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The Effect of Taiji (T'ai Chi)/Qigong (Ch'i Kung) on Balance in Older Adults

ABSTRACT

Background: The authors' objectives were to determine the effect of a six month Taiji and Qigong (TQ) intervention on the functional balance of healthy older adults, and to explore mechanisms for improvements in balance afforded by TQ training.

Methods: Sixty-eight healthy older adults (mean age 79.5, std. dev. = 8.3) were randomly and selectively assigned to participate in TQ training, or to a wait-list control (WC) group. TQ training consisted of a one-hour session three times per week for six months. Measurements were performed at baseline (T0), two months, (T2), and at the conclusion of the six month intervention (T6). Primary outcome measures included functional balance measures, sensory organization test (SOT) from computerized dynamic posturography, and chair stands (a measure of lower body strength). Secondary outcome measures included stance width in normal comfortable stance and Fall Efficacy Scale (FES) and Activities-Specific Balance Confidence (ABC) scale efficacy instruments.

Results: After two months, significant TQ training effects were observed in lower body strength (+12%, $P = .021$), single leg stance with eyes open (+83%, $P = .002$) and stance width (+22%, $P = .046$). The TQ effects for SOT vestibular function approached significance at two months and were significant at six months (+51%, $P = .03$).

No TQ effect was observed for visual SOT scores or gait speed measures. Pre-intervention scores for both TQ and WC groups were near the ceiling for SOT somatosensory, Berg Balance Scale (BBS), and efficacy instruments, thus these measures were ineffective for evaluating the healthy subject population.

Conclusions: A short (two month) intervention of moderate training frequency using traditional TQ curriculum, ie, including standing and sitting meditation, is effective in improving the functional balance of healthy older adults. Increased lower body strength, improved use of vestibular input, and wider stances are three mechanisms by which TQ training may improve postural control. Further study is needed to evaluate other balance mechanisms, and the individual and combined effects of different aspects of traditional Taiji practice.

INTRODUCTION

Taiji is an ancient art that is a fusion of Chinese philosophy and martial and healing arts which has received increasing attention within both the public and scientific communities. Because the art is a holistic form of exercise that is purportedly designed to improve, among other things, postural control and balance, strength, coordination, agility, reaction time, and flexibility, the western culture has increasingly embraced these nontraditional forms of exercise and medical treatment.[1] Additionally, Taiji is safe and inexpensive, and its slow and gentle movements make it especially well-suited to the elderly. While a preponderance of scientific evidence is gathering that Taiji practice is widely beneficial, authors of recent review articles note that limitations or biases exist in most studies.[2] Largely because of experimental and methodological limitations in existing literature, review authors generally cautiously conclude that there is limited, and sometimes contradictory, evidence that Taiji is effective in improving balance and reducing falls.[3-5] Also, though several Taiji studies have evaluated balance measures, few have investigated the mechanisms by which Taiji may improve balance.

Our study combined multiple measures of functional balance and physical performance with laboratory platform measures in an attempt to simultaneously evaluate both functional balance and balance mechanisms in healthy older adults. We hypothesized that TQ training would improve functional balance and efficacy, though because of TQ's emphasis on relaxation improvements in functional balance it would not manifest in normal gait speed measures. We further hypothesized that mechanisms for functional balance improvements include increased lower body strength, improved ability to effectively use somatosensory and vestibular perceptual information, and the adoption of wider normal stance widths. To model a practical intervention for older adults the frequency of the TQ intervention was intentionally planned as moderate, with repeated measures performed to evaluate the onset of observable benefits.

METHODS

Study Design

This study was a prospective, controlled clinical trial with two groups: TQ and WC. Outcome variables were measured three times during the intervention: at baseline (T0), two months (T2), and at the conclusion of the intervention at six months (T6).

Data collectors were blind to intervention assignment. After initial screening, eligible participants were randomized or placed into TQ and WC groups. All participants in the WC group were asked to continue their normal activity level. After the intervention study, the control group was offered the same training as received by the treatment group during the study. The Institutional Review Board at the University of Illinois (UI) at Urbana-Champaign approved the research protocol.

Subject Recruitment, Group Assignment, and Participation

Participants were recruited by announcement of the study in a weekly newsletter for employees at UI and through presentations by researchers at three Illinois senior living facilities in Champaign, Savoy, and Urbana. To be eligible, subjects had to be 60 years of age or older.

Ninety participants signed personal consent forms and provided physician consent forms to enter the screening and baseline testing. A registered nurse conducted the health screening. All were initially evaluated using the following screening methods: Health Screening by the Kinesiology Department at UI, Berg Balance Score, and Mini Mental Status.[6-7] Exclusion criteria were Berg Balance score <40, history of neurological disorders such as Parkinson's disease or stroke, cognitive impairment, use of specific medications known to impair balance or strength, and nonconsent of a physician.

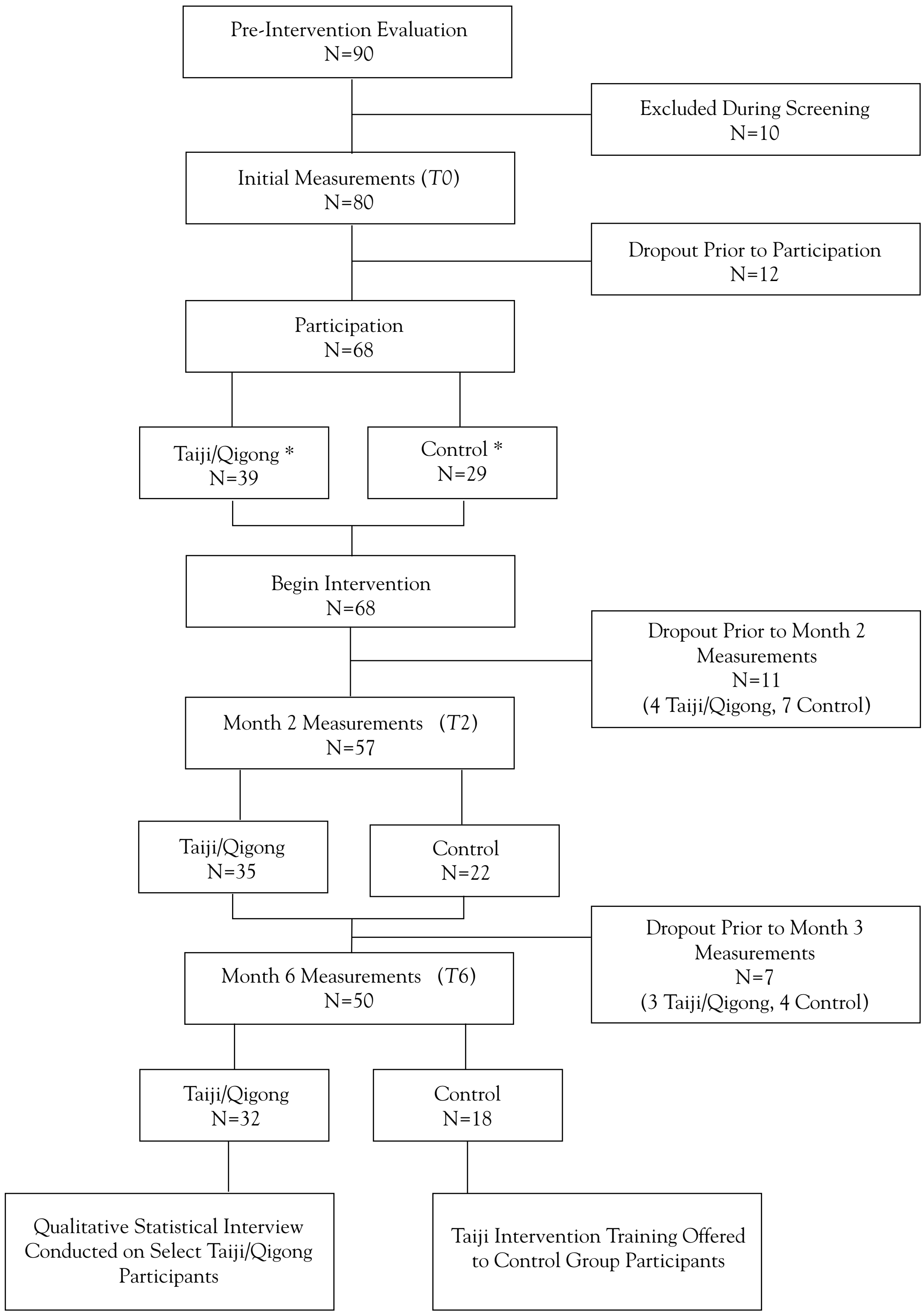
Of the 90 participants, 68 were assigned to either TQ or WC. A higher dropout rate for the TQ group was anticipated because it was assumed that some would leave the study due to disinterest, dislike, or perceived difficulty of the exercise; therefore, a greater number of participants were initially assigned to the TQ group. Forty-nine participants were randomized by a random permutation into TQ (N=39) and WC (N=16) groups. An additional 19 participants were placed in TQ (N=6) or WC (N=13) due to choice, scheduling or convenience.

Table 1 summarizes baseline demographics by group, and Figure 1 is a flowchart illustrating group assignment and participation. Eleven participants dropped out during the first two month intervention (four in TQ, seven in WC); nine due to poor health and two due to lack of interest. During the last four months of the intervention, seven participants dropped out from the study (three in TQ, four in WC); four due to health problems, two due to loss of interest, and one due to family responsibility. Those who left the study were contacted by the instructor staff and, if the reason for dropping was lack of interest, the participant was gently solicited to return. In every instance, those who dropped due to lack of interest retained their original decision and did not elect to return to the study.

Table 1. Baseline Characteristics by Group

Demographic	Taiji/Qigong	Wait/Control
N of Cases	39	29
N of Females (%)	32 (82%)	20 (69%)
Minimum age	60	67
Maximum age	97	94
Median age	82	81
Mean age (std. dev.)	79.6 (8.8)	79.3 (7.6)
N of community dwellers (%)	10 (26%)	6 (21%)
N of retirement center dwellers (%)	29 (74%)	23 (79%)
Berg Balance Score (std. dev.)	52 (4.2)	50.9 (4.6)
Mini Mental Status (std. dev.)	8.31 (0.57)	8.52 (0.83)

Figure 1. Flowchart depicting intervention screening, group assignment, and participation



*Forty-nine participants were randomized by a random permutation into TQ (N=39) and WC (N=16) groups. An additional 19 participants were placed in TQ (N=6) or WC (N=13) due to choice, scheduling or convenience.

Intervention

The curriculum was designed and taught by a nationally-recognized TQ instructor with more than 30 years traditional training and 20 years teaching experience both in China and the US. The instructor was also the principle investigator. Previous experience garnered from a pilot study on healthy older adults aided in the design of the intervention.

Classes were held at each of the three senior living centers from where participants were recruited and the instructor was assisted by one teaching assistant at each location. All three assistants were students of the instructor with a minimum of five years of practice. The TQ training consisted of a one-hour session three times per week for six months. The control group was asked not to modify their daily activities.

Design of Intervention Instruction

A complete traditional curriculum for Taiji training includes three fundamental and interrelated components: qigong, form, and push-hands.[1] Qigong can be thought of as deep breathing and/or meditative body/mind/spirit exercises, the roots of which can be traced to the middle of the first millennium BC in China, and even earlier if considering the vast antiquity of Yogic physiologic disciplines which influenced the philosophical, religious, and physiological foundations of Chinese thought.[8] Although such meditative exercise can be static or dynamic, and performed either standing, sitting or lying down, the most fundamental, and therefore most important, of all Qigong exercises are the sitting and standing meditations.[1] Indeed, the standing meditation is traditionally called "standing pole," and the Taiji form practice is called "moving standing pole." While forms are the specific movements that most people associate with Taiji and are themselves one type of Qigong, many famous sayings from the written and oral tradition of the Chinese internal martial arts pointedly counsel that standing meditation is the beginning point for efficient Taiji practice.

Push-hands can be thought of as further extension of form—taking form to the level of partner interaction in order to increase the number of variables/level of difficulty/level of skill in the cultivation of balance under more challenging conditions. It is from there that one is ready for the freestyle engagement of self-defense applications. Although push-hands can be practiced by, and is beneficial to, persons of any age, its practice generally requires a baseline development of skill and understanding and, it was, therefore, not included in this short-term intervention study.

Qigong Instruction

Qigong training was comprised primarily of static standing and sitting meditation exercises but also included practice of two traditional moving exercises called "Lower the Qi and Cleanse Internally" and "Heaven and Earth Open and Close."

In general, sitting meditation is physically easier than standing meditation. During the first week of the intervention, the participants only learned and practiced sitting medication. The standing meditation was added to the curriculum starting in the second week. The duration of sitting and standing Qigong meditation practice gradually increased from five minutes per session at the beginning of the intervention to 15 minutes each by the middle of the third month. From the beginning of the fourth month to the end of the intervention, participants practiced one session of 10 minutes sitting meditation and two sessions of 10 minutes standing during each one-hour class.

Taiji Form Instruction

A seven-movement Taiji form was distilled from the 48-movement form of the Chen style. Chen-style Taiji was used in the intervention as the instructor specializes in this style, but any style can be used as all have the same basic principles of movement. The routine included the following movements:

- "Preparatory Form" (raise arms shoulder high)
- "Lazy about Tying Coat"
- "White Crane Spread Its Wings"
- "Step Back and Whirl Arms on Both Sides"
- "Part the Horse's Mane"
- "Wave Hands Through Clouds"
- "Closing Form"

A single-form movement, called "Golden Cock Stands on One Leg," was also practiced separately for strength and balance training.

These form movements were chosen to focus on basic mobility skills: weight shifting to both sides (stepping and pivoting forward, backward, sideways, and diagonally), range of motion (emphasis on spinal rotation to both sides, bilateral upper extremity elevation and reaching forward, backward, and sideways), and coordination. They were also selected for their adaptability and their overall accessibility. Exact stance width, foot placement and arm motions were easily adapted for individual limitations, and the movements were challenging yet attainable by the seniors.

Each form was broken down into components that could be taught and practiced separately prior to being performed as part of a complete movement. The seven individual movements were then gradually connected by transitions until they could be executed continuously, from start to finish, by the end of the fourth month.

OUTCOME MEASURES

Balance Measures

Balance measures included a battery of functional balance tests and a standard laboratory platform measure of subjects' ability to utilize visual, vestibular, and somatosensory systems.

SINGLE LEG STANCE (SLS) has been one of the most frequently used measures of balance in physical training studies involving older adults.[9] The SLS is a relatively challenging task, and the length of time that a person can stand on one leg has been shown to strongly correlate with falls.[10,11] Each trial began with the participant's nonsupport foot leaving the ground and ended when the nonsupporting foot touched the ground or the participant lost balance. Each participant performed six trials (three trials on each leg) with eyes open and six trials with eyes closed.

The BERG BALANCE SCALE (BBS) consists of 14 distinct physical tasks that resemble activities of daily living, and is commonly used to assess balance performance in the elderly. As a few examples, participants were asked to "stand up from a seated position," "pick up an object from the floor from a standing position," and "stand unsupported with eyes closed." The tasks are completed in an order of increasing difficulty. Each of the tasks is graded on a scale of 0–4, for a maximum total score of 56.

The 8 FOOT UP AND GO is a measure of dynamic balance and is the total time required for the participants to rise from a seated position, walk eight feet (2.44 m), turn and return to a seated position.[12] Subjects were instructed to sit in the middle of a chair with back straight, feet flat on the floor, and hands on thighs. One foot should be slightly in front of the other, with the torso slightly leaning forward. On the signal "go" the participant is instructed to get up from the chair, walk as quickly as possible around either side of a cone placed eight feet away and sit back down in the chair. Two time measurements were recorded: total time and walk time. For total time, the timer was started on the signal "go" whether or not the participant actually started to move. For walk time, the timer was started when subjects began to take the first step. Both time measurements ended when the person sat back down on the chair. The procedure was demonstrated to the subject, and each subject was allowed to practice once. Following the practice, two test trials were administered.

GAIT SPEED was measured during three conditions: normal speed, fast speed, and while crossing over an obstacle. Two experimenters used stopwatches to measure the time in which the participants completed a seven meter walk under each of the conditions. The average of the two experimenters over the two trials was used as the outcome measure. For the normal speed and obstacle crossing tests, subjects were instructed to walk at a normal, comfortable speed, without running, and not to slow down until crossing the established finish line. The obstacle measured 30 cm high, 20 cm deep, and was placed across the entire 76 cm wide path. If subjects could not step over the obstacle, they were instructed to step around the obstacle and continue walking. For the fast speed measure, subjects were instructed to walk as fast as safely possible, without running.

The SENSORY ORGANIZATION TEST (SOT) EquiTest computerized dynamic posturography system (NeuroCom International, Clackamas, Ore) was used to evaluate the use of sensory information relevant for balance. This system consists of a force platform and visual surround, both of which can be stationary or sway-referenced (rotated in response to an individual's postural adjustments). By systematically altering visual information (via eye closure) and movement of the platform and visual surround, the device can assess an individual's ability to use information received by the somatosensory, visual and vestibular systems.

Standard protocol for administering the SOT was followed.[13] Participants wore a harness to prevent falls. The SOT includes six conditions:

1. Normal vision, fixed platform
2. Eyes closed, fixed platform
3. Vision sway-referenced, fixed platform
4. Normal vision, sway-referenced platform
5. Eyes closed, sway-referenced platform
6. Both vision and platform sway-referenced

Each trial lasts 20 seconds and is repeated three times. Sensory analysis scores are calculated from the averages of various conditions. The somatosensory ratio compares condition 2 to condition 1 and assesses postural stability when vision is removed. The visual ratio compares condition 4 to condition 1 and measures the ability of the visual system to function when somatosensory input is altered by sway-referencing.

The vestibular ratio compares condition 5 to condition 1 and assesses stability when both somatosensory and visual information have been altered by sway-referencing or eye closure, respectively.

The biomechanical measure of normal stance width was also evaluated as a potential strategic mechanism to improve balance performance. To measure *stance width*, participants were asked to walk barefoot onto a piece of white paper (24"x18") from a distance of four feet and take a comfortable stance. An examiner then traced the feet of the participants on the paper with an ink pen. The distance between the centers of the heels of the participant was later measured and recorded as the participant's stance width.

Efficacy

Fall efficacy was measured using the Fall Efficacy Scale (FES) which is a 10-item questionnaire that evaluates subjects' beliefs in their capabilities to carry out basic activities of daily living without falling.[14] The Activities-Specific Balance Confidence scale (ABC) studies a greater variety of behaviors than the FES and was also used. The ABC includes 15 questions, each of which is a measure of balance confidence on a level ranging from 0% (no confidence) to 100%.[15]

Lower Extremity Strength

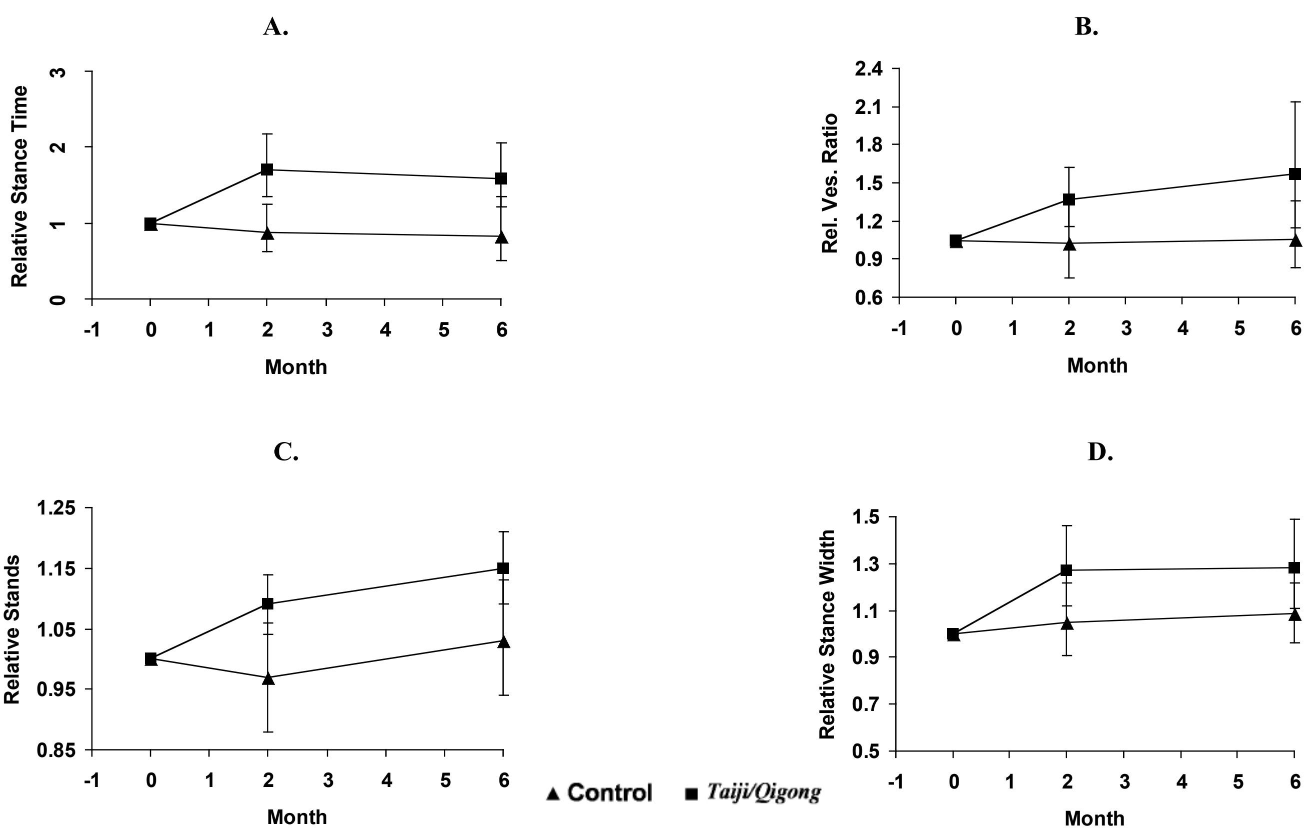
CHAIR STAND TEST (CST). The participants were asked to stand from a seated position as many times as possible in 30 seconds with arms folded across the chest. The number of full stands in 30 seconds counts as the core for this test. The CST has been shown to be a reliable and valid indicator of lower body strength in generally active, community-dwelling older adults.[16]

Statistical Hypothesis Tests

Categorical demographic data was analyzed using Fisher's Exact Test, and continuous demographic data was analyzed using the Welch unequal variance t-test, two-sided.

Outcome data was analyzed using intent to treat design (ie, all data points were used and subjects were not dropped due to missing data). Generalized Estimating Equations (GEE) were employed to compute all estimates of TQ effects. This method was selected because most of the measurements in this study are discrete binary or count data and/or are positive-definite of limited range with a nontrivial number of zero values. The GEE incorporates a transformation to linearity in the model rather than transforming the dependent variable, which is generally preferred. (Figure 2) The intent to treat analysis requires that

Figure 2. GEE model average relative performance for A) single leg stance time with eyes open, B) SOT vestibular ratio, C) chair stands, and D) stance width. Bars represent 95% CIs on predicted means.



all data be used, and GEE models can accommodate missing data provided the missing completely at random (MCAR) assumption is reasonable. The GEE model handles within-subject correlation well; GEE allows a model of covariance among repeated observations to increase the efficiency of parameter estimates. The standard errors are corrected for dependence. Bootstrapping was used for parameter estimates because the sample size of the study was modest. Several different recommended methods for computing the standard errors in the presence of heteroscedasticity were evaluated, and generally the answers obtained were very similar.

We used the subjects as their own controls and modeled their change from the baseline established in their first measurement occasion. This model is intermediate between a fully nonparametric subject-conditional model and a between-subjects parametric model because it asserts that a common distribution of relative outcomes exists conditional on a subject's initial measurement. To assess the goodness of fit of the model, we compared the concordance ρc of the predicted values to the original values, using established methods.[17] Concordance coefficients (ρc) are similar to Pearson correlation coefficients but are always smaller. The ρc values should be very close to Pearson correlation, otherwise the predicted values may differ systematically in mean and/or variance. The ρc statistics, along with the GEE model distributions and link functions, are summarized in Table 2. In general, the models fit the data quite well and examination of the Bland-Altman plots showed no major problems.

RESULTS

Demographic Data

No statistical differences were observed between groups at P =.05 in any of the categorical or continuous data in Table 1.

TQ Treatment Effects

Table 3 summarizes the GEE predicted performances for variables that showed either a statistically significant, or positive direction for, TQ effect. With the exposure models, it is always the case that the predicted group means at T0 are the same. When only group and time variables are included this value is 1. When a covariate is included, the T0 value will be a bit different from 1 but still equal between groups. Because the link functions are logs or logits in all models, the improvement is in percent change. Thus, a coefficient of 1.25 indicates that the subject is predicted to have a 25% improvement over baseline.

The TQ effect for single leg stance with eyes open (SLSO), chair stands, and stance width was significant at two months. We saw no difference between single leg stance times on right or left legs with eyes open; therefore, SLSO was analyzed as the combined average scores of both left- and right-leg stance times. The TQ effect size at T2 for SLSO is large (83% improvement relative to the WC group), and was maintained at T6 (77% improvement relative to WC). No improvements were seen at T2 in single leg stance time with eyes closed (SLSC), but the TQ effect at T6 approached significance (+29%, P = .054) for eyes closed stance on the right foot. For chair stands, TQ practitioners exhibited at 12% improvement relative to WC at both T2 and T6. On average, TQ practitioners also adopted a wider stance at T2 (+22%, P = .046), and the increased stance widths were maintained at T6, though the estimated statistical significance of the between groups comparison was nominally decreased at T6 (+21%, P = .059).

The TQ effect for SOT vestibular ratio scores was nearly significant at T2 (+35%, P = .085) and was significant at six months (+51%, P = .035). No changes were observed in SOT visual or somatosensory ratio scores. One noteworthy problem occurred during the SOT measurements. After initiating Month 6 SOT measures, it was discovered that two of the four sensors were not working properly on the Equitest postural platform. A total of seven WC (39%) and 10 TQ (31%) group participants were tested twice during month 6 measurements, before and after the platform was fixed. The occurrence of double testing was a significant covariate in the vestibular ratio model (P = .025), indicative of learning during the retesting.

No between-group differences were observed in any of the gait speed measures. Several pre-intervention scores were near the ceiling, indicating that the measures were insensitive for the healthy subject population. While the maximum possible score for the BBS is 56, the initial mean ± SD scores were 52.0 ± 4.2 and 50.9 ± 4.6 for TQ and WC groups, respectively. Similarly, the maximum FES score is 10, and our initial mean ± SD scores were 9.6 ± 0.5 and 9.4 ± 0.9 for TQ and WC groups, respectively. Initial ABC scores were also close to the maximum of 100 for that measure. The initial mean ± SD ABC scores were 86.0 ± 11 and 82 ± 13 for TQ and WC groups, respectively. Finally, the maximum SOT somatosensory ratio score is 100, and the mean and standard deviation somatosensory ratio scores across all groups and times was 97.2 (3.1).

Table 2. Distributions, Link Functions, and Goodness of Fit Results for GEE Models

Variable	Family	Link	ρ_c	ρ_c/r*
Chair stand	Poisson	Log	0.92	1.0
Single leg stance – eyes open	Gamma	Log	0.80	1.0
Single leg stance – eyes closed	Gamma	Log	0.78	0.95
Loss of balance – SOT conditions 5 & 6	Binomial	Logit	0.67	0.86
SOT vestibular ratio	Gamma	Log	0.62	0.93
Stance width	Gamma	Log	0.63	0.99

* Ratio of concordance to Pearson correlation coefficient.

Table 3. GEE Summary Statistics

	GEE Mean Predicted Performances and 95% Confidence Intervals							
	Wait/Control Month			Taiji/Qigong Month			TQ Effect *P* Month	
Variable	0	2	6	0	2	6	2	6
Single Leg Stance eyes open	1 [1, 1]	0.88 [0.63, 1.25]	0.82 [0.50, 1.34]	1.00 [1, 1]	1.71 [1.35, 2.16]	1.59 [1.22, 2.07]	.002	.020
Right Leg Stance eyes closed	1 [1, 1]	1.1 [0.94, 1.23]	0.94 [0.76, 1.15]	1 [1, 1]	1 [0.89, 1.12]	1.22 [1.11, 1.35]	.41	.054
SOT vestibular ratio *	1.04 [1.00, 1.07]	1.02 [0.75, 1.37]	1.06 [0.83, 1.36]	1.04 [1.00, 1.07]	1.37 [1.16, 1.62]	1.57 [1.15, 2.14]	.085	.030
Chair stand	1 [1, 1]	0.97 [0.88, 1.06]	1.03 [0.94, 1.13]	1 [1, 1]	1.09 [1.04, 1.14]	1.15 [1.09, 1.21]	.021	.048
Stance width	1 [1, 1]	1.05 [0.91, 1.22]	1.08 [0.96, 1.23]	1 [1, 1]	1.27 [1.12, 1.45]	1.29 [1.13, 1.47]	.046	.059

* Models were corrected using a covariate for the occurrence of double testing at month 6 due to mechanical failure.

SUMMARY AND DISCUSSION

Functional Balance

Two months of TQ training of moderate frequency (three one-hour sessions per week) was found to be sufficient for healthy older adults to realize significant improvements in functional balance, as determined with the comparatively challenging single leg stance measure. The BBS was an insufficiently challenging functional balance measure for the healthy older adult subject population. Though our initial hypothesis was that TQ training would increase fast and obstacle gait crossing speed, we saw no changes in any of the gait speed measures. We suspect that the walking distance for the fast gait measures (maximum seven meters) may have been too short for improvements in balance and strength afforded by TQ practice to manifest in gait speed.

Balance Mechanisms

Strength and the ability to utilize somatosensory, vestibular, and visual perceptual information are balance and fall risk factors. Concurrent with improvements in functional balance, we found that TQ practice improves lower body strength and the subjects' ability to utilize vestibular information. Our findings on the improvements in vestibular function are consistent with earlier cross-sectional and longitudinal studies.[18] Because TQ appears to improve the ability to utilize vestibular input, it may be a viable intervention component for medically stable persons with central and stable peripheral vestibular disorders. It is worthwhile to note that, similar to our study, the initial SOT somatosensory ratio scores in other studies were near the ceiling for Taiji and control groups, thus rendering the measure ineffective.[18,19] This observation is consistent with others that reported, "the first three conditions of the SOT protocol seem to lack the sensitivity to detect differences between older adults who do not have underlying pathology."[20] The SOT test uses mild to moderate perturbations; therefore, proprioceptor usage may be better measured in a more challenging activity when demand is higher. Taiji practice emphasizes and prizes awareness of body structure and efficiency of movement; therefore, one would expect improved sensitivity to somatosensory information to also be a mechanism of improved balance. One randomized controlled trial on healthy younger subjects did find that Taiji practice improved kinesthetic sense of the glenohumeral joint at 60°, and another nonrandomized study reported that Taiji improved arm control in older subjects.[21,22]

To our knowledge, the potential effect of TQ practice on biomechanical quiet stance factors has not yet been reported. Lateral stability has been found to increase with stance width; therefore, our findings suggest that the wider stance widths adopted by TQ practitioners may be a strategic mechanism for postural control. Wider stance widths also appear to associate with decreased postural effort, and reduced effort control is consistent with the emphasis on relaxation in TQ practice.[23-26]

Balance and Fall Efficacy

As with the BBS, the pre-intervention FES and ABC efficacy questionnaire scores for both WC and TQ were too high to measure potential improvements within or between groups with the small sample size of this study. Scale usage errors are a general problem with self-rated tests. A participant well summarizes potential scale usage error in the efficacy questionnaires: "I know that I said I was quite confident before the study began, but after practicing Taiji I really feel much more confident." Qualitative studies would be valuable for elucidating themes, such as relative confidence, which are sometimes difficult to measure quantitatively.

TQ Intervention Curriculum

While we strongly believe that the mental exercises of memorizing choreography and instilling new motor programs are important aspects of Taiji practice, it is noted that the choreography of the seven-movement Taiji form taught to the intervention participants was not learned until the end of the fourth month. Therefore, improvements in lower body strength, balance, and vestibular function do not appear to be a function of the length of form choreography. In other words, it is not important whether 8–12–24 or 106 movement forms are taught in an intervention (indeed, longer forms may discourage older adults and decrease participation). Further, in accordance with oral and written teachings of the internal martial arts tradition of China, we suspect that the inclusion of standing and sitting Qigong meditation exercises is important for efficient practice and contributed significantly to the observed benefits in the current study after only two months of practice. Both sitting and standing mediations are "mind-body" integrative exercises and, therefore, may be important in increasing attention to postural movements, enhancing neural mechanisms for improved balance and strengthening core musculature, upon which the mechanics of Taiji movement fundamentally rely.

Limitations and Suggested Further Studies

Group assignment was not purely randomized; 19 of the 68 participants were allowed to choose group participation. Analyses of the purely randomized groups is reported elsewhere.[27] Also, resources were not available to simultaneously provide attention/education to the control group. Such attention would control for nonspecific effects, such as socialization or exercise obtained from simply getting to the weekly classes. However, because the subject population was healthy older adults with relatively high functional balance skills, an attention/education intervention is not expected to significantly influence the sensory organization or biomechanical measures used in this study on a group scale. Lastly, only one principal instructor was used for the intervention, and this instructor was highly trained. The effects of the instructor can, therefore, not be separated from the effects of the intervention, and it is not known whether similar benefits can be realized, in magnitude or time, if instruction is provided by less qualified instructors.

Future studies should evaluate additional mechanisms by which TQ may afford improved postural stability. One important, yet unexamined, potential mechanism for improved postural stability is increased core strength. Taiji movement (as well as sitting and standing meditation) fundamentally relies upon and exercises core strength, and core strength is essential for postural stability. Such studies, however, are hindered by the lack of effective measures of core strength.[28]

Taiji is a "mind-body" integrative exercise that emphasizes neuromuscular control. Two studies have demonstrated evidence of neural mechanisms for improved postural stability from Taiji practice, including enhanced neuromuscular control of muscles controlling the ankle joint and improved force control in knee extensors.[29,30] Systematic study of neuromuscular activity during Taiji and Qigong practice is needed to fully understand the effect of Taiji on the integration of mind and body.

Lastly, traditional Taiji practice consists of several different components, including standing and sitting Qigong meditation. Further study is needed to understand the individual and combined benefits of these different aspects of Taiji practice.

Conclusions

Two months of moderate TQ training is sufficient to improve functional balance in healthy older adults. Increases in lower body strength and stance widths, along with the ability to utilize vestibular information, all contribute to improved postural stability in TQ practitioners.

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This research was conducted while the principal author was a pre-doctoral trainee in the Department of Kinesiology and Community Health, University of Illinois Urbana-Champaign, and while the second author was a pre-doctoral trainee in the Quantitative Methods Program at the Department of Psychology, University of Illinois Urbana-Champaign. The research was supported in part by a grant from the University of Illinois Research Board, and by a NIMH, National Research Service Award, No. MH14257, to the University of Illinois.

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