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ORIGINAL ARTICLE

Effect of Tai Chi on Physical Function, Fall Rates and Quality of Life Among Older Stroke Survivors

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Abstract

Objective: To examine the effect of a 12-week Tai Chi (TC) intervention on physical function and quality of life.

Design: Single-blind, randomized controlled trial.

Setting: General community.

Participants: Community-dwelling survivors of stroke (N=145; 47% women; mean age, 70y; time poststroke: 3y; ischemic stroke: 66%; hemiparesis: 73%) who were aged ≥50 years and were ≥3 months poststroke.

Interventions: Yang style 24-posture short-form TC (n=53), strength and range of movement exercises (SS) (n=44), or usual care (UC) (n=48) for 12 weeks. The TC and SS groups attended a 1-hour class 3 times per week, whereas the UC group had weekly phone calls.

Main Outcome Measures: Physical function: Short Physical Performance Battery, fall rates, and 2-minute step test; quality of life: Medical Outcomes Study 36-Item Short-Form Health Survey, Center for Epidemiologic Studies Depression Scale, and Pittsburgh Sleep Quality Index.

Results: During the intervention, TC participants had two thirds fewer falls (5 falls) than the SS (14 falls) and UC (15 falls) groups ($\chi^2=5.6$, $P=.06$). There was a significant group by time interaction for the 2-minute step test ($F_{2,142}=4.69$, $P<.01$). Post hoc tests indicated that the TC ($t_{53}=2.45$, $P=.02$) and SS ($t_{44}=4.63$, $P<.01$) groups had significantly better aerobic endurance over time, though not in the UC group ($t_{48}=1.58$, $P=.12$). Intervention adherence rates were 85%.

Conclusions: TC and SS led to improved aerobic endurance, and both are suitable community-based programs that may aid in stroke recovery and community reintegration. Our data suggest that a 12-week TC intervention was more effective in reducing fall rates than SS or UC interventions. Future studies examining the effectiveness of TC as a fall prevention strategy for community-dwelling survivors of stroke are recommended.

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Survivors of stroke often report poor physical function leading to significantly decreased quality of life.[1-4] After impairment as a result of stroke, gait and balance are essential components of physical function; they lead to a significantly increased risk of falling, nearly 7 times more than healthy adults of a similar age.[5-7] Regular physical activity has been shown to improve physical function, reduce fall rates, and improve quality of life.[8,9] Effective interventions for improving physical function and quality of life among survivors of stroke are critically needed.[10-12]

A growing body of evidence suggests that Tai Chi (TC) exercise leads to improved physical function, fewer falls, and better quality of life in healthy older adults.[13-16] The safety of TC has been established among adults with chronic diseases (eg, heart failure, fibromyalgia, Parkinson's disease),[17-19] including survivors of stroke.[20-23] However, the effectiveness of TC in improving physical function in survivors of stroke has not been adequately studied,[20,21] and there are no studies that have examined its effect on fall rates or quality of life. The objective of this study was to examine the effect of a 12-week TC exercise intervention on physical function, fall rates, and quality of life among a group of community-dwelling older stroke survivors compared with strength and range of movement (SS) exercise and usual care (UC).

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Methods

Design

This was a single-blind, 3-group randomized controlled trial conducted between January 2009 and December 2012.

Sample and setting

Community-dwelling survivors of stroke (aged ≥50y) who were at least 3 months poststroke and living in the greater Tucson, Arizona, area from all sex and racial/ethnic groups were eligible. Study approval was obtained from the Institutional Review Boards at the University of Arizona, HealthSouth, and Carondelet Health Network in Tucson. The investigation was conducting according to the principles delineated by the Declaration of Helsinki, which included ascertainment of the written informed consent of all subjects.

Recruitment, screening, and randomization

Details of the recruitment plan have been previously reported.[24] Briefly, potential participants were recruited from multiple sources, including radio and newspaper advertisements, flyers and brochures placed at outpatient rehabilitation centers, community centers, and physician offices. Participants were screened for safety and eligibility prior to study enrollment using standardized tests to assess functional disability (modified Rankin Scale),[25] overall physical function (Short Physical Performance Battery [SPPB]),[26] and cognitive impairment (Mini-Mental State Examination).[27] Ineligible survivors of stroke included those who had no disability (eg, no poststroke sequela), a severe disability (eg, bedridden and requiring constant nursing care), or a serious medical condition (eg, active cancer treatment) that would interfere with study participation. Participants were recruited over a 3-year period (January 2009−January 2012) in cohorts of 12 to 15 survivors of stroke. Participants were randomly assigned to TC, SilverSneakers (SS), or UC groups using simple randomization with allocation concealment.[22,28]

Interventions

Tai Chi

Participants assigned to the TC group attended a 1-hour class 3 times a week for 12 weeks. Over the 12 weeks, they gradually learned the Yang style 24-posture short-form developed by Fei,[29] which was taught at an outpatient rehabilitation center by a long-term TC practitioner with over 30 years of teaching experience. Participants were asked to replicate motions, postures, and speed of the instructor. Each class approximately consisted of a 10-minute warm-up period, 40 minutes of TC exercise, and a 10-minute cool-down period. Chairs were positioned in close proximity to the participants to allow for brief rest periods, and participants were allowed to use walkers and canes as needed throughout the class. Participants were monitored for safety by the instructor and study staff.

List of abbreviations:

CES-D	Center for Epidemiologic Studies Depression Scale
PSQI	Pittsburgh Sleep Quality Index
SF-36	Medical Outcomes Study 36-Item Short-Form Health Survey
SPPB	Short Physical Performance Battery
SS	SilverSneakers strength and range of movement exercises
TC	Tai Chi
UC	usual care

SilverSneakers

Participants assigned to the SS group attended a 1-hour class 3 times a week for 12 weeks. SilverSneakers is a national fitness program for older adults that offers different types of group-based exercise classes (eg, aerobics, strength and range of movement, water aerobics, yoga).[30] Muscular strength and range of movement classes were taught by a certified instructor at local community fitness centers. Each class approximately consisted of a 10-minute warm-up period, 40-minutes of SS exercise, and a 10-minute cool-down period. Some exercises were performed from a seated position. Chairs were positioned in close proximity to the participants to allow for brief rest periods, and participants were allowed to use walkers and canes as needed throughout the class. Participants were monitored for safety by the instructor and study staff.

Usual care

The UC group received written materials and resources for participating in community-based physical activity suitable for older adults, which they could contact on their own. In addition, they received a weekly phone call to inquire of their health status to provide individual attention.

Main outcome measures

Physical function

The SPPB is a brief performance battery specifically developed for older adults, including those with chronic diseases or disabilities, to assess balance, gait speed, and lower body strength.[26] Timed balance tests (up to 10s) with increasing levels of difficulty include a side-by-side stand, a semitandem stand, and a tandem stand. The gait speed test measures the time required to walk 4m at a normative pace. Lower body strength is assessed by a chair stand test and measures the time to perform 5 rises from a chair to an upright position as fast as possible without use of the arms. Each performance test is assigned a categorical score ranging from 0 to 4 (0: inability to complete test, 4: highest level of performance). A summary performance score (0−12) is calculated by adding the 3 performance tests. The SPPB takes approximately 5 to 10 minutes to complete. Concurrent, predictive, and known-groups validity, interrater (intraclass correlation coefficient>.90) and 2-week test-retest (intraclass correlation coefficient=.72) reliabilities, and sensitivity to change have been reported.[26,31-33] In our study, 3-month test-retest reliability was very good (Pearson r=.79−.88, P<.01). Small and substantial meaningful changes in SPPB scores among older adults are represented by a 0.5 or 1 difference, respectively.[31]

Participant-reported fall rates were used as another measure of physical function, specifically balance control. Beginning in August 2010, we interviewed participants weekly during the 12-week intervention on the number of falls and near-fall events they experienced. Falls were defined as events in which subjects end up on the floor or ground when they did not expect to. Near falls were

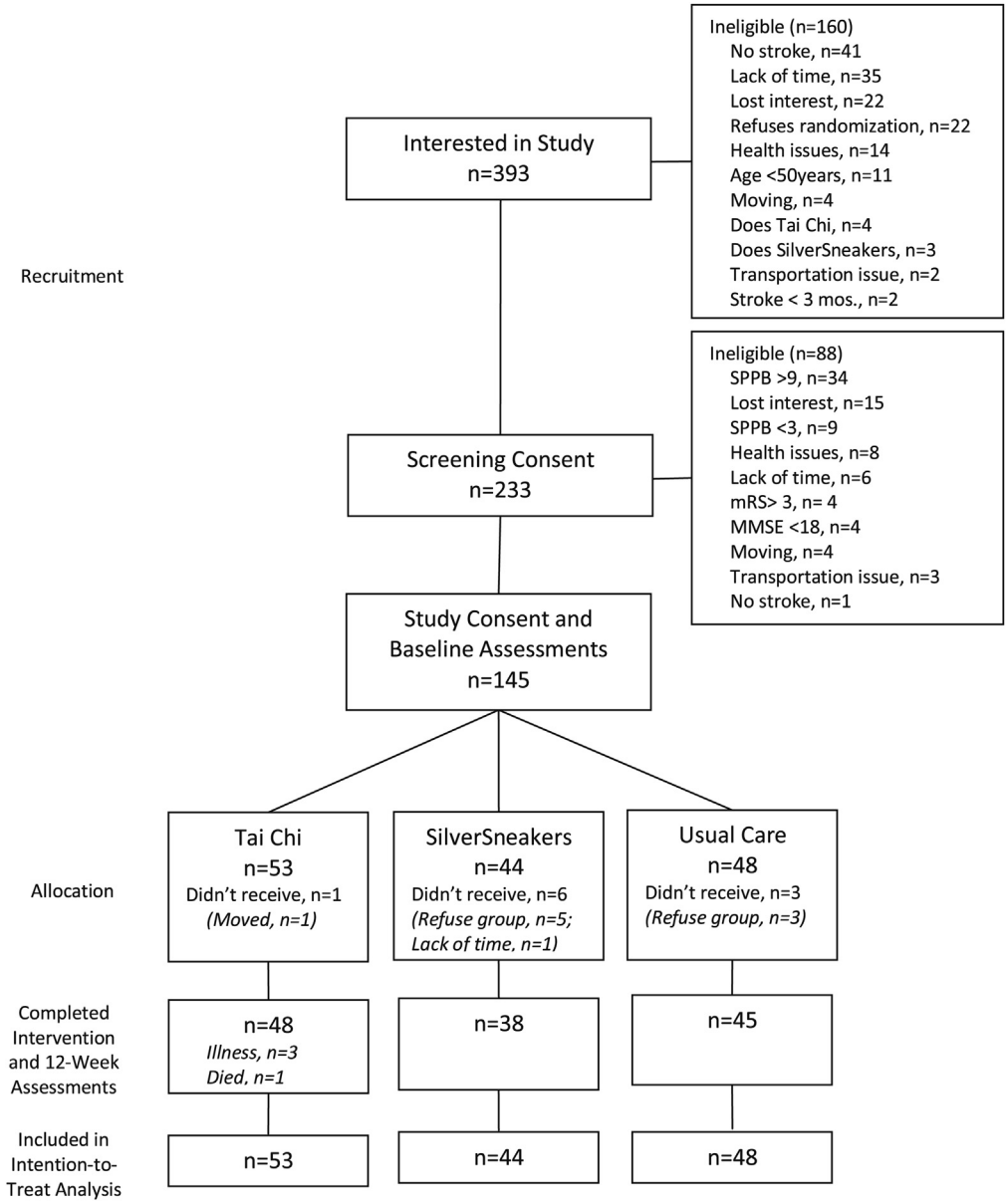

Fig 1 Study flowchart. Abbreviations: MMSE, Mini-Mental State Examination; mRS, modified Rankin Scale.

defined as events in which subjects recovered their balance without falling. We also collected information on reasons for falls and near-fall events and if these events resulted in an injury.

The 2-minute step test was used to assess aerobic endurance. It involves having the participant raise their knees one at a time to a height halfway between the middle of the patella and the iliac crest as many times as possible within 2 minutes.[34] Normative data for the 2-minute step test among older adults (n=7183) have been reported.[35] Criterion, convergent, and known-groups validity have been reported.[34] Because survivors of stroke are often afflicted with hemiparesis, we only required the nonaffected side to reach the prescribed height. In our study, 3-month test-retest reliability was moderate to good (Pearson $r=.65-.81$, $P<.01$).

Quality of life

The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) is a widely used, well-known self-report generic measure of quality of life.[36] The SF-36 has been standardized, validated, and used successfully in a variety of patient populations, including survivors of stroke.[37,38] Previous research studies examining the SF-36 has established construct, predictive, and known-groups validity, good reliability ($r>.70$), and sensitivity to change.[36,37] Scores are standardized to population norms using published algorithms with the mean score set at 50±10. Higher scores indicate better perceived quality of life. The SF-36 generally takes 5 to 10 minutes to complete.

Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D), a 20-item self-report measure that takes approximately 5 to 10 minutes to complete.[39] The CES-D is widely used in research and clinical settings as a screening test. Higher scores represent more depressive symptoms. A score ≥16 using the CES-D is considered a clinical cutpoint warranting further evaluation for depression.[39] Among survivors of stroke, construct, convergent, and discriminate validity and good reliability of the CES-D have been reported.[40,41]

Table 1 Baseline participant characteristics (N = 145)

Characteristic	All (N = 145)	TC (n = 53)	SS (n = 44)	UC (n = 48)	Group Difference
Age, mean ± SD (y)	69.9±10.0	71.5±10.3	69.6±9.4	68.2±10.3	F = 1.41, *P* = .25
Women	46.9 (68)	35.8 (19)	54.5 (24)	52.1 (25)	χ^2 = 4.15, *P* = .13
Marital status					χ^2 = 7.95, *P* = .02
Married/partner	58.0 (84)	64.2 (34)	68.2 (30)	41.7 (20)	
Single/divorced/widowed	42.1 (61)	35.8 (19)	31.8 (14)	58.3 (28)	
College graduate	79.3 (115)	84.9 (45)	77.3 (34)	75.0 (36)	χ^2 = 1.67, *P* = .50
Employment status					χ^2 = 6.15, *P* = .05
Retired	80.0 (116)	83.0 (44)	88.6 (39)	68.8 (33)	
Full- or part-time	20.0 (29)	17.0 (9)	11.4 (5)	31.3 (15)	
Income					χ^2 = 2.32, *P* = .32
<$50,000/y	65.5 (95)	58.5 (31)	65.9 (29)	72.9 (35)	
≥$50,000/y	34.5 (50)	41.5 (22)	34.1 (15)	27.1 (13)	
Race/ethnicity					χ^2 = 6.91, *P* = .03
White/European-American	78.6 (114)	81.1 (43)	88.6 (39)	66.7 (32)	
Other*	21.4 (31)	18.9 (10)	11.4 (5)	33.3 (16)	

NOTE. Values are % (n) or as otherwise indicated. Sensitivity analyses removing dropouts (n = 131) and comparing differences between groups were similar, except for race/ethnicity, which was no longer significantly different (χ^2 = 4.93, *P* = .09). Most dropouts (93%, n = 13) were white/European-American.

* Includes American Indian/Alaskan Native, Asian/Asian-American, black/African-American, Latino/Mexican-American, Middle-Eastern, Native Hawaiian/Pacific Islander, other.

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI).[42] The PSQI has 7 items and takes 5 to 10 minutes to complete. Higher scores indicate worse sleep quality (range, 0–21). A global PSQI score >5 indicates poor sleepers.[42] Construct, convergent, discriminate, and known-groups validity, along with good reliability, have been reported.[43,44]

Data analysis

Frequencies were calculated to check for extreme or logically inconsistent values. Descriptive statistics were calculated for all variables. In order to examine differences over time between groups, 3 (group: TC, SS, UC) × 2 (time: baseline, 12wk) analyses of variance were used to determine if there were significant main and interaction effects using intention-to-treat analysis. Missing data were replaced using the last observation carried forward.[45,46] Significant interactions were probed using post hoc paired *t* tests. Bonferroni correction was used to control for type I error. To determine significant differences in fall events between the 3 groups, a chi-square test with Yate continuity correction was calculated. Sensitivity analyses were also performed, excluding individuals with missing data on the last observation. Data were analyzed using IBM SPSS for Windows (version 20.0)[a] and Microsoft Excel 2010.[b]

Results

Three hundred ninety-three persons showed interest in the study and contacted study staff for further information. All interested persons were prescreened over the phone or in person. A total of 233 persons provided informed consent to be screened for safety and to determine study eligibility. After screening, a total of 145 survivors of stroke enrolled in the study and were randomly assigned to the TC (n = 53), SS (n = 44), or UC (n = 48) groups. A total of 14 participants withdrew from the study (10%), mainly because of refusal of their group assignment (n = 10). The recruitment, randomization, and retention flowchart for the study is shown in figure 1.

On average, participants (47% women) were 70 years old. Most were white/European-American (79%), married/partnered (58%), college-educated (79%), and retired/unemployed (80%). Participants in the UC group were more likely to be single, divorced or widowed, working part- or full-time, or nonwhite (*P*<.05) (table 1). Sensitivity analyses removing dropouts (n = 131) and comparing differences between groups were similar, except for race/ethnicity, which was no longer significantly different (χ^2 = 4.93, *P* = .09). Most dropouts (93%, n = 13) were white/European-American.

Most of these participants self-reported a stroke event (first stroke: 86%, ischemic stroke: 66%, hemiparesis: 73%) that occurred, on average, 3 years prior to beginning the study (37.2± 48.3mo). At baseline, participants reported mild-to-moderate disability (modified Rankin Scale: 2.1±0.7) but were without cognitive impairments (Mini-Mental State Examination: 27.9±2.4). The most common self-reported health problems were hypertension (73%), dyslipidemia (63%), irregular heartbeat (28%), and diabetes (28%). At baseline, there were no statistically significant differences between groups on stroke-related characteristics or self-reported health problems (table 2). Sensitivity analyses removing dropouts (n = 131) and comparing differences between groups were similar, except for congestive heart failure (χ^2 = 8.03, *P* = .02; TC group, n = 2) and current smoker (χ^2 = 6.41, *P* = .04; TC group, n = 1).

During the 12-week intervention, there were a total of 123 fall-related events (34 falls, 89 near falls); all events happened at home (table 3). A total of 29 (24%) fall-related events were reported to have resulted in an injury, though only 8% of those events were evaluated by a health care provider. TC participants had two thirds fewer falls (5 falls) than the SS (14 falls) and UC (15 falls) groups (χ^2 = 5.6, *P* = .06). Post hoc tests indicated that the TC group had significantly fewer falls than the UC group (χ^2 = 4.29, *P* = .04), whereas there was no significant difference between the TC and

Table 2 Baseline stroke-related characteristics and self-reported health problems (N=145)

Characteristic	All (N=145)	TC (n=53)	SS (n=44)	UC (n=48)	Group Difference
Modified Rankin Scale	2.1±0.7	2.0±0.7	2.2±0.7	2.1±0.6	F=1.30, P=.28
Mini-Mental State Examination	27.9±2.4	27.5±2.3	28.1±2.7	28.2±2.1	F=1.14, P=.32
Months poststroke	37.2±48.3	39.0±40.2	33.0±58.7	38.7±46.7	F=0.20, P=.82
Stroke type					χ^2=3.39, P=.51
Ischemic	65.5 (95)	62.3 (33)	72.7 (32)	62.5 (30)	
Hemorrhagic	23.4 (34)	22.6 (12)	18.2 (8)	29.2 (14)	
Unknown	9.0 (13)	15.1 (8)	9.1 (4)	8.4 (4)	
Hemiparesis					χ^2=9.15, P=.06
Right side	29.7 (43)	26.4 (14)	34.1 (15)	29.2 (14)	
Left side	43.4 (63)	34.0 (18)	56.8 (25)	41.7 (20)	
None	26.9 (39)	39.6 (21)	9.1 (4)	29.2 (14)	
First stroke	86.2 (125)	88.7 (47)	81.8 (36)	87.5 (42)	χ^2=1.05, P=.62
History of TIA	36.6 (53)	43.4 (23)	27.3 (12)	37.5 (18)	χ^2=2.72, P=.27
Uses walking aid	13.1 (19)	13.2 (7)	18.2 (8)	8.3 (4)	χ^2=1.96, P=.41
Recurrent stroke risk profile*					
Low risk (score 0–3)	44.1 (64)	37.7 (20)	50.0 (22)	45.8 (22)	χ^2=1.55, P=.49
Moderate risk (score 4–7)	44.8 (65)	49.1 (26)	40.9 (18)	43.8 (21)	χ^2=0.68, P=.74
High risk (score 8–15)	11.0 (16)	13.2 (7)	9.1 (4)	10.4 (5)	χ^2=0.44, P=.85
Self-reported health problems					
Hypertension	73.1 (106)	71.7 (38)	75.0 (33)	72.9 (35)	χ^2=0.14, P=.97
Dyslipidemia	62.8 (91)	54.7 (29)	72.7 (32)	62.5 (30)	χ^2=3.34, P=.20
Arrhythmia	28.3 (41)	24.5 (13)	29.5 (13)	31.3 (15)	χ^2=0.61, P=.78
Diabetes	27.6 (40)	32.1 (17)	27.3 (12)	22.9 (11)	χ^2=1.06, P=.60
Major depression	16.6 (24)	17.0 (9)	13.6 (6)	18.8 (9)	χ^2=0.45, P=.82
Congestive heart failure	15.2 (22)	7.5 (4)	15.9 (7)	22.9 (11)	χ^2=4.86, P=.09
Previous myocardial infarction	15.2 (22)	9.4 (5)	22.7 (10)	14.6 (7)	χ^2=3.32, P=.21
Asthma	12.4 (18)	13.2 (7)	9.1 (4)	14.6 (7)	χ^2=0.69, P=.78
Current smoker	7.6 (11)	3.8 (2)	4.5 (2)	14.6 (7)	χ^2=5.03, P=.08

NOTE. Values are % (n), mean ± SD, or as otherwise indicated. Sensitivity analyses removing dropouts (n=131) and comparing differences between groups were similar, except for congestive heart failure (χ^2=8.03, P=.02; TC group: n=2) and current smoker (χ^2=6.41, P=.04; TC group: n=1).
Abbreviation: TIA, transient ischemic attack.
* Based on Stroke Prognosis Instrument II.[54]

SS (χ^2=2.61, P=.11) or SS and UC (χ^2=.29, P=.59) groups (see table 3).

Most falls happened as a result of slipping/tripping (21%) or rapid ambulation (18%). Other reported fall triggers included legs or knees giving way (12%), bathroom-related incidents (eg, incontinence, 12%), reaching or leaning (6%), and vertigo/syncope (3%) (table 4). In contrast, most near falls happened as a result of rapid ambulation (26%) or vertigo/syncope (22%). Participants most commonly recovered their balance without falling (near fall) by grabbing onto or leaning against something (63%) (see table 4).

After the 12-week intervention, all groups had substantial improvements in SPPB score ($F_{1,142}$=85.29, P<.01). There was a significant group by time interaction for the 2-minute step test (aerobic endurance) ($F_{2,142}$=4.69, P<.01). Post hoc tests indicated that both the TC (t_{52}=2.45, P=.02) and SS (t_{43}=4.63, P<.01) groups had significantly better aerobic endurance over time; however, this was not observed in the UC group (t_{47}=1.58, P=.12). All groups reported better perceived physical (SF-36 physical composite score: $F_{1,142}$=4.15, P=.04) and mental health (SF-36 mental composite score: $F_{1,142}$=15.60, P<.01). Post hoc tests indicated that there was no significant change in perceived physical health for any of the groups (P>.05); however, all groups had significant improvements in perceived mental health after the 12-week intervention (P<.05) (table 5). Sensitivity analyses removing dropouts (n=131, data not reported) were similar to results obtained using intention-to-treat analyses.

Intervention adherence

Study intervention adherence rates were 85% overall for all prescribed sessions. Participants in the UC group had the highest rate at 93%; this was followed by the TC group at 82% and the SS group at 81%. The UC groups had two thirds fewer prescribed sessions (12 sessions) than the TC and SS groups (36 sessions).

All survivors of stroke in our study who were assigned to the TC exercise intervention were able to follow the instructor and perform all of the Yang style 24-posture short-form movements, regardless of age or stroke-related impairments. Participants with severe upper-extremity hemiparesis would sometimes use their unaffected side to aid movement of their affected side. Participants assigned to the SS intervention with severe upper-extremity hemiparesis followed the same approach.

Discussion

TC is a centuries-old martial art that combines physical movements with relaxation; it is suitable for survivors of stroke.[22,47] All

Table 3 Fall-related data during 12-week intervention (n=89)

During 12-wk Intervention	TC (n=30)	SS (n=31)	UC (n=28)	All (n=89)
Fallers	13 (4)	19 (6)	21 (6)	18 (16)
Repeat fallers	3 (1)	10 (3)	7 (2)	7 (6)
No. of falls	5	14	15	34
No. of near falls	32	31	26	89
Total no. of falls/ near falls	37	45	41	123
No. of injuries caused by falls/near falls	9	7	13	29
Sought medical attention because of falls/ near falls	2	4	4	10

NOTE. Values are % (n) or n. Data were collected between August 2010 and December 2012 (overall, $\chi^2=5.6$ and $P=.06$). Post hoc tests indicated that TC subjects had significantly fewer falls than UC subjects ($\chi^2=4.29$, $P=.04$).

groups had significant improvements in physical function (balance, gait speed, lower body strength) and quality of life (perceived physical, mental health) over time. When we examined fall rates, an indicator of balance control, the TC group had about two thirds fewer falls than the SS or UC groups. This is an unexpected finding given the improvements observed in balance, gait speed, and lower body strength, factors thought to reduce the risk of falls, after the intervention for all groups. On the other hand, it was not surprising that both the TC and SS groups had significantly better aerobic endurance after the intervention because the exercise doses for these interventions were based on the Physical Activity Guidelines for older adults with or without disabilities.[48,49]

This is one of the first studies conducted in the United States to examine the effects of TC exercise on physical function and quality of life in community-dwelling older stroke survivors. Our results are similar to a recent study conducted by Tousignant et al,[50] who examined the effect of TC exercise on fall-related outcomes among frail adults (n=152; mean age, 80y) compared with a conventional physical therapy balance rehabilitation program. They found that both interventions were effective in improving balance, gait, and fear of falling ($P<.05$); however, these improvements in physical function only translated to fewer falls among participants in the TC group, similar to our study results. Consequently, the effect of TC on fall-related events needs further exploration because previously reported mechanisms thought to prevent falls did not fully explain the results obtained in this study.

Several studies[51-53] have examined the reasons that survivors of stroke fall so that preventive measures can be implemented. Similar to our results, these studies[51-53] reported that walking was the most common reason associated with falling in survivors of stroke. However, effective fall prevention interventions for survivors of stroke are unclear. A recent systematic review[10] of randomized controlled trials examined single or multifactorial interventions to reduce falls among survivors of stroke. A total of 13 randomized controlled trials with a heterogeneous population of survivors of stroke from diverse settings (ie, acute care, outpatient rehabilitation, community, institutional) examining a wide variety of fall prevention interventions (eg, physical activity, education, medication) were included. Based on this review, the only intervention shown to be effective in reducing falls was the use of vitamin D supplementation for stroke survivors who were women in an institutional setting.[10] The generalizability of these results is very limited because only 26% (approximately 1.8 million) of survivors of stroke who are living in the United States are institutionalized.[4] To have the largest public health impact and determine the best fall prevention strategies, further research is needed among community-dwelling stroke survivors (approximately 5.2 million, 74%) living in the United States. Although we found no statistically significant difference in hemiparesis between groups ($\chi^2=9.15$, $P=.06$), future research may consider the impact of hemiparesis on the occurrence of falls when conducting exercise interventions.

Study limitations and strengths

The primary study limitation is the selective nature of the study population because only community-dwelling survivors of stroke uniquely interested in participating in an exercise study may have volunteered. Although we conducted a power analysis to determine our study sample, we may have underestimated the effect size and been underpowered to detect significant differences in outcomes between the groups. In addition, the observed improvements in physical function among participants in this study may have occurred as a result of a learning effect, associated with repeated use of the study measures (ie, SPPB) to assess changes after the 12-week intervention. The number of fall-related events may have been underreported by participants because of recollection bias. Finally, we did not collect data on fear of falling or

Table 4 Self-reported reasons for fall and near-fall events (n=123)

Reasons for Fall/Near-Fall Events	Slipping/ Tripping	Rapid Ambulation	Legs/Knees Weak	Bathroom Incidents	Reaching/ Leaning	Vertigo/ Syncope	Not Thinking	Other	Total
Falls	7 (21)	6 (18)	4 (12)	4 (12)	2 (6)	1 (3)	NA	10 (29)	34
Near falls	12 (13)	23 (26)	10 (11)	NA	NA	20 (22)	3 (3)	21 (24)	89
Stopped self without aid	5	8	1	NA	NA	1	1	2	18
Grabbed/leaned on person/object	5	12	8	NA	NA	15	NA	16	56
Fell on person/object	2	2	1	NA	NA	2	2	3	12
Fell back on chair when rising/sitting	NA	1	NA	NA	NA	2	NA	NA	3
Total	19	29	14	4	2	21	3	31	123

NOTE. Values are n or n (%).
Abbreviation: NA, not applicable.

Table 5 Changes in physical function and quality of life (N=145)

Measure	Score Range	Desired Score Direction	TC (n=53)		SS (n=44)		UC (n=48)		ANOVA*		
			Baseline	12wk	Baseline	12wk	Baseline	12wk	Time Main Effect	Group Main Effect	Time × Group Interaction
Physical function											
SPPB total	0–12	↑	6.8±2.2	7.7±2.3	7.1±2.1	8.6±2.7	6.8±2.1	7.9±2.4	85.29 (<.01)	0.95 (.39)	1.96 (.15)
SPPB balance	0–4	↑	2.8±1.1	3.3±1.0	2.8±1.2	3.3±0.9	2.9±1.1	3.3±1.0	39.53 (<.01)	0.01 (.99)	0.36 (.70)
SPPB strength	0–4	↑	1.2±0.8	1.5±1.0	1.1±0.7	2.0±1.2	1.2±0.7	1.7±1.0	48.00 (<.01)	1.02 (.36)	5.19 (<.01)
SPPB gait	0–4	↑	2.8±1.1	2.9±1.1	3.1±1.0	3.3±1.0	2.7±1.2	3.0±1.2	20.84 (<.01)	1.82 (.17)	0.42 (.66)
Step test†	0–∞	↑	37.9±19.2	43.8±21.6	44.4±25.0	60.7±29.6	41.1±22.0	45.5±24.8	28.18 (<.01)	3.86 (.02)	4.69 (<.01)
Quality of life											
SF-36 PCS	0–100	↑	37.4±8.4	38.3±9.9	37.5±8.4	38.8±8.6	37.1±8.9	38.6±10.5	4.15 (.04)	0.02 (.98)	0.08 (.92)
SF-36 MCS	0–100	↑	49.7±10.9	52.8±10.3	51.0±7.9	54.0±8.9	48.6±10.7	51.6±9.4	15.60 (<.01)	0.87 (.42)	0.00 (.99)
CES-D	0–60	↓	14.3±9.8	14.0±9.6	11.1±7.4	11.4±9.6	15.7±11.9	13.6±10.2	0.97 (.33)	1.84 (.16)	1.07 (.35)
PSQI	0–21	↓	6.0±3.4	5.8±3.7	6.0±3.4	6.7±3.7	6.9±4.6	6.2±3.9	0.09 (.76)	0.42 (.66)	2.07 (.13)

NOTE. Values are mean ± SD or F (*P*). At baseline, there were no statistically significant differences between groups on any of the variables of interest (all $P \geq .09$). Sensitivity analyses removing dropouts (n=131, data not reported) were similar to results obtained using intention-to-treat analyses.

Abbreviations: ANOVA, analysis of variance; MCS, mental composite score; PCS, physical composite score.

* Last observation carried forward for missing data.

† Number of steps (nonhemiparetic side) in 2 minutes.

conduct home hazard/safety issues assessments, which may have provided additional insight on potential reasons for falling.

There were several strengths in this study. As a randomized controlled trial, we used simple randomization with allocation concealment for group assignments to reduce selection bias. The study interventions were held at different locations in the community and different times of the day to prevent cross-contamination. Fidelity of the interventions was monitored by an independent study consultant. Study staff assessing the outcome measures were blinded to group assignment. Finally, all potential participants were provided with a list of local transportation services (included services for those with disabilities) that we developed to assist with transportation solutions. This likely facilitated our high intervention adherence rates.

Conclusions

The TC and SS interventions led to improved aerobic endurance; both are suitable community-based programs that may aid in stroke recovery and community reintegration. Fall rates are an important indicator of balance control among community-dwelling survivors of stroke. Our data suggest that a 12-week TC intervention led to fewer falls than SS or UC. Home safety evaluation after a stroke is recommended because the most frequently reported fall triggers included slipping, tripping, and rapid ambulation, and balance recovery was aided by grabbing onto or leaning against something. Future studies examining the effectiveness of TC as a fall prevention strategy for community-dwelling survivors of stroke is recommended.

Suppliers

a. IBM Corp, 1 New Orchard Rd, Armonk, NY 10504-1722.
b. Microsoft Corp, One Microsoft Way, Redmond, WA 98052-7329.

Keywords

Accidental falls; Controlled clinical trial [publication type]; Rehabilitation; Stroke; Tai Ji

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