Tai Chi and Low Impact Exercise: Effects on the Physical Functioning and Psychological Well-Being of Older People

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The effects of tai chi (TC) and low impact exercise (LIE) interventions on physical functioning and psychological well-being of sedentary older people were contrasted. Participants were randomized to TC, LIE, or non-exercise control groups with interventions running for 12 weeks. Post-intervention assessments with 72 participants who completed the study revealed that participants in both exercise groups improved with respect to upper body strength, balance, cardiovascular endurance, lower body strength, sleep disturbances, and anxiety. Participants in the LIE group reported better functional ability while those in the TC group reported better subjective health. Findings suggest that tai chi and low impact exercise are safe, cost-effective ways to improve both physical and psychological functioning of older people.

Keywords: tai chi; low impact exercise; exercise intervention

Although a considerable body of literature suggests that participation in regular exercise programs has physical and psychological benefits for older people (Bouchard, Shephard, & Stephens, 1994; Elward & Larson, 1992; Mazzeo et al., 1998; McAuley, 1994; McAuley & Katula, 1998; McAuley

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Rudolph, 1995; Moore & Brodsgaard, 1999; O’Connor, Aenchbacher, & Dishman, 1993; Singh, Clements, & Fiatarone, 1997), little is known about the ways in which different exercise modalities affect these outcomes. This issue has gained prominence as exercise programs having their roots in Western culture (e.g., walking, jogging) and those grounded in Eastern traditions (e.g., tai chi) have gained in popularity. The analyses that follow examine the differential effects that participation in either a low impact exercise (LIE), tai chi (TC), or no-exercise control group has on the physical functioning and psychological well-being of sedentary older people.

Knowledge concerning the benefits of physical activity for older people is based primarily on studies of traditional exercise interventions such as aerobic activity (walking, jogging, etc.). The increasing popularity of alternative and complementary modes of physical activity leads to questions concerning the extent to which they, too, are beneficial for older people. One such activity is TC, which has deep historical roots in Chinese martial arts (Wile, 1996). Research consistently finds that TC has beneficial effects on cardiovascular function (Lan, Lai, Chen, & Wong, 1998; Young, Appel, Lee, & Miller, 1999), aerobic capacity (Taylor-Piliae & Froelicher, 2004), strength and flexibility (Lan et al., 1998; Lan, Chen, Lai, & Wong, 1999), sleep abilities (Li, Harmer, Fisher, & McAuley, 2004), balance and falls (Hain, Fuller, Weil, & Kotsias, 1999; Li et al., 2004; Thornton, Sykes, & Tang, 2004; Wolf et al., 1996; Wu, 2002), and blood pressure (Thornton et al., 2004). It also has positive effects on psychological well-being, resulting in improvements to self-esteem (Kutner, Barnhart, Wolf, McNeely, & Xu, 1997; Li, Harmer, Chaumeton, Duncan, & Duncan, 2002) and reduced anxiety, depression, and mood disturbance (Brown et al., 1995; Chen & Sun, 1997; Sandlund & Norlander, 2000).

To date, few studies have contrasted the effects of participation in traditional Western exercises (e.g., low impact aerobics), walking, balance training, or education programs with those of TC. It could be hypothesized, however, that exercises that are designed to strengthen the body and varying muscles should have different physiological and psychological effects on an individual than exercises designed to improve overall balance and well-being. The existing literature, however, has not yet adequately examined the differential effects of various forms of exercise. The studies that have contrasted TC with other exercise modalities have focused almost exclusively on change in blood pressure as an outcome (Channer, Barrow, Barrow, Osborne, & Ives, 1996; Young et al., 1999), and inconsistent findings have been reported. Whereas Young et al. (1999) found that both a group of people participating in TC and those participating in a moderate impact aerobic exercise program experienced reductions in systolic and diastolic blood pressure, Channer et al. (1996) found evidence of lowered diastolic blood pressure in people participating in a TC group, and those participating in an aerobic exercise and those in a non-exercise
control group did not experience this benefit. In one of the few studies to evaluate the effects of TC and an alternative exercise program (computerized balance training) on a wide variety of primary outcomes that included biomedical, functional, and psychosocial indicators of frailty as well as occurrence of falls, Wolf et al. (1996) found that lowered blood pressure before and after a 12-minute walk was found for those participating in the TC program. Fear of falling responses and intrusiveness responses were reduced after the TC intervention. After adjusting for fall risk factors, TC was found to reduce the risk of multiple falls by 47.5%.

It is important that a broader perspective be adapted that evaluates both physical and psychological outcomes so that the differential benefits of exercise programs can be understood. One of the few studies to contrast multiple outcomes associated with participation in a TC program with a contrast group is research by Hart et al. (2004), whose contrast group participated in a physiotherapy exercise program. They found that the TC group improved in general health and social abilities, whereas the group participating in physiotherapy showed improvements in balance, walking, speed, and stair climbing. Research by Brown et al. (1995) found that women who participated in a TC group achieved a significantly greater decrease in anger and mood disturbance and a greater reduction in tension and confusion than those participating in a low intensity walking program or those in a low intensity walking plus relaxation program.

The analyses that follow contrast multiple dimensions of physical functioning and psychological well-being among a group of older people exposed to a traditional Eastern form of exercise (TC), those exposed to a traditional Western form of exercise (LIE), and a non-exercise control group. Although TC and LIE are both forms of exercise, they differ significantly from one another and, as such, should have differential effects on outcomes. TC has a significant cognitive component to it and works muscles in different ways from LIE, primarily focusing on maintaining a slow controlled tempo, with the quality of the technique being much more important than the actual amount of movement. More specific, it is hypothesized that people participating in the LIE intervention should experience a greater increase in grip strength and increased functional abilities than those participating in the TC group. Those participating in the TC group should experience greater increases to their balance (Hain et al., 1999; Li et al., 2004; Thornton et al., 2004; Wolf et al., 1996; Wu, 2002), improvements to their sleep (Li et al., 2004), reduced anxiety and depression (Brown et al., 1995; Chen & Sun, 1997; Sandlund & Norlander, 2000), and better overall subjective health (Hart et al., 2004) than those participating in the LIE group. In addition to these differences, it is expected that there will be some shared benefits to those participating in either TC or LIE...
that ensue as a function of the more general benefits from participation in exercise. More specifically, people participating in both the TC and LIE groups should experience significantly greater decreases to their blood pressure (Channer et al., 1996; Young et al., 1999) and increases to their lower body strength, endurance, and lower body flexibility than those in the non-exercise control group.

Method

Participants

To be eligible to participate in the study, individuals had to be at least 50 years old, to have not regularly exercised for at least 3 months (less than 1 hour of purposeful exercise per week), and to provide a note from their personal physician stating that they were physically fit to participate in a low to moderate intensity exercise program. As indicated in Figure 1, 114 community-dwelling individuals responded to study advertisement flyers posted in strategic locations (libraries, physicians’ offices, etc.), multiple advertisements in three local newspapers, presentations at local assisted living homes, and a university health fair. People were given details about the study via a telephone conversation with the project coordinator. Upon learning more about the requirements of the study and the conditions of participation, 30 people decided not to participate. The 84 remaining people agreed to participate in the study and completed the informed consent process and the baseline assessment.

Participants included 30 men and 54 women. The majority of the participants were White/non-Hispanic (94.4%), 2.8% were Black/non-Hispanic, and 2.8% were Asian/Pacific Islander. These figures were representative of the local community, and 72.2% of the participants were married. Most of the participants were retired (75%). Of the remaining 25%, 76.5% were working part-time. This was a well-educated sample, with 31.9% of the participants having a postcollege degree, 20.8% having a 4-year college degree, 26.4% having some college, 18.1% having a high school diploma, and 2.8% completing only some high school. The average age of people participating in the study was 69.2 ± 9.26 (M + SD) years with an age range of 52 to 82 years. Body mass index (BMI) averaged 28.96 ± 4.31 (overweight, according to the National Heart, Lung, and Blood Institute [NHLBI]; http://www.nhlbi.nih.gov/index.htm). Mean systolic blood pressure was 137 ± 23.3 mmHg and mean diastolic blood pressure was 81 ± 11.0 mmHg (both classified as prehypertensive, according to the NHLBI). The mean resting heart rate was 68 ± 12.4 beats per minute (normal, according to the NHLBI).
Experimental Design

Within a week after their baseline assessments were completed, participants were randomized into one of three groups: TC, LIE, or non-exercise control. A 2:1 ratio for exercisers to controls was used to ensure statistical
power in the primary groups of interest (TC vs. LIE). As such, 31 participants were assigned to TC, 30 to LIE, and 23 to the non-exercise control group.

Both TC and LIE classes were offered at multiple times during the day, five times a week. All classes were held at a local martial arts studio. Participants in the intervention arms of the study were expected to attend three 60-minute classes per week over the 12-week duration of the study.

**Intervention Descriptions**

The LIE segment intervention was a collective summary of movements used in traditional Western exercise. The class performed exercises focusing on enhancing the main elements of physical fitness: strength, flexibility, endurance, and balance. Each class began with a 5-minute warm-up, followed by a cardiovascular portion and strength segment. Exercises during the first 2 weeks were performed completely seated in a chair-routine design, incrementally progressing to a full 20-minute standing routine by the 7th week. Interval training was introduced in the 2nd week, at a rate of 20 seconds low intensity, 20 seconds medium intensity, and 30 seconds high intensity. This progressed to four 30/30/60-second segments by Weeks 8 through 12, leaving 12 minutes to perform steady state aerobic exercise. The endurance aspect of training progressed each week from a step tempo of 102 beats per minute (bpm) at Week 1 to a step tempo of 135 bpm at Week 12.

A progressive strength program was developed incorporating the use of red TheraBand exercise bands (medium resistance, 8mm) for the upper body. TheraBand exercise bands, made of latex, provide positive and negative resistance. When used properly, they help improve strength, range of motion, and flexibility of the muscles. Each week, the strengthening portion progressed by either increasing repetitions or shortening the length on the band for greater resistance. New exercises were consistently added to the routine to allow muscles to be worked from a variety of angles and to help maintain interest in the program. Participants paired up by Week 6 for lat pulls and Week 9 for a second set of triceps exercises. No added resistance was used for lower body strength training. A progressively more difficult routine was achieved by slight variation of the motion (not holding onto anything), adding repetitions, and decreasing rest time between sets. Abdominal/core strengthening was completely performed in the chair. As an overview of the progress made, the class began with one set of 8 repetitions per exercise, and by Week 12, they were completing three sets of 12 repetitions per exercise.
A series of static and dynamic balance exercises was presented. For dynamic balance, participants performed heel-toe walking forward, backward, with arms extended, and with distracters (others walking by in the opposite direction) as their balance progressively increased throughout the study. Static balance was trained with participants standing on one foot for specific amounts of time (increased to 1 minute by Week 12) with or without holding onto something for support (depending on fitness ability). A wall-mounted horizontal bar was available for those with the need to stabilize with one hand while performing the various movements. Finally, each session concluded with a series of seated lower body and upper body stretches as a cool-down. There was musical accompaniment for all classes. Brief breaks for water were taken as needed between exercises.

TC was taught using a 10-posture choreography made up of basic and classic postures from the Yang family style (Li, Fisher, Harmer, & Shirai, 2003). The 10 forms were as follows: (a) commence tai chi, (b) ward off—left, (c) grasp the sparrow’s tail—right, (d) wave hands like cloud—left, (e) single whip—left, (f) brush knee/push palm—right/left, (g) fair lady weaves shuttles—left/right, (h) grasp sparrow’s tail—left, (i) carry tiger to the mountain, (j) close tai chi. This choreography was chosen because each form can be traced back to its origin. A typical TC class began with a 10-minute meditation period where participants stood still with eyes either closed or only slightly open and focused on maintaining stillness, eliminating other thoughts and distractions of the day and breathing deeply and slowly. The instructor spoke softly to them throughout this time, reinforcing these ideas. Next, the participants completed a 5-minute qigong warm-up, which stretched the entire body and prepared the participants for the exercise session. After meditation and qigong were completed, a question-and-answer period was held. The instructor first corrected the form from the previous class and then shared his lesson for the day. Each lesson involved both a physical form and comment concerning the philosophy behind TC. There was often dialogue between the instructor and the class. At this point, about 40 minutes of the 60-minute class had passed. At the beginning of each week, the instructor introduced a new form to the class and had them begin practicing and working it into their choreography. Later in the week, participants continued working on this new form until it was mastered. On average, one new form per week was introduced. Each class ended with an energy-washing qigong.

As indicated above, the two interventions differed from one another in several respects. First and foremost was the nature of the intervention. The LIE class stressed a combination of cardiovascular and strength training, whereas the TC class focused on philosophy and choreography. For those
in TC, class was a time for the instructor to adjust and correct form, maintain a rapport with the participants, and keep the participants actively thinking about the concept of TC and its application to their lives. The TC group normally performed about 10 to 15 minutes of actual movement during a typical class, whereas the LIE group performed continuous exercise throughout the entire session.

Instructors for both the TC and LIE classes were well accomplished. They had numerous certifications in their respective areas and at least 15 years’ teaching experience. Instructors had at least 8 years of training and experience focused specifically on exercise in older adults.

Adherence for both TC and LIE classes was excellent throughout the entire intervention, with 91.4% of participants attending at least 80% of the required classes. Class attendance ranged from 72.2% to 100.0%.

Measures

Baseline and follow-up assessments (which were completed within 2 weeks of the end of the intervention period) were identical. The performance-based assessments included the chair stand test, 2-minute step test, chair sit-and-reach test, and the 8-foot up-and-go tests developed as part of the Senior Fitness Test (SFT; Rikli & Jones, 1999). In addition, the grip strength test (Shiffman, 1992) was administered.

The chair stand test assesses lower body strength. It involves counting the number of times, within a 30-second time period, that a person can come to a full stand from a seated position with arms folded across the chest. The moderately high correlation between chair stand test scores and leg press scores \( r = .78 \) for men and \( .71 \) for women provides criterion-related evidence of the test’s validity as a measure of lower body strength (Jones, Rikli, & Beam, 1999).

The 2-minute step test is a measure of aerobic endurance. It is the number of times in 2 minutes that a person can step in place, raising the knees to a height halfway between the patella (kneecap) and iliac crest (front hip bone). A correlation of \( r = .73 \) was found between the 2-minute step test and the Rockport 1-mile walk test (Rikli & Jones, 2001). The same research group, in a study involving older men and women, reported a similar correlation \( r = .74 \) between 2-minute step test scores and treadmill performance (Rikli & Jones, 2001).

The chair sit-and-reach test assesses lower body flexibility, in particular hamstring flexibility. The test begins with the participant sitting on the edge of a standard folding chair. With arms outstretched, hands overlapping, and middle fingers even, the participant slowly bends forward at the hip joint,
reaching as far forward as possible toward or past the toes of the straight-
ened leg. The score is the distance from the tips of the middle fingers to the
top of the shoe. The midpoint at the top of the shoe represents the zero
point, with distances short of this point recorded as a negative score and dis-
tances past the toe recorded as a positive score. The correlation between
chair sit-and-reach test scores and the goniometer-measured criterion was
.81 for women (mean age = 74.0 years) and .76 for men (mean age = 74.5
years) (Jones, Rikli, Max, & Noffal, 1998).

The 8-foot up-and-go test measures agility and dynamic balance. The par-
ticipant is instructed to sit in the middle of the chair with back straight, feet flat
on the floor, and hands on the thighs. On the signal “go,” the participant gets
up from the chair, walks as quickly as possible around either side of a cone
located 8 feet away from the center of the chair, and sits back down in the
chair. A stopwatch is used to time this test. The test is significantly related to
scores on the Berg Balance Scale ($r = .81$), to gait speed ($r = .61$), and to the
Barthel Index of ADLs ($r = .78$) (Podsiadlo & Richardson, 1991).

The grip strength test is a quick and easy measure to gauge upper body
strength that has been used in countless studies (Shiffman, 1992). While
standing comfortably, participants are instructed to hold the T.K.K. 5401
dynamometer (Tokyo, Japan) in their nondominant hand while allowing
their arm to hang freely at their side. Upon receiving the “go” signal, par-
ticipants exert maximal force by squeezing the dynamometer as hard as
they can for 3 seconds. Criterion validity has been well established with the
T.K.K. 5401 and the Jamar dynamometer ($r = .94$; Peolsson, Hedlund, &
Oberg, 2001). Reliability coefficients for strength testing are usually .90 or
higher (Bohannon, Horton, & Wikholm, 1991).

In addition to the performance-based measures, participants provided
self-report information concerning their health, depressive symptoms, func-
tional abilities, sleep, falls, and anxiety.

Participants were asked to rate their health using the following question: “In
general, would you say your health is excellent, very good, good, fair, or poor?”
Responses included excellent (5), very good (4), good (3), fair (2), and poor (1).

Depressive symptoms were assessed using the Center for Epidemiological
Studies Depression Scale (CES-D; Radloff, 1977). The CES-D contains 20
items, with scores for each item ranging from 0 (rarely) to 3 (most or all of the
time). As such, scores on the CES-D can range from 0 to 60. The scale has
test–retest stability, excellent concurrent validity by clinical and self-report cri-
teria, and substantial evidence of construct validity (Radloff, 1977). Cronbach’s
alpha for the scale was .89.

The Functional Ability Scale (FAS) was used to assess self-reported
mobility and activity tolerance (Kovar, Fitti, & Chyba, 1992). This 10-item
instrument measures the degree of perceived difficulty, on a 4-point scale from 0 (no difficulty) to 3 (unable), with walking, standing, sitting, bending, reaching, grasping, and lifting. Item scores are summed, with higher scores indicative of greater functional impairment. Cronbach’s alpha for the scale was .80.

The sleep disturbances subscale of the Pittsburgh Sleep Quality Index (PSQI) (Buysee, Reynolds, Monk, Berman, & Kupfer, 1989) was used. This self-rated questionnaire includes nine questions concerning sleeping trouble. Each question is rated by the participant on a 0 (no problems in the past month) to 3 (problems three or more times a week) scale. Scores on the scale were summed and, as such, range from 0 to 27, with a higher total score reflecting more sleep problems. Cronbach’s alpha for the scale was .74.

Anxiety was assessed using the state form of the State-Trait Anxiety Inventory (STAI; Spielberger, 1989). The scale includes 20 statements that require individuals to rate how they currently feel on a 4-point scale. Test–retest reliabilities for the state scale range from 0.62 to 0.85. Cronbach’s alpha was .93.

All contrasts among the TC, LIE, and non-exercise control groups were made using repeated measures ANOVA. An alpha of .05 was considered statistically significant. Post hoc differences on variables for which there were significant overall differences were followed up and analyzed using Scheffé tests. Although sample size was relatively small, power calculations, run using SamplePower (SPSS Inc., n.d.), ranged from .52 to .97 depending on the outcome variable.

**Results**

There were no statistically significant differences on height, weight, BMI, age, heart rate, systolic blood pressure, and diastolic blood pressure at baseline among participants in the three groups. Although the control group experienced mild hypertension ($M = 140.2/81.6$ at baseline) and both exercise groups were considered to be in the high normal range, these differences were not statistically significant. The groups were similar at baseline on all performance-based measures with the exception of the sit-and-reach test. On this test, the TC group scored significantly better (more flexible, $p < .05$) than the control and LIE groups. Although all differences at baseline are important to take into consideration and potentially adjust for statistically, the difference in flexibility of less than 1 inch is functionally and clinically nonsignificant and common in the exercise literature; hence, it was not controlled in subsequent
analyses. There were no significant differences at baseline between the three groups on any of the self-report measures.

Over the course of the 12-week intervention, 12 people withdrew from the study (14.3%), most for medical reasons (e.g., newly diagnosed illnesses, surgery, fall unrelated to study participation). Although more participants withdrew from the TC group than the LIE group or control group (8 TC, 2 LIE, and 2 controls), follow-up conversations indicated that none of the participants withdrew for any reason directly related to the study. There were no statistical differences in either demographic characteristics or study variables between people who dropped out of the study and those who completed it.

**Blood Pressure and Heart Rate**

As indicated in Table 1, there was no statistical change in either systolic or diastolic blood pressure over time for participants in the three groups. There was no statistical change in resting heart rate in the three groups.

**Performance-Based Measures**

Both exercise groups performed statistically better on the chair stand test at the postassessment than they did at baseline ($p < .05$). The LIE group improved lower body strength by 19.9% (pre: $11.9 \pm 3.68$; post: $14.7 \pm 5.5$), whereas the TC group improved lower body strength by 11.9% (pre: $12.4 \pm 3.93$; post: $13.8 \pm 4.47$). No significant changes were observed for the control group. There were no statistically significant differences in improvement between the LIE and TC groups on the chair stand test.

Both exercise groups made significant improvements on their aerobic endurance as measured by the 2-minute step test ($p < .01$), whereas the control group score did not significantly change. The LIE group made the most progress on the 2-minute step test, increasing their score by 31.9% (pre: $70.1 \pm 32.3$; post: $102.9 \pm 33.8$). The TC group increased their score by 25.7% (pre: $67.7 \pm 30.2$; post: $91.2 \pm 28.5$), whereas the controls made a smaller, statistically nonsignificant improvement of 11.7% on this test (pre: $61.0 \pm 29.2$; post: $69.1 \pm 27.4$). There was no statistically significant difference between the improvement of the LIE and TC groups on this test.

Although there were no statistically significant changes on the sit-and-reach test for any of the groups, the data (Table 1) indicate a trend in which the control group decreased their score (less flexibility) over time, whereas both the LIE and the TC groups made improvements.
Table 1. Physical Assessment and Fitness Testing Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control Baseline (N = 23)</th>
<th>Low Impact Exercise Baseline (N = 30)</th>
<th>Tai Chi Baseline (N = 31)</th>
<th>Degrees of Freedom</th>
<th>F</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Post (N = 21)</td>
<td>Post (N = 28)</td>
<td>Post (N = 23)</td>
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<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>140.2 ± 19.7</td>
<td>136.4 ± 27.3</td>
<td>134.3 ± 18.2</td>
<td>between groups: 2</td>
<td>.95</td>
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<td></td>
<td>142.8 ± 23.4</td>
<td>137.0 ± 23.4</td>
<td>129.3 ± 14.3</td>
<td>within groups: 68</td>
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<td>total: 70</td>
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<td>Diastolic blood pressure (mmHg)</td>
<td>81.6 ± 9.6</td>
<td>80.1 ± 11.4</td>
<td>81.1 ± 12.8</td>
<td>between groups: 2</td>
<td>.44</td>
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<td></td>
<td>84.6 ± 9.9</td>
<td>83.8 ± 10.4</td>
<td>82.2 ± 9.3</td>
<td>within groups: 68</td>
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<td>total: 70</td>
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<tr>
<td>Pulse (bpm)</td>
<td>68.7 ± 10.8</td>
<td>66.8 ± 14.0</td>
<td>70.95 ± 11.9</td>
<td>between groups: 2</td>
<td>1.43</td>
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<td></td>
<td>67.9 ± 11.4</td>
<td>70.0 ± 14.7</td>
<td>70.77 ± 11.0</td>
<td>within groups: 68</td>
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<td></td>
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<td>total: 70</td>
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<tr>
<td>Chair stand test (stands)</td>
<td>11.2 ± 3.40</td>
<td>11.9 ± 3.68</td>
<td>12.4 ± 3.93</td>
<td>between groups: 2</td>
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<td>11.8 ± 3.53</td>
<td>14.7 ± 5.15</td>
<td>13.8 ± 4.47</td>
<td>within groups: 69</td>
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<td>2-minute step test (steps)</td>
<td>61.0 ± 29.2</td>
<td>70.1 ± 32.3</td>
<td>67.7 ± 30.2</td>
<td>between groups: 2</td>
<td>7.97</td>
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<tr>
<td></td>
<td>69.1 ± 27.4</td>
<td>102.9 ± 33.8</td>
<td>91.2 ± 28.5</td>
<td>within groups: 69</td>
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<td>total: 71</td>
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<tr>
<td>Sit-and-reach left leg (inches)</td>
<td>−.83 ± 3.77</td>
<td>.28 ± 3.74</td>
<td>1.69 ± 4.30</td>
<td>between groups: 2</td>
<td>1.89</td>
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<td>−1.00 ± 4.25</td>
<td>1.45 ± 3.67</td>
<td>2.6 ± 4.18</td>
<td>within groups: 69</td>
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<td>total: 71</td>
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<tr>
<td>Sit-and-reach right leg (inches)</td>
<td>−.74 ± 3.70</td>
<td>.50 ± 3.64</td>
<td>1.97 ± 3.75</td>
<td>between groups: 2</td>
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<td>−1.00 ± 3.97</td>
<td>1.34 ± 3.65</td>
<td>3.02 ± 4.06</td>
<td>within groups: 69</td>
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<td>Group 3</td>
<td>Between Groups</td>
<td>Within Groups</td>
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<tr>
<td>Up and go (seconds)</td>
<td>7.6 ± 2.21</td>
<td>7.6 ± 1.62</td>
<td>7.4 ± 1.43</td>
<td>12.32&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>69±1.43</td>
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<td>7.5 ± 2.21</td>
<td>5.9 ± .94</td>
<td>6.2 ± 1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grip (kg)</td>
<td>23.8 ± 7.02</td>
<td>25.4 ± 8.10</td>
<td>25.9 ± 10.28</td>
<td>3.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>69±1.00</td>
</tr>
<tr>
<td></td>
<td>23.9 ± 6.77</td>
<td>27.6 ± 8.08</td>
<td>27.9 ± 11.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Data are reported as $M \pm SD$.

a. Low impact exercise group improvement at $p < .05$ significance.
b. Tai chi group improvement at $p < .05$ significance.
c. Low impact exercise group improvement at $p < .01$ significance.
d. Tai chi group improvement at $p < .01$ significance.
The LIE and TC groups both significantly improved their balance \( (p < .01) \), as measured by the up-and-go test. The LIE group increased their scores by 22\% (pre: 7.6 ± 1.62; post: 5.9 ± 0.94), and the TC group increased their scores by 15\% (pre: 7.4 ± 1.43; post: 6.2 ± 1.36). There was no change in scores for the controls. There were no statistically significant differences between the improvement for the LIE and TC groups on this test.

Upper body strength, as measured by grip strength, significantly increased for both exercise groups with a 7.8\% (pre: 25.4 ± 8.10; post: 27.6 ± 8.08) increase in the LIE group and a 7.1\% (pre: 25.9 ± 10.28; post: 27.9 ± 11.00) increase in the TC group \( (p < .05) \). There was no change in grip strength for the controls. There were no statistically significant differences between the improvement for the LIE and TC groups on the grip strength test.

**Self-Report Data**

As indicated in Table 2, the TC group was the only one to report statistically significant \( (p < .05) \) increases in subjective health over time (pre: 3.39 ± 0.66; post: 3.70 ± 0.70).

There were no statistically significant differences across the groups on CES-D scores, although the data suggest a trend in which the control group experienced an increase in depressive symptoms over time, whereas the TC group and LIE group both experienced a decrease in depressive symptoms.

There was a significant improvement in functional abilities as measured by the FAS for the LIE \( (p < .05) \) group (pre: 26.1 ± 4.15; post: 26.7 ± 3.93), no change in the TC group (pre: 27.08 ± 2.04; post: 27.08 ± 2.59), and a trend for a decrease in the control group.

There were significant differences in the sleep disturbance scale between the exercise groups and the control group \( (p < .05) \). The control group’s mean score increased (more problems sleeping) over time by more than 11\% (pre: 6.2 ± 5.04; post: 7.0 ± 5.07), whereas the scores for both exercise groups decreased. There were no significant differences between the TC and LIE groups on this measure.

Anxiety level of people in both exercise groups decreased significantly \( (p < .01) \), whereas members of the control group experienced a trend for increased anxiety over time. There was no statistically significant difference between the TC and LIE groups on this measure.

**Discussion**

Data from this study indicate that relatively healthy, older people who previously had been relatively inactive and who participate in either an LIE or a
### Table 2. Psychological Profile Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control Baseline (N = 23)</th>
<th>Low Impact Exercise Baseline (N = 30)</th>
<th>Tai Chi Baseline (N = 31)</th>
<th>Degrees of Freedom</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post (N = 21)</td>
<td>Post (N = 28)</td>
<td>Post (N = 23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjective health</td>
<td>3.33 ± 0.91</td>
<td>3.5 ± 0.69</td>
<td>3.39 ± 0.66</td>
<td>between groups: 2</td>
<td>2.34b</td>
</tr>
<tr>
<td></td>
<td>3.43 ± 0.98</td>
<td>3.46 ± 0.88</td>
<td>3.70 ± 0.70</td>
<td>within groups: 69</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total: 71</td>
<td></td>
</tr>
<tr>
<td>CES-D</td>
<td>9.1 ± 6.83</td>
<td>10.1 ± 5.70</td>
<td>11.1 ± 7.98</td>
<td>between groups: 2</td>
<td>1.58</td>
</tr>
<tr>
<td></td>
<td>10.6 ± 8.82</td>
<td>8.7 ± 8.80</td>
<td>9.6 ± 8.87</td>
<td>within groups: 69</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total: 71</td>
<td></td>
</tr>
<tr>
<td>Functional Ability Scale</td>
<td>26.1 ± 3.97</td>
<td>26.1 ± 4.15</td>
<td>27.08 ± 2.04</td>
<td>between groups: 2</td>
<td>2.64a</td>
</tr>
<tr>
<td></td>
<td>25.0 ± 5.07</td>
<td>26.7 ± 3.93</td>
<td>27.08 ± 2.59</td>
<td>within groups: 69</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total: 71</td>
<td></td>
</tr>
<tr>
<td>Pittsburgh Sleep Score</td>
<td>6.2 ± 5.04</td>
<td>6.2 ± 4.53</td>
<td>6.4 ± 3.84</td>
<td>between groups: 2</td>
<td>2.94ab,c</td>
</tr>
<tr>
<td></td>
<td>7.0 ± 5.07</td>
<td>5.4 ± 3.93</td>
<td>4.9 ± 2.59</td>
<td>within groups: 69</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total: 71</td>
<td></td>
</tr>
<tr>
<td>Spielberger Anxiety Scale</td>
<td>45.3 ± 10.93</td>
<td>43.6 ± 9.64</td>
<td>44.8 ± 9.50</td>
<td>between groups: 2</td>
<td>3.75ab,d</td>
</tr>
<tr>
<td></td>
<td>42.8 ± 12.12</td>
<td>45.3 ± 8.70</td>
<td>47.1 ± 9.66</td>
<td>within groups: 61</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total: 63</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Data are reported as $M \pm SD$. CES-D = Center for Epidemiological Studies Depression Scale.

a. Low impact exercise group improvement at $p < .05$ significance.
b. Tai chi group improvement at $p < .05$ significance.
c. Low impact exercise and tai chi groups improvement over control group at $p < .05$ significance.
d. Low impact exercise and tai chi groups improvement over control group at $p < .01$ significance.
TC intervention for a period as brief as 12 weeks experience significant improvements to both their physical and psychological well-being. Although the statistical power for some of the individual outcomes was less than optimal, the consistent findings across these diverse outcomes suggest the powerful beneficial effects that exercise can have on older people. Findings from this study indicate that whereas the control group either declined or remained stable over time, both exercise groups showed improvements in upper and lower body strength, balance, and aerobic endurance. Exercising participants experienced significant reductions in anxiety and improved sleep, whereas those who did not exercise experienced increased problems in these areas. The LIE group, but not the TC group, experienced improvements in their functional ability. The TC group, but not the LIE group, reported a significant improvement in their subjective health.

Disablement in older people causes substantial hardship to individuals and to society (Chan et al., 2002; Fried et al., 2001). With the aging of the population and continued survival gains among the elderly, the national implications of increased frailty are substantial. Since age-related physiologic changes as well as extended exposure to environmental risks make it unlikely that the major diseases will be eliminated, the most promising approach to prevention of disability in the aged population is to reduce the functional consequences of disease and aging (Mor et al., 1989). The most effective way to do so is through structured exercise programs.

One of the most intriguing findings from this study is that, contrary to our expectations, people participating in the TC and LIE groups experienced similar gains. These findings are surprising because in terms of instruction, class goals, interaction of members, and class tempo, the two exercise groups were quite distinct. A typical TC class, for example, would spend 20 minutes learning a new movement and then mastering it for the remainder of that week’s sessions. Two thirds of the TC class time was spent on mini-lectures, including meditation and group discussion. In fact, much of the TC class time was spent not moving or doing any physical exercise. The LIE class, on the other hand, devoted the overwhelming majority of its time to doing some form of physical exercise. That these two divergent forms of intervention should result in almost parallel results requires further study.

Our finding concerning improvements in both physical and psychological domains warrants further attention. At the time of the postassessment, both physical and psychological improvements were evidenced for members of both active interventions. As such, it is not possible to understand whether changes in one domain proceeded, followed, or occurred concurrently with changes in the other. Given the different nature of the two interventions, it could be hypothesized that the mechanisms underlying change in the two
groups would differ from one another. As such, it could be postulated that for the LIE group, physical changes preceded psychological changes, whereas for the TC group, psychological changes preceded physical changes. Further studies that include more frequent assessments of study participants are needed to address this important issue.

It is informative also to note where the LIE and TC groups differed. Only the TC group evidenced significant improvements to their subjective health, whereas only the LIE group reported improvements to their functional ability. The finding of significant improvement to functional abilities is important because without any intervention, this capability tends to decline with age (Guralnik & Ferrucci, 2003). Further work in this area should focus on identifying interventions that are most effective for changing outcomes with the greatest effect on older persons’ ability to function independently.

Although previous studies have found that participation in both aerobic exercise and TC lowers blood pressure (Channer et al., 1996; DeSouza et al., 2000; Ko, Tsang, & Chan, 2006; Tanaka et al., 2000; Tran & Weltman, 1985), this study did not support those findings. It is possible that there were no significant changes to diastolic blood pressure because it was close to normal at baseline. The lack of findings with regard to systolic blood pressure may be due to controlling variables not addressed in this pilot study, such as the prevalence of hypertension among the participants and their usage of antihypertensive medications.

Although there were no statistically significant changes to depressive symptoms, it is important to note that depressive symptomatology increased over time for members of the control group, whereas the level of depressive symptomatology for both TC and LIE participants decreased over time. Previous research has found that participation in both LIE and TC programs has resulted in decreased depressive symptoms (Chen & Sun, 1997; Moore & Brodsgaard, 1999; O’Connor et al., 1993; Singh et al., 1997). Many of these intervention studies lasted longer than 12 weeks; hence, consistent with our trend data, a statistical reduction in depressive symptoms is likely to be attainable if the duration of the intervention is extended.

Despite these intriguing findings, there are some limitations to study generalizability. First, the sample size was relatively small, participants were advantaged in terms of education and income, and as with any randomized controlled trial, participants self-selected to participate. Second, the principal investigator, project coordinator, and instructors were not blinded to the intervention groups. As is the case in many exercise studies, one instructor conducted the TC group and a second instructor conducted the LIE group. Although both instructors followed specific protocols in their classes, this study cannot necessarily be generalized to classes taught by other instructors. Third, although the participants
were generally healthy, most had been fairly inactive prior to beginning this intervention. This may have allowed for some of the dramatic changes evident in the data, in particular concerning the fitness assessments, as most of the progress during an exercise intervention occurs with novices during the initial stages of the program. Moreover, the range in physical fitness levels of individuals at baseline was large and may have influenced findings.

Further research should be designed to remedy some of the limitations of this study, in particular sample size, frequency of assessments, and intervention duration. Prospective studies that follow participants for longer periods of time and use more frequent assessments would provide important information about the mechanisms underlying changes in physical health and psychological well-being. These mechanisms of change may be different depending on the baseline health status of the individual, thus, further research would be beneficial to examine this not only in the healthy elderly but also in the physically frail elderly. Because TC is a holistic art encompassing the body, mind, and spirit, it would be interesting for further studies to examine the role of TC and cognitive function in those with mild to moderate impairment, in particular with the increasing rate of dementia and Alzheimer’s disease in this population (Hogan, 2005; National Institute on Aging, 2002). In addition, although much is known about the short-term benefits of exercise, relatively little research has examined the long-term effects of participating in exercise programs.

There is evidence from this study that both LIE and TC have beneficial effects for older people. Results highlight the important physical and psychological benefits that exercise programs can have on healthy yet sedentary older people. The similar benefits recognized by participants in the LIE and TC groups were neither predicted nor consistent with their different philosophies and regimens. Results from this study do suggest that there are multiple ways by which older people can improve their physical and psychological well-being. Professionals who work with older people should be encouraged to develop individualized programs of exercise that are consistent with the needs and demeanor of the individuals whom they serve.

References


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