Tai Chi as a Balance Improvement Exercise for Older Adults: A Systematic Review

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ABSTRACT

Purpose: The purpose of this systematic review was to identify exercise parameters and the most common outcome measures used in tai chi (TC) research.

Methods: Ovid Medline and PubMed were used to identify longitudinal studies published from January 2000 to July 2007 written in English with the key words tai chi, tai ji, tai chi quan, tai ji quan, balance, falls, and falling. Qualifying studies had subjects aged 60 years or older.

Results: In all 19 qualified prospective studies, older vigorous and likely transitional frail individuals seemed to benefit more from TC than did older frail individuals. The most commonly used TC parameters were Yang's style, with 12 or fewer forms, durations of 12 weeks or longer, frequencies of twice a week or more, and session lengths of at least 45 minutes. The most common outcome measures observed were a combination of 2 to 5 of the following 10 measures (from most to least common): fear of falling, single-leg stance, posturography, rate of falling, flexibility, walking velocity, Berg Balance Scale, Timed up and Go, Functional Reach, and ankle and knee joint strength and range of motion. Improvements were reported in almost all of these measures.

Conclusions: This review indicates that TC may be an economic and effective exercise program for improving balance and balance confidence in older adults.

Key Words: exercise, falls, rehabilitation, traditional Chinese medicine

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INTRODUCTION

Tai chi (TC), a Chinese martial art and exercise system, has lately been recognized as an effective intervention for fall risk prevention among older people.[1-3] The term *tai chi* is the common English spelling of the martial art/exercise, but it is also spelled in the literature as "taiji," "taijiquan," "taichichuan," and "t'ai chi"; "taijiquan," the Chinese pinyin romanization, is the form most often found in scholarly social science literature. The Library of Congress and most university libraries also catalogue romanized Chinese with pinyin. We choose the popular romanization tai chi because it is the spelling most familiar to both clinicians and patients and is the standard rendition of the term in PubMed. Through slow, repetitive, and alternating movement of the legs with the knees slightly flexed, TC practitioners shift their body weight from one leg to the other in sequential, graceful movements that emphasize smooth trunk rotation and coordination between the body and extremities.[4,5] The literature reviewed in this article indicates that TC has been used to enhance postural control, especially for those suffering from complicated conditions with disruptions in their visual and somatosensory systems.[6,7] The practice of TC is thought to increase awareness of body alignment during movement by focusing on the placement of the feet, an upright position of the head and trunk, and the intentional, attentive body movement in the direction of the specific TC postures.[8] Furthermore, several scientific studies of TC have demonstrated improvements in lower extremity range of motion,[9] strength,[9] and proprioception,[10] as well as enhanced neuromuscular responses involved in controlling the ankle joint during perturbations[11] and in controlling stepping strategies of the swing leg during gait.[12]

In the last 2 decades, particularly since 2000, investigations have been conducted regarding the effectiveness of TC in improving balance in older people.[1-3] However, significant differences among these studies in terms of the selection of subjects, appropriate TC exercise parameters, and outcome measures challenge interpretation of TC effectiveness and indicate a need for more standardized assessment procedures. The purpose of this systematic review is to identify the types of older adults who could benefit the most from practicing TC, the most appropriate TC protocol (in terms of TC style, number of forms, duration, frequency, and time length of sessions) for improving balance, and the balance parameters that TC could improve in terms of balance measurements.

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METHODS

Data Sources and Searches

Ovid Medline and PubMed were used to identify articles published since January 2000 that were written in English and contained the key words tai chi, tai ji, tai chi quan, tai ji quan, "balance", "falls", and "falling." The year 2000 is a somewhat arbitrary but significant benchmark for beginning this review. Although several health-related scholarly articles appeared on TC prior to that year, the literature increases in both scope and number after 2000. For example, from 1980 to 1999, a PubMed search finds 29 articles with the term tai chi in their titles. From 2000 to 2007, 181 articles appear with tai chi in their titles.

Study Selection

The following inclusion criteria were used to select previously published studies: (1) must be longitudinal study, including randomized controlled trials, quasirandomized trials, and preintervention and postintervention analyses; (2) TC had to be one of the interventions investigated; (3) the subjects had to be 60 years or older; and (4) outcomes measured included one or a combination of strength, balance, activity performance, fear of falling, and rate of falling. All of these studies were first screened by one of the authors (H.L.) before further data extraction by both authors (H.L. and A.F.).

Quality Assessment

The quality of selected articles was ensured using the following criteria: (1) subjects were randomly selected; (2) no population group with a mixture of different ages (<60 years old and ≥60 years old) was presented in the study; (3) in the randomized controlled trials and quasirandomized trials, the groups had similar baseline characteristics and equal opportunity to receive the interventions; (4) outcomes were assessed blindly; and (5) statistical methods were applied appropriately.

Data Analysis

All data were extracted by the 2 authors and summarized with an analysis of the information presented from each study (Table 1). The analysis focused on 3 categories: recruited subjects and their functional status, parameters of TC intervention (style, forms, duration, frequency, and session length), and outcome measurement (balance, functional performance, lower extremity strength, fear of falling, and rate of falling).

RESULTS

From January 2000 to July 2007, 18 studies (with 20 articles published), including 15 controlled studies and 3 pretest and posttest (within subjects) studies, met selection criteria (Table 1).

Who Can Benefit from TC?

Tai chi could be practiced by older people (Table 1) who live independently in a community[11-13,16-19,22,24,25,28,29] or in senior living facilities (congregated housing, retirement centers, and/or assisted living facilities)[14,15,20-22,26] or in nursing homes.[15,30] However, the ability of TC to improve balance seems to be based on the subjects' functional status. Speechley and Tinetti[31] proposed 9 frail attributes (age > 80, abnormal gait/balance, infrequent [<1/wk] walking activity for exercise, decreased shoulder strength, decreased knee strength, lower extremity disability, depression, taking sedatives, and near-vision loss) and 4 vigorous attributes (age < 80, intact cognition, frequent exercise, and good near-vision) for the assessment of functional status. *Vigorous* is defined as possessing at least 3 vigorous attributes and fewer than 2 frail attributes; *frail* is defined as possessing a minimum of 4 frail attributes and fewer than 1 vigorous attribute. *Transitional frail* is defined as possessing attributes between the vigorous and the frail. With these definitions in mind, we evaluated all selected studies and found that, based on the subject selection criteria among these studies, subjects in 4 studies[22-24,26] could be categorized with Speechley and Tinetti's definition. Among these 4 studies, balance improvement was identified in subjects with a vigorous status[23,24] or with a transitional frail status.[22,26] Also, using this categorization, Wolf et al[26] reported that TC did not decrease the risk ratio of falling in older people who were transitional frail prior to the study. When both the TC and the control groups contained both transitional frail and frail subjects, no significant difference could be identified in fall rate between the groups.[14,30]

Furthermore, Fried et al[32] developed another categorization of older people using 5 attributes (unintentional weight loss, weakness, exhaustion, slowness, and low physical activity) primarily based on Short Form 36 (SF-36) subscores to categorize them into frail (3 or more of 5 attributes), prefrail (1 or 2 of 5 attributes), and nonfrail (none of 5 attributes) phenotypes. During our review, we did not analyze the subjects in each reviewed study by using Fried et al's categorization, because the SF-36 scores were not available from these reviewed studies. However, using this categorization, Faber et al[15] reported that TC exercise has positive effects in regards to falling and physical performance in prefrail but not frail older people. The "frail" in Fried et al's categorization is not exactly the same as the frail in Speechley and Tinetti's categorization, but individuals in both categorizations with the lowest functional level are considered frail. Considering this evidence, improvement of balance and physical performance could be demonstrated among vigorous older people but remains a topic of debate among transitional frail subjects[26] and might not be apparent in frail older people.[15,30]

Whether or not a TC participant had to use an assistive ambulatory device during TC practice seemed to play a role in affecting the rate of falling and the fear of falling among the elderly[14,15,18,22,26,30] who were frail or transitional frail (prefrail), living either in senior living communities[14,18,22,26] or in nursing homes.[15,30] None of the studies in this review included wheelchair users or those who are unable to stand up during TC practice, although some TC learning books are available to these people.[33,34]

Table 1. Studies Meeting Inclusion Criteria for Analysis

Study	Method	Subjects	TC Styles & Forms	Duration/Frequency/Session Length
Gatts and Woollacott[11] Gatts and Woollacott[12]	RCT TC vs education on balance and stress	22 elderly (Berg ≤ 44) with history of operation on knee, hip, and back)	Yang, form undescribed	3 wk, 5 d/wk, 90 min/d
Audette et al[13]	Controlled trial TC vs brisk walking	19 community sedentary older women	Yang, 10 forms (note: 1-2 forms a week for 8 wk, then perform the whole 10 forms for 4 wk)	12 wk, 3 d/wk, 60 min/d (15-20 min warm-up, and then 40-45 min TC)
Choi et al[14]	Quasiexperimental TC vs routine daily activity	68 fall-prone older persons	Sun, 12 forms (music background)	12 wk, 3 d/w, 35 min/d (10 + 20 + 5)
Faber et al[15]	RCT TC vs functional walking	278 subjects from 15 nursing homes	Yang, 7 forms	20 wk, 1d/wk for 4 wk, then 2 d/wk for 16 wk, 90 min/d (30 for social activity and 60 for TC), then follow-up for 52 wk
Li et al[16] Li et al[17]	RCT TC vs stretching exercise	256 older physically inactive community dwellers	Yang, 24 forms	26 wk, 3 d/wk, 40-50 min/d
Lin et al[18]	Controlled TC vs education on fall prevention	1200 in 6 rural villages (finally 88 TC and 5 control)	Chen, 13 forms	52 wk, 6 d/wk, 60 min/d
Maciaszek et al[19]	RCT TC vs routine daily activity	49 older subjects with diagnosis of osteopenia or osteoporosis in community	Yang, 5 forms	18 wk, 2 d/wk, 45 min/d
Nnodim et al[20]	Controlled: TC vs combined balance and step training	213 older subjects from local senior centers	Yang, 12 forms	10 wk, 3 d/wk, 60 min/d
Richerson and Rosendale[21]	Pre-post	18 healthy elderly and adults with diabetes mellitus	Yang, 24 forms	26 wk, 1 d/wk, no session length mentioned
Sattin et al[22]	RCT TC vs wellness education	311 community residents	Yang, 6 forms	48 wk, 2 d/w, 60-90 min/d
Taggart et al[23]	Pre-post (case control)	Old women (>65 yr)	Yang, form undescribed	12 wk, 2 d/wk, 30 min/d
Tsang and Hui-Chan[24]	RCT TC vs general education	49 healthy older subjects	Wu (Ng), 108 forms	8 wk, 6 d/wk, 90 min/d. Practiced in morning time
Voukelatos et al[25]	RCT TC vs routine daily activity	702 older community dwellers	Mix of Yang and Sun, no standardized forms mentioned	16 wk, weekly, 60 min/d, then follow-up for 24 wk
Wolf et al[26]	RCT TC vs balance training vs wellness education	200 transitional frail	Yang, 6 forms	48 wk, 2 d/wk, 60-90 min/d, then follow-up for 4 mo
Wu and Keyes[27]	Pre-post	17 independent living elderly	Yang, form undescribed	15 wk, 3 d/wk, 60 min/d
Zhang et al[28]	RCT TC vs general daily activity	49 elderly community dwellers	Yang, 24 forms for practice with instructors and first 11 of the 24 forms for self-practice at home	8 wk, daily, no session length mentioned
Woo et al[29]	RCT TC vs resistant exercise vs no exercise at all	180 elderly in community center	Yang, 24 forms	12 mo, 2 d/wk, no session length mentioned
Nowalk et al[30]	RCT TC vs strength training and conditioning vs general education	110 elderly residents in independent living facilities and nursing homes	No description for style and form	3 d/wk, assessment every 6 mo for total 24 mo. No session length mentioned

Abbreviations: RCT, randomized controlled trial; TC, tai chi.

Styles of TC

The term "style" refers to sequences of TC movements generally differentiated by lineage names (Chen, Yang, Wu, etc). What is now known as Chen-style TC was the earliest TC, originating around the middle of the 16th century in China. The term TC or TC chuan (supreme ultimate boxing) does not appear in historical documents until the late 19th century, but the "internal" or "soft" martial art styles that adopted the name can be documented as early as the late 18th century.[35] Besides Chen style, there are 4 other styles of TC that are popular today (Yang, Wu, Sun, and Wu/Hao) and claim their origins in Chen style, though this is a matter of some debate among Chen-style practitioners.[4] It should be noted that "Wu/Hao" TC bears no relation to "Wu"-style TC. Wu, Wu, and Hao are family names, but the 2 Wus are represented by different Chinese characters.

Today, Yang style is the most popular style practiced by older populations.[11,13,15,16,19-23,25-29] Its characteristics are slow, large, graceful, sequential movements from one pose to the next with an upright posture and high stance position (knees bent slightly, less than 30°). Chen style[18,25,30] is ostensibly more "martial" in appearance. It requires a lower stance (knees bent more, around 30°-60°) that may require more energy expenditure during practice.[36] Chen also intersperses quick, explosive movements and stamping with slow movements,[5,36] which may explain why Chen style was not as common as Yang style for older populations in the studies reviewed.

Other styles were reported in our review studies: 1 for Sun style[14] and 1 for Wu style,[24] but no Wu/Hao style was reported. Almost all TC styles include slow and fast versions, weapons forms, and 2-person exercises. Slower forms are generally learned first and weapons and 2-person exercises added later. The Sun style features relatively fast hand and slow leg movements.[5] The Wu style set is slow, requiring internal power to maintain the trunk in a constant upright posture,[4] whereas the Wu/Hao style requires a high stance position (like Yang style) with relatively rapid execution of small movements.[5]

TC Forms

The term "form" refers to individual movements within those styles. Fourteen studies in this review reported the numbers of forms used by older people, as shown in Table 1. These numbers range from 5 forms[19] to 108 forms.[24] Within this range are styles that include 6 forms,[22,26] 7 forms,[15] 10 forms,[13] 12 forms,[14,20] 13 forms,[18] and 24 forms.[16,21,28,29] The 24-form Yang style was the most frequently reported. In 1956, the Chinese Sports Commission[4] adopted Yang Style to develop a simplified 24-form TC for ordinary Chinese to learn and practice. The 24 forms also gained popularity in competition. Many other shorter forms, most often based on the Yang style,[13,15,19,20,22,26] were adopted or modified for the research studies considered in this review. In most of these articles, the number of forms was selected on the basis of the subject's functional level. Healthy, functionally independent subjects could learn and practice 24 to 108 TC forms,[16,21,24,27,29] whereas those with lower functional levels might learn much shorter forms.[14,15,20,26] For example, subjects who were identified to be frail were provided only 6 forms[26] or 7 forms.[15] Only one study[26] referred to a pre-2000 research[37] that described specific forms practiced by older subjects but did not explain why the forms were selected.

Description of Interventions

The duration, frequency, and session length of TC exercise prescribed to older people for balance improvement varied among studies. As shown in Table 1, the range in duration stretched from 3 weeks[12] to 8 weeks,[24,28] 10 weeks,[20] 12 weeks,[13-15,23] 15 weeks,[27] 16 weeks,[25] 18 weeks,[19] 26 weeks,[16,21,30] 48 weeks,[22,26] 52 weeks,[18,29,30] and even 104 weeks (2 years).[30] The frequency of TC practice in these studies varied from once a week[15,21,25] to twice a week,[15,19,22,23,26,29] 3 times a week,[13,14,16,20,27,32] and 5 to 7 times a week.[11,18,24,28] The time length of each TC practice session ranged from 30 minutes[23] to 35 minutes,[14] 45 minutes,[19] 40 to 50 minutes,[16] 60 minutes,[13,18,20,25,27] 60 to 90 minutes,[22,26] and even 90 minutes.[11] In summary, most of the TC protocols required a duration of 12 weeks or more, with a frequency of at least 2 times a week and minimum of 45 minutes of TC session time.

Several points about the reviewed studies are notable. First, a few studies mentioned warm-up (5-20 minutes) and cooldown (5-10 minutes) times before and after TC practice. The w*arm-up* exercises included stretching, deep breathing,[27] range of motion (ROM) exercise in a seated position,[13,14] or social activity.[14] The cooldown exercises included ROM exercises, resting,[14] and social[2] or visualization exercises.[27]

Second, short duration (<12 weeks), high frequency (on daily basis), and long sessions (at least 60 minutes) were usually reserved for vigorous and/or transitional frail older subjects.[11,20,28] From the research under review, such protocols seem ill-suited for people who fatigue easily or are not able to stand for too long without assistance. Longer duration (12 weeks or more), lower frequency (2-3 times a week), and session length of 45 minutes or more were most commonly used for older adults, including older frail and transitional frail subjects.[13,15,16,19,22,26,27]

Third, the studies under review appeared to use 2 primary mechanisms to avoid fatigue and learning frustration: (1) provide enough warm-up time, rest intervals, and cooldown time to avoid fatigue and loss of interest;[13-15] and (2) provide time for discussion during warm-up or cooldown time.[28]

Fourth, some researchers agreed that a follow-up study may be necessary to investigate adherence to TC exercise after the period of training.[15,25,30]

Fifth, a study showed that it may take 5 minutes on average to complete the 24-form Yang style (no age restriction),[36] while an older individual may need 2 continuous minutes to complete a 6-form Yang TC without hesitating or stopping during performance.[26] However, no studies have reported how long (on average) a healthy older (≥65) individual needs to learn to perform these TC exercises independently.

Sixth, for assistive ambulatory device (AAD) users to practice TC, it may require 3 months to progress from dependence on an AAD to independence during the practice of TC.[26]

Outcomes of TC Intervention

Various measures were used to determine the effect of TC intervention, including measurements of static and dynamic balance, functional performance, muscle strength and flexibility, and subjective measures (Table 2). After TC practice, static balance has been measured with posturography, single-leg standing (SLS) time, and tandem stance time. The results from the measures seemed to be unclear. Some studies demonstrated significant improvements in static balance as measured by posturograph,[21,25,27] SLS time,[13,17,21.27,28] and tandem stance time.[20,25] However, other studies reported that such improvements were not identified in posturography[29] and SLS time,[14,20] and the improvement in tandem stance time after TC intervention was not better than with other balance exercise training.[20] Among these static balance measures, 3 studies[13,20,26] compared SLS time under the conditions of eyes open versus eyes closed. The results showed that TC improved the SLS time when the subjects' eyes were open but not when their eyes were closed.

Table 2. Outcome Measures Used in Studies Included in the Systematic Review

Static balance
1. Posturography: significantly improved with eyes open on a platform[21,25,27] and on a mat[25] but was not identified in other studies (on a platform).[23,29]
2. Single-leg stance: significantly improved,[13,17,21.27,28] but not in others.[14,20]
3. Tandem stance: improved,[20,25] but the improvement from TC practice was not better than with other balance exercise training.[20]
Anticipatory dynamic balance
1. Posturography: significantly improved.[10,19]
2. Functional reach.[16,17,26]
2. Functional reach.[16,17,26]
3. Stepping reaction time: improved.[25]
4. Berg Balance Scale: improved,[16,23] but not on a Berg component (turn and pick up an object from floor).[26]
5. Tinetti/Performance Oriented Mobility Assessment Balance Scale: improved.[18]
Functional performance
1. Performance-oriented mobility assessment[15]
2. Gait velocity: improved on one 1 study on a 50-ft (15.24-m) distance,[17] but not improved on others on a 8-m[29] or a 10-m[26,28] distance.
3. Improved maximal step length.[20]
4. Improved Timed Up & Go[17,27,30]
5. Chair rise: no difference compared with nonintervention group.[26]
6. Improved Tinetti Gait Scale.[16,18]
Muscle strength and flexibility
1. Strength improved on the knee[11,13] and the ankle[11,13,14] flexors and extensors, but not on gripping strength.[26]
2. Trunk flexibility by bending toward floor improved,[14,28] but not on another.[29]
Subjective measures
1. Fear of falling improved[14,17,22,23,27,28] but not on other studies.[18,26]
2. Groningen Activity Restriction Scale (for disability) improved.[15]
3. Rate of falling improved[17,25] but not on others.[14,15,18,20,26,29]
4. Time to first fall improved[25] but not on another study.[30]
Compared with other exercises
1. TC is significantly better than education on wellness[22,24] or on fall prevention.[11,18]
2. TC is also more effective for balance improvement than routine daily activity (nonintervention)[14,19,25,28,29,] or stretching.[17]
3. Balance improved but not significantly better than the resistance strengthening exercise,[29] functional balance training,[20] or walking.[13,15]
Abbreviation: TC, tai chi.

Dynamic balance improvement was not too contradictory. All measures of dynamic stance from the selected articles demonstrated significant improvement as examined by posturograph,[19,24] stepping reaction time,[25] maximal step length,[20] and the Functional Reach Test.[16,17,26] Measures of combined static and dynamic balance, such as the Tinetti Balance Scale[18] and the Berg Balance Scale, [16,17,23] demonstrated significant improvement as well. However, the Berg component of turning and picking up an object from floor did not improve.[26]

Researchers saw significantly improved performance on the Performance Oriented Mobility Assessment,[15] Timed Up and Go,[17,27,30] and Tinetti Gait Scale.[16-18] Gait velocity was reported significantly improved in 1 study[17] but not in others.[26,28,29] Also, no difference was found between the TC group and control group in a study that measured chair rise.[26]

Grip strength was reportedly not improved,[26] but significant increases in lower extremity muscle strength were reported for the knee[11] and ankle[11,14] flexors and extensors.[13] Significant improvement in trunk flexibility seen in bending over toward the floor was documented in 2 studies[14,28] but not in others.[29]

Subjective measures were conducted and significant improvements were revealed in fear of falling (measured with Falls Efficacy Scale or Activities-Specific Balance Confidence Scale),[14,17,22,23,27,28] rate (number) of falling (ROF),[17,25] time to first fall,[25] and self-reported health status (Groningen Activity Restriction Scale).[15] However, insignificant improvement was also reported in other studies in fear of falling,[18,26] ROF,[14,15,18,20,26,29] and time to first fall.[30] Taken together of these seemingly contradictory results, fear of falling improvement[14,17,22,23,27,28] was reported in more studies than the ROF.[17,25] In many studies, the ROF was not reported to be significantly improved at the end of the TC intervention[14,15,18,20,26,29] or at the 5-month follow-up after a 15-week TC intervention.[26]

Tai chi is a cost-effective intervention that requires no additional instruments or equipment.[13,15,20] As shown in Table 2, TC practice can result in improvements in many balance measures when compared with general education,[11,18,22,24] stretching,[17] and routine daily activity.[14,19,25,28,29] However, TC did not appear to be better than other physical therapy interventions, such as resistance strengthening,[29] functional balance training,[20] or functional walking.[13,15]

Quiet or Music Background

One study mentioned that a music background was used during TC practice.[14] However, TC is supposedly practiced with total concentration and inner calm that helps to sustain and maintain the circulation of "qi" (vital life energy in Chinese philosophy).[4] Sufficient and well-circulated qi is the basic mechanism to maintain the balance of "yin" (softness, darkness, weightlessness, and femininity) and "yang" (hardness, brightness, heaviness, and masculinity) inside the body as well as between the inner world and the outside environment.[4] So, during practice, practitioners may need to concentrate and feel each TC movement. On the basis of this, TC instructors generally eschew listening to music as a cue or reminder during performance of the exercise.

CONCLUSIONS

Based on the results summarized previously, many studies have demonstrated that performance on balance measures can be improved for older subjects by practicing TC. The benefits and general mechanism of how and why TC improves the quality of life for older adults have been well evaluated and reviewed by others.[1-3] In this review article, our discussion focused more on studies that reported unsuccessful progress in one or more balance measures after TC training. Explanations for these results might be attributed to the following areas: (1) subject categorization, (2) TC style and form selection, (3) selection of duration, frequency, and session length, and (4) use of background music. In other words, these 4 areas might need to be considered by clinicians before TC is provided.

In this review, results from 2 studies[15,26] (which used stratification to group subjects) indicated that older people in frailty did not typically benefit, in terms of performance on measures of balance, from TC. However, in other studies without stratification (subjects from the vigorous, transitional frail, and frail categories were mixed together), it was uncertain whether the results were significantly different between the TC group and the control group. Many of these studies demonstrated better results after TC practice,[11-13,15-17,19,20,21,25,27,29] but some showed no difference between TC practice and non-TC practice[18,20,28,29] in terms of static balance, fear of falling, and rate of falling. Because we were not able to determine how many subjects in each of these studies could be categorized as frail, it might be reasonable for us to inquire if the number of frail subjects in each of these studies could alter the final measured results.

As demonstrated in this review, the style most commonly used for older TC practitioners is Yang style, selected primarily because of its slow movements and the decreased physical demand during the movements. As of forms, 2 questions arise during form selection: (1) What is the appropriate number of forms? (2) What forms should be selected? Various numbers of TC forms, from short (5 forms[19]) to long (108 forms[24]), have been provided to the older population. For individuals with balance deficits and decreased memory ability, the short TC forms might be the best choice with which to begin. In terms of which forms should be selected, each individual TC form requires the practitioner to perform specific body movements that can vary widely between forms. Therefore, the TC providers' choice of forms might impact the subjects' abilities to benefit from TC. For example, some forms (such as the Parting Wild Horse's Mane form) may require more weight shifting and posture changes than other forms (such as the Cloud Hands form). As a result, it is possible that the forms selected for practice might affect the outcomes measured after TC training. It might also be necessary for TC providers to justify why certain TC forms (particularly the short forms) are selected.

In order to effectively provide TC as an exercise prescription, a clinician needs to consider which TC parameters are the most appropriate for older individuals. Short duration (<12 weeks) may be good for more functionally independent individuals, but it usually required increased frequency and session length.[12,24] Long duration with less frequency and less actual TC practice time might have favorable effects on those with a balance deficit.[26] The whole session time may include the warm-up, the actual TC time (including rest intervals), and cooldown.[13,14,27] Doing so may reduce fatigue and learning frustration as well as increase interest and ability to remember learned TC forms. Taken together, these results suggest that the selection of TC exercise parameters can likely affect the outcome measures after TC practice. Also, a regimen of 12 or fewer forms, a duration of 12 weeks or longer, a frequency of 2-3/wk, and a session length of at least 45 minutes might be an appropriate prescription for older people with balance deficits in the practice of TC.

The possible benefit or detriment of background music during TC is questionable. Use of music might affect the benefit of TC for subjects by interrupting the inner focus required during TC practice. Only 1 study[14] from our review reported the use of background music during TC practice, and it found no improvement in the outcome measures of SLS time, ankle strength, and rate of falling. We could not conclude whether the lack of improvement was a result of the background music, but use of music in TC is worthy of discussion and future research.

The 4 areas discussed previously could affect the outcome measures obtained after TC practice individually or in combination. However, the reviewed studies generally indicate that TC may be an economic, effective, and safe exercise program for balance training. Further research that incorporates more sophisticated research designs is necessary. To perform TC, one does not need additional exercise equipment but only a small open area.[4] The low (short forms) to moderate (long forms) intensity and slow movement of each form[4] may minimize energy consumption and risk of injury during performance. Although there are contradictory results, improvements have been reported by almost all of the reviewed longitudinal studies as measured by one or more of the following: balance, performance,

muscle strength, and/or subjective evaluations. Results also indicate that TC, commonly performed in groups, might be more beneficial to the vigorous and likely the transitional frail older adults. Older people in the frail category may need an individually designed exercise program rather than a group intervention, such as TC.[30]

For future studies, some factors that could affect the outcome measurements may need to be considered. These factors include the following: stratification based on frailty, validation of the specific TC style and forms selected, the specific mechanics of each TC form, the consistency among instructors in communicating the correct performance of the TC forms, assurance of the quality of movement in each form, use of light background music, and a longer term of follow-up after TC training.

REFERENCES

1. Kuramoto AM. Therapeutic benefits of Tai Chi exercise: research review. WMJ. 2006;105:42-46.
2. Verhagen AP, Immink M, van der Meulen A, Bierma-Zeinstra SM. The efficacy of Tai Chi Chuan in older adults: a systematic review. Fam Pract. 2004;21:107-113.
3. Wu G. Evaluation of the effectiveness of Tai Chi for improving balance and preventing falls in the older population—a review [Review]. J Am Geriatr Soc. 2002;50:746-754.
4. Sheng JZ, Gu LX, Fu ZW, et al. The Comprehensive Book of Tai Ji Quan. 2nd ed. Beijing, China: People Sports Press; 2006.
5. Bonifonte P. T'Ai Chi for Seniors: How to Gain Flexibility, Strength, and Inner Peace. Franklin Lakes, NJ: New Page Book; 2004.
6. Li YC, Wong AM, Chou SW, Tang FT, Wong PY. The effect of Tai Chi Chuan on postural stability in the elderly: preliminary report. Chang Gung Med J. 2000;23:197-204.
7. Wong AM, Lin YC, Chou SW, Tang FT, Wong PY. Coordination exercise and postural stability in elderly people: effect of Tai Chi Chuan. Arch Phys Med Rehabil. 2001;82:608-612.
8. Liao W. Tai Chi Classics. Boston, MA: Shambhala Publications, Inc; 1990.
9. Wu G, Liu W, Hill J, Millon D. Spatial, temporal and muscle action pattern of Tai Chi gait. J Electromyography Kinesiol. 2004;14:343-354.
10. Xu D, Hong Y, Li J, Chan K. Effect of Tai Chi exercise on proprioception of ankle and knee joints in old people. Br J Sports Med. 2004;38:50-54.
11. Gatts SK, Woollacott MH. Neural mechanisms underlying balance improvement with short-term Tai Chi training. Aging (Milano). 2006;18:7-19.
12. Gatts SK, Woollacott MH. How Tai Chi improves balance: biomechanics of recovery to a walking slip in impaired seniors. Gait Posture. 2007;25:205-214.
13. Audette JF, Jin YS, Newcomer R, Stein L, Duncan G, Frontera WA. Tai Chi versus brisk walking in elderly women. Age Ageing. 2006;35:388-393.
14. Choi JH, Moon JS, Song R. Effects of Sun-style Tai Chi exercise on physical fitness and fall prevention in fall-prone older adults. J Adv Nurs. 2005;51:150-157.
15. Faber MJ, Bosscher RJ, Chin AP, Marijke J, Van Wierngen PC. Effects of exercise programs on falls and mobility in frail and prefrail adults: a multicenter randomized controlled trial. Arch Phys Med Rehabil. 2006;87:885-896.
16. Li FZ, Harmer P, Fisher KJ, McAuley E. Tai Chi: improving functional balance and predicting subsequent falls in older persons. Med Sci Sports Ex. 2004;36:2046-2052.
17. Li FZ, Harmer P, Fisher KJ, et al. Tai Chi and fall reductions in older adults: a randomized controlled trial. J Gerontol Biol Sci Med Sci. 2005;60:187-194.
18. Lin MR, Hwang HF, Wang YW, Chang SH, Wolf SL. Community-based Tai Chi and its effect on injurious falls, balance, gait, and fear of falling in older people. Phys Ther. 2006;86:1189-1201.
19. Maciaszek J, Isiski W, Szeklicki R, Stemplewski R. Effect of Tai Chi on body balance: randomized controlled trial in men with osteopenia or osteoporosis. Am J Chinese Med. 2007;35:1-9.
20. Nnodim JO, Strasburg D, Nabozny M, et al. Dynamic balance and stepping versus Tai Chi training to improve balance and stepping in at-risk older adults. JAGS. 2006;54:1825-1831.
21. Richerson S, Rosendale K. Does Tai Chi improve plantar sensory ability? A pilot study. Diab Tech Thera. 2007;9:276-286.
22. Sattin RW, Easley KA, Wolf SL, Chen Y, Kutner MH. Reduction in fear of falling through intense Tai Chi exercise training in older transitional frail adults. JAGS. 2005;53:1168-1178.
23. Taggart HM. Effect of Tai Chi exercise on balance, functional mobility, and fear of falling among older women. Appl Nurs Res. 2002;15:235-242.
24. Tsang WWN, Hui-Chan CW. Effect of 4- and 8-week intensive Tai Chi training on balance control in the elderly. Med Sci Sports Ex. 2004;36:648-657.
25. Voukelatos A, Cumming RG, Lord SR, Rissel C. A randomized, controlled trail of Tai Chi for the prevention of falls: the central Sydney Tai Chi trial. JAGS. 2007;55:1185-1191.
26. Wolf SL, Barnhart HX, Kutner NG, McNeely E, Coogler C, Xu TS. Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training. JAGS. 2003;51:1794-1803.
27. Wu G, Keyes LM. Group tele-exercise for improving balance in elders. Telemed J E Health. 2006;12:561-570.
28. Zhang JG, Ishikawa-Takata K, Yamazaki H, Morita T, Ohta T. The effects of Tai Chi Chuan on physiological function and fear of falling in the less robust elderly: an intervention study for preventing falls. Arch Gerontol Geriatr. 2006;42:107-116.
29. Woo J, Hong A, Lau E, Lynn H. A randomized controlled trial of Tai Chi and resistant exercise on bone health, muscle strength and balance in community-living elderly people. Age Ageing. 2007;36:262-268.
30. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. JAGS. 1991;39:46-52.
31. Fried LP, Tangen CM, Walston J, et al; Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56(3):M146-M156.
32. Nowalk MP, Prendergast JM, Bayles CM, D'Amico FJ, Colvin GC. A randomized trial of exercise program among older individuals living in two long-term care facilities: the FallsFree program. JAGS. 2001;49:859-865.
33. Quarta C. T'ai Chi in A Chair: Easy 15-Minute Routines for Beginners. Gloucester, MA: Fair Winds Press; 2001.
34. Colon D. Senior's Tai Chi Workout: Improve Balance, Strength and Flexibility. Victoria, BC, Canada: Trafford Publishing; 2006.
35. Wile D. Lost T'ai-chi Classics from the Late Ch'ing Dynasty. Albany, NY: State University of New York Press; 1996.
36. Li JX, Hong Y, Chan KM. Tai Chi: physiological characteristics and beneficial effects on health. Br J Sports Med. 2001;35:148-156.
37. Wolf SL, McNeely E, Coogler CE, et al.Exploring the basis for Tai Chi Quan as a therapeutic exercise approach. Arch Phys Med Rehabil. 78:886-892; 1997.