), are holistic in nature and have increased in popularity over the past few decades. Several randomized controlled trials have evaluated TC&QG interventions from multiple perspectives, specifically targeting older adults. The purpose of this report was to synthesize intervention studies targeting TC & QG and identify the physical and psychological health outcomes shown to be associated with TC&QG in community dwelling adults over 55.

Based on specific inclusion criteria, 36 research reports with a total of 3,799 participants were included in this review. Five, categories of study outcomes were identified, including falls and balance, physical function, cardiovascular disease, psychological and additional disease specific responses. Significant improvement in clusters of similar outcomes indicated interventions utilizing TC&QG may help older adults improve physical function and reduce blood pressure; fall risk; and depression and anxiety. Missing from the reviewed reports is a discussion of how spiritual exploration with meditative forms of PA, an important component of these movement activities, may contribute to successful aging.

Keywords

Tai Chi; older adults; randomized controlled trials; community dwelling; adaptation

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The number of adults over age 65, is rapidly increasing in the United States [from 31 to 34 million between 1990 and 2000; (US Census Bureau, 2004)] and with this increase, there is a pressing need for age and capacity appropriate physical activity (PA) programs that will engage older adults (World Health Organization, 2002). Healthy People (HP) 2010 lists PA as the number one initiative for all age groups (U.S. Department of Health and Human Services, 2006b), due to the strong association of PA with positive physiological and psychological health outcomes across many populations (Gregg et al., 2003; U.S. Department of Health and Human Services, 2006a). A primary concern for the aging individual is the decline in physical function, compounded with the increased prevalence of sedentary behavior, falling short of HP 2010 goals and the American College of Sports Medicine (ACSM) and American Heart

Association (AHA) guidelines for PA for older adults (Nelson et al., 2007). The ACSM and AHA 2007 guidelines recommend at least 30 minutes of moderate intensity PA at least 5 times per week, strength training and flexibility two times a week and balance training. In 2005, 47% of the young-old (65 to 74) reported no leisure time activity, with the old-old (over 75 years old), 60% reporting no leisure time activity (U.S. Department of Health and Human Services, 2006b). Strength training and flexibility rates also fall short of meeting the goals.

The interplay of mind-body theoretical concepts and PA has increased in popularity since the 1990's and mind-body based exercise makes up 30% of the exercise programs in fitness centers (La Forge, 2005). Mind-body practices that blend physical movement or postures, a focus on the breath and mind to achieve deep states of relaxation have been recently defined as "Meditative Movement" (MM) (Larkey, Jahnke, Etnier, & Gonzalez, in press), and include, but are not limited to, familiar forms such as Yoga, Tai Chi, Qigong, and other less familiar forms such as Sign-Chi-Do, Neuromuscular Integrative Action and Eurythmy (Borik, 2004; Kitchner-Bockholt, 1992; Rosas & Rosas, 2005; Steiner & Wegman, 2003). Two of these forms, Tai Chi (TC) and Qigong (QG), are grounded in the principles of traditional Chinese medicine (TCM) and have been described as equivalent in terms of basic forms and principles, and have consistently produced a number of similar health outcomes (Chodzko-Zajko et al., 2006; Larkey et al., in press).

QG is considered the ancient root (before recorded history) of all TCM practices (Jahnke, 2002) and many branches of Qigong have developed over 5000 years. There are hundreds of forms of Qigong exercises developed in different regions of China that have been created by specific teachers, some designed for specific or general health enhancement purposes. Tai Chi, also known as Tai Chi Chuan, was developed in the 12th -14th century and has become one of the best known and most highly choreographed forms of QG. TC is described as a traditional Chinese exercise that is suitable for older adults and patients with chronic disease (Wong, Lin, Chou, Tang, & Wong, 2001). It is a "series of graceful movements linked together in a continuous sequence so that the body is constantly shifting from foot to foot, with a lower center of gravity" (Wong et al., p. 608). TC incorporates deep breathing and mental concentration during the movement to achieve harmony between body and brain. Both TC and QG movements can be practiced standing, walking, sitting or lying down. Mind-body interactions as well as the potential for improved functional outcomes resulting from these forms of PA make them particularly appealing for older adults.

ACSM and AHA guidelines for PA for older adults recommend that sedentary older adults begin with balance, flexibility and strength training to build endurance prior to participating in moderate to vigorous-intensity aerobic PA (Nelson et al., 2007). Further, they recommend the measurement of intensity for older adults be measured on a 10 point scale with an emphasis on slight increases in heart rate and breathing as a measure of moderate-intensity. Both TC and QG are particularly suitable for older adults, as they are implemented without the aerobic and musculoskeletal strain that is sometimes associated with higher intensity exercise as described above, and show a growing body of research that indicates a wide range of potential health benefits (Wong et., 2001). These two MM forms of PA, Tai Chi and Qigong (TC&QG), were systematically assessed for benefits to the health and quality of life of older adults.

Prior reviews have reported on specific outcomes of TC or QG, primarily addressing only one of these practices, and not considering the similarity of the two forms and the similar outcomes. These reviews have covered a wide variety of outcomes, many focused on specific diseases or symptoms including: hypertension (Lee, Pittler, Guo, & Ernst, 2007); cardiovascular disease (Cheng, 2006; Lee, Pittler, Taylor-Piliae, & Ernst, 2007); cancer supportive care (Lee, Chen, Sancier, & Ernst, 2007; Lee, Pittler, & Ernst, 2007a; Mansky et al., 2006); arthritic disease (Lee, Pittler, & Ernst, 2007b); stroke rehabilitation (Taylor-Piliae & Haskell, 2007); effect on

aerobic capacity (Taylor-Piliae & Froelicher, 2004); falls and balance (Verhagen, Immink, van der Meulen, & Bierma-Zeinstra, 2004; Wayne et al., 2004); maintenance of bone marrow density (Wayne et al., 2007); and shingles-related immunity (Irwin, Pike, & Oxman, 2004). Other reviews have addressed a broad spectrum of outcomes to demonstrate how TC (Adler & Roberts, 2006; Hogan, 2005; Kemp, 2004; Li, Hong, & Chan, 2001; Matsuda, Martin, & Yu, 2005; Wang, Collet, & Lau, 2004; Wolf, Coogler, & Xu, 1997b) or QG (Lan, Lai, & Chen, 2002; Sancier, 1996, 1999; Sancier & Hu, 1991) have improved health across a variety of outcomes among mainly older adults. While many of these reviews employed strict selection criteria, others use abstracts from research conducted in China (sometimes with limited information on study design) and were not restricted to RCTs.

The purposes of this review and synthesis of literature were to: a) identify the physical and psychological health outcomes shown to be associated with TC&QG practice in older adults participating in randomized controlled trials and b) identify gaps in this research for recommendations for future research.

Method

Research reports were selected for review based on the following criteria: a) articles were published in a peer reviewed journal between 1993 and 2007; b) TC or QG described as the primary intervention; c) participants over 55. While 65 is the lower limit of older adults by definition, the lower age limit of 55 was selected to include older adults with chronic disease and those transitioning to retirement (Eliopoulos, 2005); d) printed in English; and e) limited to randomized controlled trials. The following databases were used to conduct literature searches for potential articles: Cumulative Index for Allied Health and Nursing (CINAHL), Psychological Literature (PsychInfo), PubMed, and Cochrane database. Key words included Tai Chi, Tai Chi Chuan and taiji, qigong; and older adults, aged, and elderly; and were combined, then further narrowed with qualitative and RCT terms separately. Tai Chi, Tai Chi Chuan, taiji, and qigong were entered in Google Scholar search engine with additional hand searches and secondary sources to complete the search for inclusion of articles. Further sorting measures included those studies conducted with a community dwelling population. Residents in independent living facilities were included due to the comparable level of independent living as community dwelling older adults.

Based on the inclusion criteria, 36 RCTs were included in this review. One RCT report was included with a minimal age less than 55 because the age for inclusion in the RCT was over 50, but the reported median age was 70 (sd = 9.2) with a large majority of study participants within the range of this review (Brismee et al., 2007). The reports were entered into a table for further comparison and analysis; and compared for consistently confirmed (or disconfirmed) health benefits, design, theory, strengths and limitations, and to identify the next steps in research in this important area of study for older adult health.

Findings

Description of Studies

Across the 36 articles selected for inclusion, the number of participants in each study ranged from 14 to 702 for a total of 3799 (Table 1). Participants were mostly women (71.97%). Seven studies conducted in countries outside of the USA reported the lowest proportion of women, with a range between 0 and 50% women. Because many of the studies were international, the country of origin was emphasized to recognize the potential generalizability of the research across a variety of geographic-bound populations. Some of the authors reported results from the same study in more than one article and were not duplicated in the table.

A variety of TC and QG forms were used in the interventions with sometimes limited descriptions of the duration, frequency and level of intensity of the exercise. The length of intervention ranged from 3 weeks to 12 months, with the preponderance of interventions at 3 to 6 months. Most classes lasted 60 minutes each, meeting 2 to 3 times weekly (ranging from 1 to 7 days/week). The level of intensity was not reported across the studies, however, TC and QG forms were previously defined as a gentle movement which indicates they were performed at a low to moderate intensity. The TC forms included a number of styles, and for many of the styles, the practice was adapted from larger to smaller number of movements (e.g., a Yang form with 108 original movements adapted to a 10 or 24 movement practice); Tai Chi Chih; Taijiquan; Easy Tai Chi; Yang; Sun-style, and a variety of hybrids (e.g., combining Yang and Sun styles). The Qigong forms described were Baduanjin, Guolin, and Medicinsk. Some of the movements were designed for the specific population such as groups with a history of osteoarthritis (Chou et al., 2004; Song, Lee, Lam, & Bae, 2003) or diabetes (Tsang, Orr, Lam, Comino, & Singh, 2007). Easy Tai Chi was designed specifically for older adults (Li, Fisher, Harmer, & Shirai, 2003).

The countries involved in the reports are USA (13); Hong Kong (4); Australia (3); Italy (2); Korea (2), Poland (1); and Sweden (1). Two of the studies conducted in the USA included a significant African American population and none reported inclusion of Hispanic population (Li et al., 2005b). Several populations have been the target of TC&QG interventions, including those with a history of: sedentary lifestyle; various forms of arthritis; Parkinson's disease; depression; frail or at risk for falls; type II diabetes; cardiac disease including chronic stable atrial fibrillation and coronary artery disease; pre-hypertension; and varicella. A few studies were conducted with relatively healthy older individuals. A wide range of outcomes have been addressed in these selected studies of older adults practicing TC&QG: balance and falls; physical function; cardiovascular fitness; psychological; and treatment of disease or symptom.

Balance and Falls

The most frequently studied outcomes were balance and factors related to risk for falls (Table 1). Of the 18 articles that were included in this review of balance and falls, 16 articles addressed balance directly, showing significant improvements (mostly in response to TC, but two using a combination of TC and QG), 7 directly measured effects of TC on falls and 7 measured the effect of TC and QG on fear of falling. While fear of falling may be considered a psychological factor, it was included in the review of balance and falls due to the relevance to falls.

There are multiple dimensions to balance requiring multiple measures to assess changes (Spiriduso, Francis, & MacRae, 2005). One leg standing is a common measure and reported significant improvements compared to control groups (Audette et al., 2006; Choi, Moon, & Song, 2005; Gatts & Woollacott, 2006; Li et al., 2005b; Song et al., 2003; Stenlund, Lindstrom, Granlund, & Burell, 2005; Zhang, Ishikawa-Takata, Yamazaki, Morita, & Ohta, 2006). In some studies with strong control groups (i.e., interventions that included some form of exercise that could be expected to also generate improvements), TC treatment still showed improvements in outcomes such as single leg stance and balance, though not significant (Judge, Lindsey, Underwood, & Winsemius, 1993; Tsang, Orr, Lam, Comino, & Singh, 2007; Wolf, Barnhart, Ellison, & Coogler, 1997). The Timed Up & Go test, a common measure of balance, showed significant reductions in time for completion for TC compared to control groups (Gatts & Woollacott, 2006; Li et al., 2005b). Climbing boxes and coordination improved significantly for those who practiced a combination of TC and QG more than a sedentary control (Stenlund et al., 2005). For two studies, neither group reported changes for tandem standing test (Stenlund et al., 2005; Tsang et al., 2007). One study failed to detect significant changes in flexibility and knee strength with TC or control, but significant improvements were found in trunk flexion and abdominal strength with TC (Song et al., 2003). The intervention described in this study

was minimal compared to others reviewed, with practice 3 times per week in the first two weeks and only once a week thereafter for the remaining 10 weeks.

Gatts and Woollacott (2006) reported significant improvement of tandem stance for TC practitioners. They also reported significant improvements in neural responses among the TC practitioners. Significant improvements in strength and flexibility have also been reported among TC practitioners as well as Berg Balance Scale and Dynamic Gait Index and posturographic parameters of balance (Audette et al., 2006; Choi et al., 2005; Judge et al., 1993; Li et al., 2005b; Maciaszek, Osiski, Szeklicki, & Stemplewski, 2007; Voukelatos, Cumming, Lord, & Rissel, 2007; Yang et al., 2007b). Three studies reported similar changes in balance, function, and strength compared to an exercise control (Tsang et al., 2007; Wolf et al., 1997; Woo, Hong, Lau, & Lynn, 2007). A study evaluating the effect of a combination of QG and TC reported significantly improved activity levels among practitioners compared to sedentary controls (Stenlund et al., 2005).

A few studies directly examine the impact on falls. Some reported a significant reduction in falls comparing TC to a control (Li et al., 2005b; Voukelatos et al., 2007; Wolf et al., 2003a) and others reported no difference in fall rates between groups (Choi et al., 2005; Tsang et al., 2007; Wolf et al., 2003b; Woo et al., 2007). Changes in fear of falling provide another dimension of TC and QG impact on falls, since improvements in this self-efficacy proxy measure are eventually related to changes in fall events. The remaining studies in this cluster used TC and most reported a significant reduction in fear of falling scores (Choi et al., 2005; Li, Fisher, Harmer, & McAuley, 2005a; Sattin, 1992; Wolf et al., 2003a; Zhang et al., 2006). One study reported more of a reduction of fear of falls than control groups receiving balance training or education (Wolf et al., 1997). One QG study reported slight but not significant improvement of fear of falling and falls efficacy scores compared to a sedentary control (Stenlund et al., 2005).

Physical Function

Table 1 shows a summary of the reviewed studies that improved physical function among sedentary and healthy older adults. A number of the studies included in this group address general perceptions of overall function, health, and self-efficacy for physical function. There were 9 TC studies that showed significant improvements in physical function at three levels of outcomes: functional fitness; functional performance (observed) ; and functional performance (self-report) (Spirduso et al., 2005).

Functional fitness—Key components of functional fitness include: strength, power, flexibility, balance, and endurance (Spirduso et al., 2005) One of the earlier TC studies in the United States was reprinted in 2003 (Wolf et al., 2003a). The primary outcome of this study was to compare TC to balance training for fall reduction. Some of measures of physical function also improve balance. Wolf et al. reported significantly less loss of grip strength among the TC practitioners compared to the balance training or education control group, without changes of other measures of physical fitness such as hip strength or lower extremity range of motion. Muscle strength and peak power increased, but not significantly between TC and a seated calisthenics and stretching program designed for diabetics (Tsang et al., 2007).

Functional performance, observed—Functional performance is measured by observed field tests that imitate activities of daily living (Spirduso et al., 2005). One study reporting the use of TC and hydrotherapy showed significant improvements of Up and Go, 50-foot walk time and stair climb for hydrotherapy compared to a wait-list control, and TC group only improved stair climb (Fransen, Narin, Winstanley, Lam, & Edmons, 2007). Significant improvements were also reported for 50-foot walk , one leg stand, and chair rise compared to

wait-list control groups (Li et al., 2004; Li et al., 2003). For another group, chair stand time significantly decreased (12.3%) among TC practitioners while it increased (13.7%) among the wellness education control group (Wolf et al., 2006). Other tests among this group showed similar patterns of change when performing 360° turn and picking up objects, but the results were not significant. Gait speed and functional reach improved among both groups and the one leg stand did not change significantly for either group (Wolf et al.).

One study was unable to report significant changes in the 6-minute walk or other measures of function following 45 minutes of TC designed for persons with diabetes, 2 times a week for 16 weeks, but this intervention was being compared to a “sham” exercise program including seated calisthenics and stretching (Tsang et al., 2007). However, habitual PA did increase for the TC group and decrease for the control group.

Functional performance, self-report—In addition to observed measures of functional performance, it is also common to utilize self-reported measure of activities (Spirduso et al., 2005). Using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), significant improvement in physical function was reported for TC practitioners compared to control group following training and a return to normal after a period of detraining (Brismee et al., 2007). Another study reporting the use of TC and hydrotherapy showed similar improvements in the WOMAC and SF-12 physical component compared to a wait-list control group (Fransen et al., 2007). Other studies of TC reported significant improvements in SF-20 physical component and self-efficacy, SF-12 component, and SF-12 instrumental activities of daily living, respectively (Li et al., 2001; Li et al., 2004; Li et al., 2003). The former was compared to a wait-list control and the two latter were compared to a gentle stretching control.

Physical function components of the SF-36 improved significantly for TC compared to a sedentary control (Irwin, Olmstead, & Oxman, 2007; Irwin, Pike, Cole, & Oxman, 2003). TC practitioners reported significantly lower Sickness Impact Profile scores ($p < .05$) compared to a sedentary control group of older adults with osteoarthritis (Greenspan, Wolf, Kelley, & O'Grady, 2007), while self-reported health scores did not change for either group.

Cardiovascular Health

The third most frequently published RCTs of TC&QG on older adults on a specific outcome was effects on cardiovascular health. This category includes measures such as blood pressure, BMI, and VO₂ Max. Of the 9 studies in this category, 7 employed TC and 2 used QG.

Statistically significant decreases in systolic and diastolic blood pressure ranging from 7-13.2 and 2.4-4 mm hg respectively ($p < .05$) were reported in studies of TC 3 times per week times 12 weeks (Wolf et al., 2003a; Wolf et al., 2006; Young, Appel, Jee, & Miller, 1999). One study did not report a significant decrease in blood pressure or heart rate, however there was a reported significant increase of pre-ejection fraction following 20 minutes of TC components more than a passive rest period and slow movement which is related to sympathetic nervous system activity (Motivala, Sollers, Thayer, & Irwin, 2006). Heart rate variability was significantly improved for TC practitioners compared to brisk walking and a sedentary control group (Audette et al., 2006).

Measures of body composition were reportedly unchanged when the duration of the study was less than 16 weeks (Song et al., 2003; Wolf et al., 2003a; Young et al., 1999). Another study was unable to report changes following a 12 month intervention, however, the baseline BMI was within normal range (Thomas et al., 2005). A study among transitionally frail older adults who practiced TC for 48 weeks showed a 2.3% ($p < .05$) decrease in measured BMI compared to an increase among the sedentary control group (Wolf et al., 2006). Two studies were unable to report significant differences between group changes in energy expenditure. Of these two,

however, one did report increases in energy expenditure for TC and resistance training verses a sedentary control (Thomas et al.) and the other higher energy expenditure among the Aerobic exercise class compared to TC (Young et al.). Both of the QG studies measured 6-minute walk as an outcome. One reported more of an improvement for the aerobic training than the QG group (Burini et al., 2006) and the other a significant improvement among the QG group that practiced 90 minutes, 2 times a week for 16 weeks (6-minute walk increased 114 meters, $p = .001$) compared to a wait-list control that decreased the distance (Pippa et al., 2007). There were no changes in ejection fraction, BMI, or cholesterol for QG or control for the latter study.

Psychological Outcomes

A cluster of studies were conducted on outcomes related to mental and emotional health, including depression, anxiety, mood states and related biomarkers of these factors. Five studies evaluated the effect of TC&QG on depression, in older adults using 4 different scales. Of those, two studies reported significant reductions in depression. One study group practiced QG (Center for Epidemiological Studies Depression Scale) and one TC (Geriatric Depression Scale) compared to newspaper reading and wait-list control groups respectively (Chou et al., 2004; Tsang, Fung, Chan, Lee, & Chan, 2006). Two studies used the Beck Depression Inventory. One compared QG and aerobic training, reporting no changes in depression (Burini et al., 2006) and the other compared TC to a health education control with significant improvements in both groups over time (Irwin et al., 2007). A fifth study reported a significant decrease in depression and stress among hydrotherapy practitioners (Depression Anxiety and Stress 21) while the TC and wait-list control remained unchanged (Fransen et al., 2007). The SF-12 mental score did improve significantly for TC practitioners compared to a stretching control group (Li et al., 2003) and both the TC and exercise control group (Li et al., 2004) while a third study reported no changes within or between TC, hydrotherapy or wait-list control group (Fransen et al., 2007).

Disease Outcomes

A final grouping of studies are listed in Table 1 showing some studies that were conducted to examine effects on specific symptom outcomes associated with specific diseases, including arthritis; Parkinson's disease; and immune system strength relative to participants with herpes varicella or influenza vaccination (response to vaccination). Changes in bone mineral density and sleep quality were added to this category because the study populations were selected for specific diseases or symptoms. One QG, one combination QG and TC and 6 TC studies are reported here.

Among studies with arthritis patients, relief of pain and stiffness were examined in response to interventions. Reports of pain (Brismee et al., 2007) and stiffness (Song, Lee, Lam, & Bae, 2007) significantly improved more for TC participants compared to sedentary or wait-list control groups. Another study reported a trend towards significant reductions in pain among TC (5.2, 95% C.I., -0.8, 11.1) and significant improvement for hydrotherapy (6.5, 95% C.I., 0.4, 12.7) participants compared to wait-list control group following 12 weeks (Fransen et al., 2007). While the latter study did not report significant improvements, the trend towards improvement indicates TC may improve joint pain among TC practitioners.

The effect of QG compared to aerobic training on self-report of symptoms of Parkinson's disease reported no change among both groups (Burini et al., 2006). Both groups showed low scores at baseline. Immune function was also studied. One study reported the increased immunity from the varicella zoster vaccine among healthy TC practitioners and the other reported the effect of TC on varicella zoster virus immunity (Irwin et al., 2007; Irwin et al., 2003). Measures have included significantly improved symptoms related to the disease and quality of life. The VZV-RCF increased significantly more for TC practitioners ($p < .05$) than

those receiving health education or wait-list control (Irwin et al., 2007; Irwin et al., 2003). A third study reported a significantly higher response to the 2003-2004 influenza vaccination among participants who practiced a combination of QG and TC compared to a sedentary control group (Yang et al., 2007a).

Bone mineral density loss was significantly different for female TC and resistance training participants compared to a sedentary control group, but no reported differences for men (Woo et al., 2007). Bone loss at the hip was relatively unchanged for female TC (0.07 ± 0.64) and resistance training (0.09 ± 0.62) participants compared to a sedentary control group (-2.25 ± 0.6). Sleep latency (time needed to fall asleep) was significantly reduced by 18 minutes and sleep duration was increased by 48 minutes among TC participants compared to low-impact exercise (Li et al., 2004).

Discussion

Strengths

There are several strengths of the reviewed RCTs. First, a number of studies clustered around similar designs and outcomes, and provided high quality evidence of effects on particular health parameters. For example, balance was assessed across 16 studies and one leg stance was used in 8 of them. Physical function was assessed in 11 articles. In 6 of these articles, variations of the timed walk test, such as the 6-minute and 50-foot walk was measured, most showing significant effects for QG (Pippa et al., 2007) and TC (Li et al., 2004; Li et al., 2003; Wolf et al., 2006). Nine articles assessed cardio-pulmonary effects with 2 studies using the 6-minute walk test as a fitness measure, and 5 studies measuring blood pressure. These clustered studies of outcomes using the same means of measurement and showed similar results when inactive control groups were used, and provided the basis for defining more conclusive benefits of TC&QG in the older adult.

Balance and falls—The risk factors for falls are multifaceted, therefore a falls prevention program must address all of these risks (Spirduso et al., 2005). The types of exercises selected should include components of balance, flexibility, strength and some aerobic conditioning (Rubenstein & Josephson, 2006). Because older adults may have been sedentary for some time, it is suggested that participants begin with balance and muscle strengthening exercises and gradually advance to the aerobic activities (Nelson et al., 2007). One of the major components of TC and QG is body posture adjustment (Chodzko-Zajko et al., 2006), thus it is not surprising to review multiple studies designed to evaluate outcomes of falls and balance.

Interventions that reported improved components of balance were designed to screen for sedentary or transitionally frail older adults and compared the TC or QG intervention to a wait list control group. Many of the multiple outcomes reported significant improvements. For example, balance was assessed across 16 studies and one leg stance was used in 8 of them. Other studies used various combinations of outcomes to measure balance. Fear of falling is equally important as older adults who are afraid of falling are reportedly sedentary. A group of TC studies reported reductions in fall rates compared to the control groups (Li et al., 2005b; Voukelatos et al., 2007; Wolf et al., 2003a) and others no difference between the groups (Choi et al., 2005; Tsang et al., 2007; Wolf et al., 2003b; Woo et al., 2007). While no changes were reported in some of the studies, it is important to note that older adults may increase their risk for falls in the initial phases of engaging in physical activity and it is notable that they did not report higher fall rates than their control groups.

Physical function—One goal of our aging population is to maintain functional independence and ability needed to age in place (National Association of Area Agencies on Aging, 2006; Spirduso, et al., 2005; World Health Organization, 2002). Improvement of

physical function is also a component of fall reduction strategies, resulting in some cross-over of information between the two categories of outcomes. In addition to the previously described measures to improve balance, studies to improve physical function also show significant results, especially when compared to inactive controls such as wait-list or usual care (Brismee et al., 2007; Greenspan et al., 2007; Irwin et al., 2007; Irwin et al., 2003; Li et al., 2001). Even when compared to an active control, TC participants were able to show improved physical function (Li et al., 2003; Li et al., 2004; Wolf et al., 2003b). In one study, both TC and control group tended to improve to indicate that the TC intervention is just as effective as the previously known interventions to improve physical function (Fransen et al., 2007). One intervention failed to report significant improvements among TC compared to seated calisthenic, with the investigators reporting the limitation of a weak study design (Tsang et al., 2007).

Cardiovascular health—Common measures of cardiovascular health include blood pressure, BMI, and VO₂ Max. Exercise is known to reduce blood pressure among people with mild hypertension within the first few weeks (American College of Sports Medicine, 1998). Interventions using TC and QG have reported statistically significant changes in these parameters over time (Wolf et al., 2003a; Wolf et al., 2006; Younget al., 1999). One study did not report changes in blood pressure, but the measurement was different from the others (Motivala et al., 2006). For this study, blood pressure was measured before and after a 20 minute session of TC to determine the immediate effects. Motivalta et al. were able to report a decrease of the pre-ejection fraction. One study reported a significant improvement in VO₂ Max (Audette et al., 2006).

Changes in BMI are difficult to measure. Wolf et al. (2006) was able to report a reduction of BMI following a 48 week TC intervention compared to a sedentary control among a transitionally frail population. Improved time for completion of the 6-minute walk improved for QG practitioners. One group improved significantly compared to a sedentary control (Pippa et al., 2007) and the second improved significantly, but not as much as the aerobic training control group (Burini et al., 2006).

Psychological outcomes—There is clearly a need to evaluate the effect of TC and QG on psychological outcomes such as depression. Nearly 20% of older adults experience depression which is a major risk factor for suicide (National Institute of Mental Health, 2003). Exercise, particularly mindful-movement PA, is a low risk treatment that has been reported to decrease depression rates among older adults (Blumenthal et al., 1999; Lawlor & Hopker, 2001).

The studies reporting changes in depression showed varying results, with a small cluster of studies reporting conflicting results. Only two studies reported significant reductions in depression (Chou et al., 2004; Tsang et al., 2006). Of the studies that failed to report results, two were shorter in duration (Burini et al., 2006; Fransen et al., 2007) and the third reported significant improvement in both the intervention and a health education control group. More evidence is needed to draw conclusions regarding the efficacy of TC or QG on psychological outcomes.

Disease outcomes—Many of the previous reviews were disease outcome focused. The outcomes introduced in this category offer new areas of research, especially for older adults. The studies of TC among a population of older adults with a history of arthritis are promising with two reporting improved symptoms of pain and a third article showing a trend towards improvement. Research is needed in populations with diagnosed disorders that specify specific perceived physical symptom improvements (such as function and sleep duration) with repeated measures of dose-response. Additional research is needed to provide conclusions regarding the effectiveness of TC or QG on the diseases.

Most of the 36 studies were conducted in a community group format. A group format for older adults provided social contact and was consistent with the ways most older adults learn, practice, and maintain new behaviors. The reviewed studies were completed in a wide range of populations including African Americans within the USA and reports from many nationalities participating in Hong Kong, Australia, Korea, and Sweden. While most of the studies were conducted in the United States, 6 countries reported on various outcomes of TC&QG; that context contributed to the generalizability of meditative movement across geographic populations. These factors, the community group format and the wide range of populations studied, support generalizability of findings across populations in naturalistic settings.

Limitations

There were a few limitations to the reviewed RCTs. Although the previous studies did focus on a range of physical and psychological health outcomes, they did not provide an evaluation of spirituality which is an important component of the mindful-movement PA interventions. Much of the written and oral teachings regarding TC&QG emphasize the spiritual components of these practices, suggesting that spiritual connection is critical to the aspects expected to initiate healing (Jahnke, 2002; Yang & Grubisich, 2005).

Aging adults may experience loss of confidence or negative self beliefs that compound the physiological changes due to sedentary activity and disuse. There is a growing body of knowledge to support the importance of spirituality and religion among the aging population (Eisenhandler, 2005; Flood, 2002, 2005a, 2005b; Koenig, 2006; Nelson-Becker, 2005). Additional evidence links the promotion of spirituality to improved QOL in aging populations (Moberg, 2005; Riley et al., 1998); yet no research has examined the relationship between mind-body exercise and improved aging, specifically physical function.

Studies reporting the psychological impact of TC&QG lack consistent measures of outcomes. While five studies evaluated depression, four different scales were used to assess this outcome (Burini et al., 2006; Fransen et al., 2007; Irwin et al., 2007) with two studies finding significant results (Chou et al., 2004; Tsang et al., 2006). For the other disease specific studies, the effects of TC&QG on bone marrow density and immune function are recent areas of interest and those studies need to be replicated so the strength of the outcomes measured can be more effectively evaluated. Third, there was a noted lack of theoretical underpinning aside from the principles of TC&QG across all of the studies. For example, theoretical approaches that addressed mind-body interactions that might guide a TC or QG intervention were not included in the reviewed reports.

Fourth, lack of detail in design of the studies was a significant limitation. Most of the studies employed a convenience sample and did not screen for the population at risk for those studies showing improvement in disease symptoms. Many of the studies were pilot studies, thus did not have a large enough sample size for statistical power. Those with large sample size were able to report significant findings (Greenspan et al., 2007; Li et al., 2005b; Sattin et al., 2005; Voukelatos et al., 2007). Although nearly all of the outcomes measured found significant results when TC&QG were compared to inactive or weak controls, the range of intervention duration varied from 3 weeks to 12 months. It is suggested that learning TC takes a long time and if all elements are not incorporated into the practice, the potential benefits may not be evidenced (Yang & Grubisich, 2005). Not all of the research reviewed discussed the inclusion of all elements of traditional TC that includes body, mind, and breath. This is a fundamental problem in the interpretation of the results of interventions using TC or QG. Duration of intervention, dose (amount of time practiced, level of intensity, and frequency) were often not reported consistently, making it difficult to know exactly what level of practice (dose of intervention) might be needed to achieve results.

Fifth, there are limitations in generalizability. This review showed significant improvement in a variety of outcomes and some disease symptoms, but the results were demonstrated on relatively narrow gender and ethnic groups. For instance, most of the studies in the United States include mostly women in contrast to those conducted in other countries. This limits the findings to women. While there was a global distribution of findings, none of the populations included a sample of Hispanics.

Conclusion

Following this review of the current literature on TC&QG in the older adult population, it appears that participants are impacted from multiple perspectives. To date, the studies have evaluated physical and psychological outcomes and even quality of life, but none of the RCT studies have explored the spiritual influence of meditative movement such as TC and QG. Spirituality is important to successful aging (Flood, 2005a, 2005bf)., yet few studies of TC have reported on the spiritual components that underpin the mindful movement PA of TC and QG

This review focused on efficacy in outcomes.. Continued research of meditative movement in this population is important to understanding the mechanisms of the movement. Studies should include models of implementation and evaluation that consider account the broader spectrum of adaptation to aging, including spiritual elements, as well as addressing the fit and applicability of TC&QG across racial and ethnic groups.

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Table 1

Tai Chi and Qigong Studies

Authors	Year	Country	No. of subjects Mean age Sex (Male/Female)	Exercise duration (minutes × days per week)	Exercise group	Control group	Reported outcomes * = $p < .05$ ns = not significant
Audette Jin Newcomer Stein Duncan & Frontera	2006	USA	27 Sedentary women 71.4 years 0/27	12 weeks (60 minutes × 3 days)	Tai Chi (TC) 10 movement Yang (n=11)	Brisk Walking (BW) (n=8); Usual Care (UC) later recruited and not randomized (n=8)	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*; and balance, only non-dominant one leg stance (OLS) with eyes closed ↑ in TC more than BW* Cardiovascular Health: VO2 max ↑ in TC more than BW and UC*; heart rate variability, high frequency ↑ and low frequency ↓ in TC only* no between Physical Function: Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) ↑ in TC more than HL* with ↓ for detraining period Disease Outcomes (Arthritis): Pain ↓ in TC more than HL*; adverse outcomes ns
Brisnee Paige Chyu Boatright Hagar McCaleb Quintela Feng Zu Shen	2007	USA	41 History of knee osteoarthritis 70 years 7/34	12 week TC and 6 week no training (40 minutes × 3 days / 6 weeks group training and 6 weeks home training; and 6 weeks detraining)	TC Yang 24-form simplified (n=18)	6 weeks of health lecture (HL) followed by no activity same as exercise group (n=13)	
Burini Farabollini Ianucci, Rimatori Riccardi Capecci Provinciali & Ceravolo	2006	Italy	26 History of Parkinson's disease 65 years 9/17	7 weeks each of Aerobics (45 min × w days) and Qigong (50 min × 3 days) 20 sessions each with 8 weeks between sessions	Qigong (QG) (n=11)	Aerobic Training (AT) sessions (n=11)	Cardiovascular Outcomes: 6-minute walk and Borg scale for breathlessness ↑ and spirometry and cardiopulmonary exercise test ↓ for AT more than QG* Psychological Outcomes: Beck Depression Inventory ns Disease Outcomes (Parkinson's): Parkinson's Disease Questionnaire ns for both; Unified Parkinson's Disease Rating Scale ns; Brown's Disability Scale ns
Choi Moon & Song	2005	South Korea	59 Living in care facility, ambulatory with at least 1 fall risk factor 77.8 years 15/44	12 weeks (35 min × 3 days)	TC Sunstyle (n=29)	UC (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 meter walk ↓ more than UC*; OLS eyes open ns
Chou Lee Yu Macfarlane Cheng Chan & Chi	2004	Hong Kong	14 Chinese with depression from a psychogeriatric clinic 72.6 years 7/7	3 months (45 min × 3 days)	TC Yang Style 18 form (n=7)	Waitlist (WL) (n=7)	Psychological Outcomes: Center for Epidemiological Studies Depression Scale ↓ TC more than WL*

Authors	Year	Country	No. of subjects Mean age Sex (Male/Female)	Exercise duration (minutes × days per week)	Exercise group	Control group	Reported outcomes * = $p < .05$ ns = not significant
Fransen Nairn Edmons, 2007		Winstanley Lam & Australia	152 History of chronic symptomatic hip or knee osteoarthritis 70.13 years 40/112	12 week (60 min × 2 days) week	TC for Arthritis by Dr. Lam from Sun Style 24- forms (n=56)	Hydrotherapy (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: Timed Up & Go (TUG), 50-foot walk, and stair climb ↓ more for H than WL*; timed stair climb for ↓ TC and H ns; and SF-12 Physical ↑ H more than WL* and TC more than WL borderline* Psychological Outcomes: Depression Anxiety & Stress 21 ↓ in H* and TC ns; and SF-12 Mental ns Disease Outcomes (Arthritis): Pain and function ↓ TC and H ns
Gatts and Woollacott,	2006	USA	19 Balance impaired seniors 68-92 years 2/17	3 weeks (90 min × 5 days)	TC Twelve Classical Tai Chi Postures (n=11)	TC Based and axial mobility program (TCB); same group practiced TC after control time (n=8)	Falls and Balance: TUG ↓ more for TC than TCB*; Functional Reach (FR) ↑ for TC and TCB; OLS and tandem stance both legs ↑ more TC than TCB*; tibialis anterior more ↑ for TC than TCB*; and gastrocnemius ↑ only TC after TCB time*
Greenspan Wolf Kelley O'Grady	2007	USA	269 Congregate independent living, transitionally frail women with at least 1 fall in past year > 70 years and 50% over 80 0/269	48 week (60 increasing to 90 min × 2 days)	TC 6 simplified forms (n=103)	Wellness Education (WE) (n=102)	Physical Function: Sickness Impact Profile (SIP) for physical function and ambulation ↓ more TC than WE*; SIP and physical and ambulation perceived health status ↓ TC more than WE* and self-rated health TC and WE ns
Irwin Olmstead & Oxman,	2007	USA	112 Healthy older adults 70 years 41/71	16 weeks (40 min × 3 days)	TC (n=59)	Health Education (HE) (n=53)	Physical Function: 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 Outcomes: Beck Depression Score ↑ TC and HE ns Disease Outcomes (Immune Function): Varicella zoster virus (VZV) responder cell frequency ↑ TC more than HE*
Irwin Pike Cole & Oxman	2003	USA	36 Healthy older adults 60 years 5/13	15 week (45 min × 3 days)	TC (n=14)	WL (n=17)	Physical Function: SF-36 only role-physical and physical functioning improved more for TC than WL* Disease Outcomes (Immune Function): VZV cell- mediated immunity CMI ↑ more for TC than WL*
Judge Lindser Underwood & Winsemius,	1993	USA	21 Sedentary women 68 years 0/21	6 months (20 min walking plus other exercise × 3 days for TC and no exercise for 12 weeks, then 30 min	TC simple with strength training and walking (n=12)	Flexibility Training (FT) (n=9)	Falls and Balance: OLS ↑ more for TC than FT ns; knee extension ↑ more for TC than FT*; and sitting leg press improved TC and FT ns

Authors	Year	Country	No. of subjects Mean age Sex (Male/Female)	Exercise duration (minutes × days per week) x1 day for FT)	Exercise group	Control group	Reported outcomes * = $p < .05$ ns= not significant
Li Fisher Harmer & McAuley,	2005	USA	256 Sedentary over 70 77/48 years 77/179	6 month (60 min × 2 days)	TC eight form Easy (n=125)	Stretching Control (SC) (n=131)	Falls and Balance: Activities Specific Balance (ABC) ↑ and Survey of Activities and Fear of Falling ↓ more for TC than SC*; falls self-efficacy ↑ (mediator)
Li Fisher Harmer & Shirai,	2003	USA	48 Older adults 68.88 years	3 months (?) min × 3 days)	TC Yang 8-form easy Tai Chi (n=26)	SC (n=22)	Physical Function: SF-12 physical, instrumental activities of daily living, OLS, 50-ft walk, and chair rise all improved TC more than SC* Psychological Outcomes: SF-12 mental ↑ more TC than SC*
Li Fisher Harmer Irbe Tearse & Weiner,	2004	USA	118 History of moderate sleep complaints over 60 75.4 years 22/96	24 week (60 min × 3 days)	TC Yang (n=62)	SC (n=56)	Physical Function: OLS and SF-12 physical ↑; and chair rise and 50-ft walk ↓ TC more than SC* Psychological Outcomes: SF-12 mental ↑ both ns Disease Outcomes (Sleep): Sleep duration and efficiency ↑ and sleep quality, latency, duration, and disturbances; Epworth Sleepiness Scale and Pittsburgh Sleep Quality Index ↓ more for TC than SC*; and sleep dysfunction both and medication ↓ TC only ns
Li Harmer Fisher McAuley Chaumeton Eckstrom & Wilson,	2005	USA	256 Sedentary over 70 77.48 years 77/179	6 month (60 min × 2 days)	TC Yang Style 24 forms (n=125)	SC (n=131)	Falls and Balance: Fewer falls and fewer injurious falls for TC than SC*; and Berg Balance Scale, Dynamic Gait Index, FR and OLS ↑ and 50 ft walk and TUG ↓ more for TC than SC* all sustained at 6 month follow-up
Li Harmer McAuley Fisher Duncan & Duncan,	2001	USA	94 Sedentary over 65 72.8 years 9/85	6 month (60 min × 2 days)	TC Yang style 24 forms (n=49)	WL (n=45)	Physical Function: SF-20 physical Function and self- efficacy ↑ among TC more than WL over time* r scores
Maciaszek Osinski Szelekicki Stemplewske	2007	Poland	49 Sedentary men with osteopenia or osteoporosis 60 to 82.1 years 49/0	18 week (45 min × 2 days)	TC 24 form (n=25)	UC (n=24)	Falls and Balance: Posturographic parameters: T ↓; E and TW ↑ for TC*; and E and TW ↑ more for TC than UC*
Motivala Sollers Thayer & Irwin,	2006	USA	32 Out of 63 who completed RCT for Herpes Zoster risk in aging study 68.5 years 14/18	37 week (?) min × 1 day)	TC	Passive-Rest (PR) and slow moving physical movement	Cardiovascular Health: Pre-ejection period ↑ post task more for TC than PR*; BP and heart rate (HR) for TC and PR ns
Pippa Manzoli Corti Congedo Romanazzi & Parruti,	2007	Italy	43 History of stable chronic atrial fibrillation 68 years 30/13	16 week (90 minutes × 2 days)	Qigong (n=22)	WL (n=21)	Cardiovascular Health: 6-minute walk ↑ for TC and ↓ for WL*; Ejection fraction, Body Mass Index (BMI), cholesterol ns
Sattin Easley Wolf Chen & Kutner,	2005	USA	217 History of 1 or more falls in past year and over 70 (55 African Americans) 70-97 years 12/205	48 weeks (60-90 min × 2 days)	TC 6 of 24 Simplified (n=158)	WE (n=153)	Falls and Balance: ABC ↑ and Falls Efficacy Scale (FES) ↓ more among TC than WE* Psychological Symptoms: FES ↓ more among TC than WE*

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Song Lee Lam & Bae,	2003	Korea	72 History of osteoarthritis and no exercise for 1 year prior 63 years 0/72	12 week (60 min × 3 days for 2 weeks then × 1 day for 10 weeks)	TC Sun Style modified for arthritis (n=22)	UC (n=21)	Falls and Balance: OLS; trunk flexion and sit ups ↑ more for TC than UC*; Flexibility and knee strength TC and UC ns Cardiovascular Health: BMI, 13 min ergometer TC and UC ns Disease Outcomes (Arthritis): Pain, joint stiffness, and perceived less difficulty in performance of activities of daily living ↓ more for TC than UC*
Song Lee Lam & Bae,	2007	Korea	72 History of osteoarthritis and no exercise history for 1 year prior 63 years 0/72	12 week (60 min × 3 days for 2 weeks then × 1 day for 10 weeks)	TC Sun Style modified for arthritis (n=22)	UC (n=21)	Disease Outcomes (Arthritis): Pain and stiffness ↓ and perceived benefits ↑ more for TC than UC*; TC performed more health behaviors than UC*
Stenlund Lindstrom Granlund & Burell,	2005	Sweden	95 History of Coronary Artery Disease 77.5 years 66/29	12 weeks (60 min QG and 120 min of discussion on various themes)	TC & QG (TC & Medicinsk Qigong) (n=48)	UC (n=47)	Falls and Balance: Fear of falling, FES, tandem standing, OLS Left, Climb boxes Left TC and UC ns; OLS Right and climb boxes right ↑ more for TC than UC*; co-ordination ↓ more for UC than TC*; and self reported activity level ↑ for TC more than UC*
Thomas Hong Tomlinson Lau Lam Sanderson Woot,	2005	Hong Kong	207 Healthy older adults 68.8 years 113/94	12 months (60 min × 3 days)	TC Yang style 24 forms (n=64)	Resistance Training (RT) (n=65) or UC (n=78)	Cardiovascular Health: 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
Tsang H.W. Fung Chan & Chan,	2006	Hong Kong	82 History of depression and chronic illness over 65 82.43 years 16/66	16 weeks (30-45 min × 3 days)	QG Baduanjin (n=48)	Newspaper Reading (NR) group with same intensity (n=34)	Psychological Outcomes: Geriatric Depression Scale ↓ more for QG than NR*; Personal Well Being ↑ for QG and ↓ NR*; and General Health Questionnaire ↓ QG and ↑ NR*; and Self-concept ↓ more TC than NR*; Chinese General Self-efficacy and Perceived Benefits Questionnaire ↑ more for QG than NR*
Tsang T. Orr Lam Comino & Singh,	2007	Australia	38 History of type 2 diabetes and sedentary 65.4 years 8/30	16 week (45 min × 2 days)	TC for diabetes (12 movement hybrid from Yang and Sun (n=17)	SE (seated calisthenics and stretching) (n=20)	Falls and Balance: Balance index ↓ TC and SE ns; OLS open ↑ TC more than SE ns; OLS closed and tandem walk ↓ TC and SE ns; Falls 0-2 TC and SE ns Physical Function: 6-minute 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 PA ↑ TC and ↓ SE*; SF-36 (except Social Function ↑ for TC and ↓ SE*) and ATT19 TC and SE ns
Voukelatos Cumming Lord Rissel,	2007	Australia	702 Adults >60 69 years 112/589	16 weeks (60 min × 1 day)	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)*

Authors	Year	Country	No. of subjects Mean age Sex (Male/Female)	Exercise duration (minutes) × days per week	Exercise group	Control group	Reported outcomes * = $p < .05$ ns = not significant
Woolf O'Grady Easley Guo Kressig & Kutner,	2006	USA	311 History of transitionally frail with average of 5.6 comorbidities	48 weeks (60-90 min × 2 days)	TC 6 of 24 simplified forms (n=158)	WE (n=153)	Physical Function: Gait Speed and FR ↑ TC and WE ns; Chair stands ↓ 12.3% TC and ↑ 13.7% WE*; 360° turn and pick up object similar change TC and WE ns; and OLS ns Cardiovascular Health: BMI ↓ TC and ↑ WE*; SBP and HR ↓ TC and ↑ WE*; DBP ↓ TC more than WE*
Wolf Sattin Kutner O'Grady Greenspan & Gregor,	2003	USA	291 History of at least 1 reported fall 80.85 years 20/291	48 weeks (60-90 min × 2 days)	TC 6 of 24 simplified forms (145)	WE (141)	Falls and Balance : TC lower risk for falls from month 4 to 12 RR falls TC and WE 0.75 (CI=0.52-1.08) ns
Wolf Barnhart Ellison Coogler & Gorak,	1997	USA	72 Sedentary older adults 77.04 years 12/60	15 weeks (60 min × 2 days TC group)	TC 108 forms simplified to 10 forms (n=19)	Balance Training (BT) (n=16) and WE (n=19)	Falls and Balance: Balance: Dispersion for OLS (eyes open), toes up (eyes open and closed), Center of Balance (COB) X with toes up (eyes open) and COB Y (OLS eyes open and closed) ↓ more BT than WE and TC*; Dispersion for toes up (eyes open), COB X OLS (eyes open and closed) and Toes up (eyes closed), and COB Y for toes up (eyes open and closed) TC, BT, and WE ns; Fear of falling ↓ more TC than BT and WE ns
Wolf Barnhart Kutner McNeely Coogler & Xu,	2003	USA	200 Adults over 70 76.2 years 58/242	15 weeks (45 minutes weekly in class plus 15 min 2 × daily)	TC (n=72)	BT (n=64) and WE (n=64)	Falls and Balance: Fear of falling ↓ more for TC than BT and WE*; Intrusiveness ↓ more for TC than WE ns; RR for falls in TC 0.632 (CI 0.45-0.89)* using FICSIT fall definition and for BT and other fall definitions ns Physical Function: Left hand grip strength ↓ more in BT and WE than TC*; Strength of hip, knee and ankle via Nicholas MMT 0116 muscle tester, lower extremity ROM changes TC, BT and WE ns Cardiovascular Health: BP ↓ more for TC than BT and WE*; 12-minute walk ↑ 0.01 mile for BT and WE and ↓ 0.02 for TC*; Body composition changes for TC, BT and WE ns
Woo Hong Lau & Lynn,	2007	China	180 Older adults 65-75 / 68.91 90/90	12 months (? min × 3 days)	TC Yang style 24 forms (n=30)	Resistance Training (RT) (n=29) and UC (n=29)	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 Disease Outcomes (Bone Density): Women: Bone marrow density (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 Verkuilen Rosengren Grubisich Reed & HsiaoWeeksler,	2007	USA	49 Healthy adults over 60 80.4 years 10/39	6 months (60 min × 3 days)	QG (sitting and standing) and Taiji Chen style Essential 48 movement form (n=33)	WL (n=16)	Falls and Balance: Sensory Organization Test vestibular ratios and Base of Support measures ↑ more for TC than WL*; Sensory Organization Test visual ratios and feet opening angle for TC and WL ns
Yang Verkuilen Rosengren Mariani Reed Grubisich & Woods,	2007	USA	50 History of flu immunization and	20 weeks (60 min × 3 days)	QG (sitting and standing) and Taiji Chen style Essential 48 movement form (n=27)	WL (n=23)	Disease Outcomes (Immune Function): Hemagglutination Inhibition assay ↑ 109% for TQ compared to ~10% for WL*

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Young Appel	Jee Miller, 1999	USA	62 History of BP between 130 and 159 and not taking medications for hypertension or insulin (45.2% black) 66.7 years 13/49	12 weeks (60 min × 2 days class with goal of 30-45 min/4-5 days /week)	TC Yang Style 13 movements (n=31)	Aerobic Exercise (AE) class at 40 to 60% HR reserve (n=31)	Cardiovascular Health: BP↓ TC and AE *; BMI ↑ slightly TC and AE ns; and time in moderate activity, weekly energy expenditure, and leisurely walking ↑ for AE more than TC ns
Zhang Ishikawa-Takata & Ohta,	2006	China	47 History of poor balance and over 60 70.270.4 25/22	8 weeks (60 min × 7 days)	TC simplified 24 forms Zhou (n=24)	UC (n=23)	Falls and Balance: OLS, trunk flexion, and FES ↑ more TC than UC*; 10 min walk ↓ TC and UC ns