

ประสิทธิผลของการออกกำลังกายระดับเบาแบบไทยโยคะในการพัฒนา
สมรรถภาพกายและคุณภาพชีวิตในผู้สูงอายุที่มีพฤติกรรมเนือยนิ่ง
EFFECTIVENESS OF LOW-INTENSITY THAI YOGA EXERCISE FOR IMPROVING
FUNCTIONAL FITNESS AND QUALITY OF LIFE IN INACTIVE OLDER ADULTS

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บทคัดย่อ

การวิจัยเชิงทดลองนี้มีวัตถุประสงค์เพื่อเปรียบเทียบประสิทธิผลของการออกกำลังกายระดับเบาที่มุ่งพัฒนาความยืดหยุ่นและการทรงตัวซึ่งประกอบด้วยการออกกำลังกาย 2 รูปแบบคือ ไทยโยคะและไทเก็ก ในการพัฒนาสมรรถภาพกายที่จำเป็นต่อการดำเนินกิจกรรมประจำวันและคุณภาพชีวิตในผู้สูงอายุที่มีพฤติกรรมเนือยนิ่ง โดยสุ่มตัวอย่างผู้สูงอายุที่มีพฤติกรรมเนือยนิ่งจำนวน 39 คน (อายุเฉลี่ย 67 ± 6 ปี เพศหญิง 29 คน) เข้ากลุ่มทดลองรูปแบบการออกกำลังกายแบบไทยโยคะ หรือแบบไทเก็กเป็นระยะเวลา 12 สัปดาห์ ๆ ละ 2 ครั้ง ๆ ละ 90 นาที หรือกลุ่มควบคุมแล้วทำการวัดสมรรถภาพกายโดยใช้แบบทดสอบสมรรถภาพกายสำหรับผู้สูงอายุ และประเมินคุณภาพชีวิตโดยใช้แบบสำรวจสุขภาพ 36 ตัวชี้วัด (SF-36) แบบประเมินทางระบาดวิทยาจากภาวะซึมเศร้า (CES-D) แบบประเมินการออกกำลังกายในผู้สูงอายุ (PASE) และแบบประเมินความเปลี่ยนแปลงจากการออกกำลังกาย (PACES) ทำการวัดและเก็บข้อมูลก่อนการทดลอง สัปดาห์ที่ 6 สัปดาห์ที่ 12 และสัปดาห์ที่ 24 วิเคราะห์ข้อมูลโดยใช้การวิเคราะห์ความแปรปรวนแบบวัดซ้ำ (Repeated-measures ANOVA) ผลการวิจัยพบว่า ผู้สูงอายุในกลุ่มที่ออกกำลังกายแบบไทยโยคะมีพัฒนาการที่ดีขึ้นอย่างมีนัยสำคัญทางสถิติในด้านความแข็งแรงของร่างกายส่วนบน (28.8%, $F=2.881$, $P=0.01$) และร่างกายส่วนล่าง (28.4%, $F=4.624$, $P<0.001$) ความยืดหยุ่นของร่างกายส่วนบน (64.1%, $F=4.209$, $P=0.001$) และร่างกายส่วนล่าง (103.8%, $F=2.806$, $P=0.01$) การก้าวเดินและการทรงตัว (14.6%, $F=3.281$, $P=0.005$) ความทนทานของระบบหายใจและหัวใจ (11.3%, $F=5.395$, $P<0.001$) ความมีพลังชีวิต (17.7%, $F=2.387$, $P<0.001$) และความเปลี่ยนแปลงจากการออกกำลังกาย (24.0%, $F=3.415$, $P=0.004$) ซึ่งพัฒนาการทั้งหมดนี้สามารถคงอยู่จนถึงระยะหลังการทดลองไปแล้วอีก 12 สัปดาห์ จึงสรุปได้ว่าผู้สูงอายุที่มีพฤติกรรมเนือยนิ่งสามารถพัฒนาสุขภาพและคุณภาพชีวิตของตนเองได้โดยการออกกำลังกายระดับเบาแบบไทยโยคะ

คำสำคัญ: ไทยโยคะ ออกกำลังกาย คุณภาพชีวิต สมรรถภาพกาย

Abstract

Evidence suggests that older people can gain significant health benefits not only from moderate- to vigorous-intensity exercise but also from low-intensity physical activity. However, the comparative efficacy of structured low-intensity range of motion and balance exercise regimens to improve functional fitness and quality of life in inactive elderly has received limited investigation. This research determined the effect, and durability of Thai Yoga and Tai Chi on measures of physical independence and quality of life in older adults. This study used a randomized, multi-arm, controlled trial design. Thirty-nine participants (67 ± 6 y, 29 women) were randomly assigned to Thai Yoga, Tai Chi, for 12 weeks, twice weekly for 90-minutes each session, or a control group. Functional fitness was evaluated using the Senior Fitness Test battery. Quality of life was assessed using self-report measures that included the 36-item-Short-Form Health Survey (SF-36), the Centre for Epidemiological Studies of Depression (CES-D), the Physical Activity Scale for the Elderly (PASE), and the Physical Activity Enjoyment Scale (PACES). Outcome measures were assessed at baseline, six, 12, and 24 weeks. The data were analyzed using repeated-measures ANOVA, with alpha set at 0.05. Findings indicated that Thai Yoga participants significantly improved upper-body-strength (28.8%, $F=2.881$, $P=0.01$), lower-body-strength (28.4%, $F=4.624$, $P<0.001$), upper-body-flexibility (64.1%, $F=4.209$, $P=0.001$), lower-body-flexibility (103.8%, $F=2.806$, $P=0.01$), agility-and-dynamic-balance (14.6%, $F=3.281$, $P=0.005$), aerobic-endurance (11.3%, $F=5.395$, $P<0.001$), SF-36-vitality-dimension (17.7%, $F=2.387$, $P<0.001$), and PACES (24.0%, $F=3.415$, $P=0.004$) with the beneficial effects were maintained 12 weeks after completion of the intervention. The findings suggest that inactive older people can improve their health and well-being through low-intensity Thai Yoga exercise.

Keywords: Thai Yoga, exercise, quality of life, functional fitness

Introduction

Physical inactivity is associated with increased mortality and risk of chronic disease, reduced quality of life, earlier onset of physical frailty and declining function. Such effects of sedentary living impose a considerable burden on society, with older adults being the most physically inactive of any age group. In contrast, the introduction of physical activity has been shown to categorically ameliorate many of the effects of secondary aging (WHO, 2016). Thus, for all healthy older adults it is recommended that they participate in a minimum of 30 minutes of moderate-intensity aerobic physical activity 5 days per week, plus resistance exercise regimen twice weekly, and supplemental flexibility and balance exercises to maintain physical function and

reduce the risk of falls (Nelson et al., 2007). However, less than 14% of older adults over the age of 65 are currently meeting these standards (WHO, 2016).

Clearly many older adults are having difficulty meeting these minimum recommended levels of physical activity. However, evidence suggests significant health benefits are still afforded to older individuals when participating in significantly lower levels of physical activity than recommended (Healey et al., 2007; Demakakos et al., 2010). Furthermore, low-intensity physical activity is associated with improved maintenance of physical fitness (Song et al., 2003) and enhanced pleasant sensations of exercise engagement in older adults (Resnick & Spellbring, 2000). Consequently, in this study we sought to investigate the effects of two forms of structured low-intensity exercise regimen that emphasize range of motion and balance. Tai Chi and Thai Yoga are regimens that contain these characteristics.

Tai Chi is a Chinese martial art and the practice of this form is associated with a low metabolic load and significant physiological benefits. Improved cardio respiratory capacity (Frye et al., 2007), strength, balance (Song et al., 2003; Frye et al., 2007; Takeshima et al., 2007), flexibility, and quality of life (Song et al., 2003; Frye et al., 2007) are observed with this form of exercise regimen. In contrast, the effects of Thai Yoga have received considerably less attention.

Thai Yoga is a traditional form of exercise practiced extensively in Thailand for many centuries. Its main principles and techniques are similar to traditional yoga. Both yoga styles are classified as low-intensity exercise which affords participants significant physical and psychological benefits (Buranruk et al., 2010; Chen et al., 2008). However, Thai Yoga is less strenuous with postures that are less challenging and easier to perform than the traditional yoga (NTTM, 1997). Thus, the practice of Thai Yoga may be more accessible for people who are sedentary or have low motivation. However, clear evidence from a randomized controlled trial on the effectiveness of Thai Yoga exercise on the physical and psychological benefits is currently rare.

Therefore, the main hypothesis of the study was that a community-based twice weekly Thai Yoga and Tai Chi program of 12 weeks duration would improve functional fitness including strength, flexibility, balance and endurance, and health-related quality-of-life in inactive older people, and these effects would be sustained until the 24-week of the study period.

Methods

Participants

Individuals were eligible to participate in the study if they were aged over 60 years, apparently healthy as determined by the Physical Activity Readiness Questionnaire

(ACSM, 1997), participating in less than 150 minutes of moderate or vigorous physical activity per week as determined by the Physical Activity Scale for the Elderly (Washburn et al., 1993), and free from contraindications that would limit participation in a low-intensity exercise program. Thirty-nine eligible volunteers (10 men and 29 women) were invited for a baseline evaluation.

Study Design

This was an assessor-blinded, randomized controlled trial approved by the Phetchaburi Rajabhat University Human Research Ethics Committee. Eligible subjects firstly provided written informed consent before completed baseline assessments of functional fitness and health-related quality-of-life. Subjects were then randomly allocated and counter balanced to Thai Yoga, Tai Chi or control group. Participants then completed a 12-week low-intensity exercise regimen that took place twice weekly and lasted 90 minutes each. They were reassessed at 6 weeks, 12 weeks and 24 weeks.

Thai Yoga Intervention

The Thai Yoga intervention employed a modified, 90 minute, 15-posture Thai Yoga routine (NTTM, 1997) which was taught by a qualified Thai Yoga instructor (Figure 1A-C). Each session commenced with 10-minute diaphragmatic breathing and meditation in a seated position followed by a 5-minute warm-up with stretching exercise in a standing position. The 15-posture routine was then commenced, initially in a seated position for eight of the 15 postures that included facial and head massage, stretching exercises designed to promote shoulder flexibility and arm strength followed by postures designed to strengthen trunk muscles and to increase flexibility of the hips, arm, wrist and finger joints (Figure 1A). The next four postures performed in a standing position designed to develop flexibility and strength in the lower- and upper-body (Figure 1B). The final three postures involved stretching and flexing movements of the legs and knees, arm and shoulders as well as full body stretching in a lying position (Figure 1C). All postures within the Thai Yoga routine were held for a maximum of 20 seconds and repeated 3 – 5 times. Each class ended with 5 minutes of supine relaxation and 5 minutes of standing diaphragmatic breathing and stretching.

Tai Chi Intervention

The Tai Chi program designed for older adults with osteoarthritis was taught by a qualified instructor using the 12-movement Sun style routine (Figure 1D-L). This style of Tai Chi requires a higher stance (knees flexion less than 30°) thus a more upright posture is adopted and frequent moving of the feet to reduce the challenge to the base of support (Lam & Horstman, 2002).

Basic movements consisted of commencement (Figure 1D), opening and closing hands (Figure 1E), single whips (Figure 1F), waving hands (Figure 1G), and closing

forms (Figure 1D). Advanced movements included brushing the knee and twist stepping (Figure 1H), playing the lute (Figure 1I), Parry and punch with stepping forward to deflect downwards (Figure 1J), blocking and closing (Figure 1K), pushing the mountain (Figure 1L), opening and closing hands (Figure 1E), and closing forms (Figure 1D). One set of the basic and advanced movements took about approximately two minutes, and 10 – 15 sets of these movements were performed in each session. A session consisted of a preliminary 10-minute warm-up stretching exercise, 60 minutes of Tai Chi and a 10-minute of qigong with deep breathing as a cool-down.



Figure 1 Summary of Thai Yoga postures and Tai Chi forms

Participants in both experimental groups were encouraged to complete unsupervised home-based training for 20 minutes a day on the other remaining days each week for the duration of the 12-week intervention. Following this period each subject was encouraged to continue their unsupervised home sessions or attend community-based classes for the remaining 12 weeks of the investigation (Week 24).

Control Intervention

Participants in the control group did not attend any formal facilities-based exercise training intervention. However, they received telephone-supervised exercise

regimen that encouraged home-based increases in physical activity (Kolt et al., 2007). All participants attended a face-to-face instructional session and were provided with written information. This was then followed by regular telephone counseling sessions weekly. At the end of study (Week 24), participants in this group were offered to take part in either the Thai Yoga or Tai Chi classes at the community center.

Experimental procedures

Outcome measures included functional fitness and health-related quality-of-life. Functional fitness was measured using the Senior Fitness Test. Quality of life was assessed using four validated questionnaires. All outcomes measures were assessed at baseline, Week 6, Week 12 and Week 24.

Senior Fitness Test (SFT)

The SFT consists of six validated and reliable assessments of physical attributes required for daily living, specifically developed for older adults (Rikli & Jones, 1997). It comprises assessments of strength, 30-second chair stand and arm curl tests; range of motion, chair sit-and-reach and back scratch tests; agility and dynamic balance, 8-foot up-and-go test; and endurance, 6-minute walk test. The assessments were conducted by research assistants who were blinded to the treatment allocation.

Self-Report Quality of Life

Four validated questionnaires were completed by participants to assess quality of life. Physical activity levels were assessed using the Physical Activity Scale for the Elderly (PASE; Washburn et al., 1993). The Physical Activity Enjoyment Scale (PACES; Motl et al., 2001) was used to evaluate enjoyment of doing physical activity. A Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992) was completed to determine physical and mental outcomes. Finally, depressive symptoms were assessed using the Center for Epidemiological Studies of Depression (CES-D; Radloff, 1977) survey.

Statistical Analysis

A sample size of 13 subjects per group was required for a power of 0.80 to detect a difference between means of three groups with an alpha of 0.05 (Takeshima et al., 2007). Data were analyzed on an intention-to-treat basis. Baseline group mean comparisons were performed using one-way analyses of variance (ANOVA) with post hoc analysis to determine group differences. Repeated-measures ANOVA procedures were conducted and Bonferroni post hoc analyses were used to determine group differences, with alpha set at 0.05.

Results

At baseline, no significant difference was observed in participant characteristics between the three groups. Similarly, no significant difference at baseline was observed

in all performance-based measures of the seniors fitness test (Table 1). The mean scores on the six-item SFT were well within the normal range of the average SFT scores for populations aged between 65 and 69 years (Rikli & Jones, 1997). There were also no significant differences at baseline between the three groups on the self-report measures of quality of life (Table 2).

The attendance rate over the period of the 12-week intervention was 96% and 85% for the Thai Yoga and Tai Chi groups, respectively. During the training period, four and three subjects dropped out of the Tai Chi and control groups, respectively. No exercise-related injuries occurred among study participants during the 12-week trial.

Table 1 Changes in functional fitness outcomes from baseline to 6, 12 and 24 weeks

Outcome Measures	Thai Yoga (n = 13)	Tai Chi (n = 13)	Control (n = 13)	Significance		
				Thai Yoga vs. Control	Tai Chi vs. Control	Thai Yoga vs. Tai Chi
30-sec Chair Stand (no. of repetitions)						
Baseline	13.0 (11.4, 14.6)	14.6 (12.5, 16.7)	14.2 (11.6, 16.8)	.652	.959	.483
Week 6	15.3 (13.7, 16.8)	14.9 (13.4, 16.4)	14.6 (12.1, 17.0)	.025*	1.000	.025*
Week 12	16.7 (15.2, 18.1)	15.7 (14.4, 16.9)	14.5 (12.1, 16.9)	<.001*	.611	.007*
Week 24	18.5 (15.4, 21.4)	17.3 (15.7, 19.0)	15.1 (12.7, 17.3)	.001*	.258	.078
30-sec Arm Curl (no. of repetitions)						
Baseline	13.6 (11.7, 15.5)	15.4 (12.8, 17.9)	15.5 (12.8, 18.2)	.441	.995	.498
Week 6	15.5 (13.6, 17.2)	16.2 (14.4, 18.0)	16.1 (13.0, 19.0)	.349	.942	.536
Week 12	17.5 (15.9, 19.1)	16.9 (15.3, 18.4)	16.3 (13.4, 19.1)	.009*	.732	.056
Week 24	18.4 (16.0, 20.7)	17.5 (16.0, 19.0)	17.1 (14.3, 19.9)	.006*	.843	.027*
Chair Sit & Reach (Inches)						
Baseline	2.0 (-0.2, 4.3)	1.0 (-1.5, 3.5)	1.6 (-1.1, 4.3)	.964	.926	.804
Week 6	3.2 (0.8, 5.6)	1.3 (-1.0, 3.6)	2.0 (-0.4, 4.5)	.321	.954	.200
Week 12	4.1 (1.9, 6.2)	1.2 (-1.4, 3.9)	1.9 (-0.5, 4.4)	.013*	.978	.007*
Week 24	4.0 (1.3, 6.6)	1.9 (-0.1, 4.0)	2.2 (-0.3, 4.8)	.066	.850	.194
Back Scratch (Inches)						
Baseline	-2.7 (-6.0, 0.6)	-3.2 (-5.7, -0.7)	-1.5 (-4.0, 1.1)	.783	.605	.954
Week 6	-1.4 (-4.7, 1.7)	-3.3 (-5.6, -0.9)	-1.4 (-3.9, 1.1)	.018*	.772	.087
Week 12	-0.9 (-4.1, 2.2)	-3.0 (-5.2, -0.8)	-1.3 (-3.8, 1.1)	.005*	.558	.068
Week 24	-0.8 (-3.9, 2.1)	-2.4 (-4.3, -0.4)	-1.5 (-4.0, 1.1)	.021*	.395	.304
8-foot Up & Go (Seconds)						
Baseline	5.4 (4.9, 5.9)	5.4 (4.8, 5.9)	5.5 (4.8, 6.0)	.994	.966	.988
Week 6	4.8 (4.4, 5.2)	5.3 (4.7, 5.8)	5.2 (4.6, 5.7)	.181	.585	.022*
Week 12	4.6 (4.2, 5.0)	4.9 (4.7, 5.3)	5.2 (4.6, 5.7)	.013*	.523	.481
Week 24	4.5 (4.1, 4.8)	4.9 (4.4, 5.3)	5.2 (4.6, 5.7)	.013*	.679	.271
6-min Walk (Yards)						
Baseline	589 (526, 653)	603 (576, 631)	618 (578, 658)	.606	.878	.884
Week 6	624 (583, 664)	620 (592, 647)	610 (579, 640)	.023*	.265	.467
Week 12	656 (612, 700)	624 (592, 657)	613 (583, 643)	<.001*	.242	.015*
Week 24	647 (599, 695)	627 (600, 658)	613 (574, 651)	.001*	.165	.139

Remark All values are mean and 95% confidence intervals. P values were calculated with repeated-measures ANOVA.

*Significance at $P < 0.05$.

Table 2 Changes in quality of life outcomes from baseline to 6, 12 and 24 weeks

Outcome Measures	Thai Yoga (n = 13)	Tai Chi (n = 13)	Control (n = 13)	Significance		
				Thai Yoga vs. Control	Tai Chi vs. Control	Thai Yoga vs. Tai Chi
PASE						
Baseline	192 (152, 233)	194 (139, 250)	195 (135, 255)	.996	1.000	.998
Week 6	247 (209, 286)	207 (158, 256)	202 (155, 249)	.233	.978	.321
Week 12	229 (179, 280)	208 (161, 255)	203 (160, 246)	.558	.977	.686
Week 24	234 (162, 305)	206 (165, 246)	235 (180, 290)	.999	.674	.642
CES-D						
Baseline	7.3 (3.3, 11.2)	6.2 (3.6, 8.8)	7.3 (3.7, 10.9)	1.000	.879	.879
Week 6	6.5 (2.8, 10.3)	5.4 (3.0, 7.8)	4.8 (1.9, 7.6)	.597	.624	.999
Week 12	5.9 (2.4, 9.4)	4.8 (3.2, 6.3)	5.2 (1.8, 8.5)	.925	.939	.999
Week 24	4.6 (1.7, 7.5)	3.4 (1.2, 5.5)	6.4 (3.1, 9.7)	.482	.424	.994
SF-36 Physical component						
Baseline	75.3 (66.3, 84.3)	78.0 (68.1, 88.1)	85.8 (79.4, 92.3)	.157	.354	.876
Week 6	75.7 (63.2, 88.2)	75.8 (65.8, 85.7)	84.3 (76.6, 92.0)	.888	.981	.793
Week 12	75.1 (64.7, 85.5)	77.1 (66.6, 87.6)	85.1 (77.1, 93.1)	.985	.998	.974
Week 24	71.9 (59.2, 84.6)	74.9 (63.7, 86.1)	85.1 (77.2, 92.9)	.927	.938	.999
SF-36 Mental component						
Baseline	78.5 (71.0, 86.1)	83.1 (76.3, 90.0)	86.0 (78.7, 93.4)	.264	.817	.594
Week 6	80.1 (67.8, 92.4)	81.1 (75.3, 86.9)	85.1 (79.8, 90.5)	.892	.973	.777
Week 12	83.7 (76.6, 90.9)	84.1 (77.8, 90.4)	84.9 (78.4, 91.4)	.375	.901	.631
Week 24	83.6 (76.6, 90.4)	85.7 (78.7, 92.6)	86.6 (80.9, 92.4)	.625	.914	.859
SF-36 Vitality scale						
Baseline	58.8 (47.9, 69.8)	70.7 (60.1, 81.3)	70.7 (59.4, 82.1)	.230	1.000	.230
Week 6	71.1 (61.7, 80.5)	68.8 (59.4, 78.2)	66.9 (53.8, 80.0)	.009*	.925	.023*
Week 12	69.2 (56.7, 81.7)	69.6 (59.9, 79.3)	70.7 (59.8, 81.7)	.050*	.965	.040*
Week 24	70.4 (61.0, 79.7)	74.2 (64.7, 83.7)	68.8 (55.9, 81.8)	.035*	.665	.406
PACES						
Baseline	61.6 (58.3, 64.8)	62.4 (58.5, 66.3)	62.8 (57.9, 67.7)	.888	.988	.945
Week 6	70.5 (64.9, 76.0)	67.4 (62.4, 72.3)	65.1 (58.1, 72.1)	.010*	.439	.166
Week 12	76.4 (73.6, 79.2)	69.8 (64.9, 74.7)	68.2 (61.4, 75.0)	.001*	.681	.010*
Week 24	76.3 (73.9, 78.7)	69.6 (64.8, 74.4)	68.1 (61.7, 74.5)	.002*	.749	.014*

Remark PASE, Physical Activity Scale for the Elderly; CES-D, Center for Epidemiological Studies of Depression; PACES, Physical Activity Enjoyment Scale; SF-36, 36-Item Short-Form Health Survey.

All values are mean and 95% confidence intervals. P values were calculated with repeated-measures ANOVA.

*Significance at $P < 0.05$.

Changes in physical performance

Over the study period, lower-body strength improved significantly only in the Thai Yoga group. The relative change of the 30-second chair stand test from baseline to 6, 12 and 24 weeks in the Thai Yoga group were significantly greater than the improvement observed within the Tai Chi group and those in the control group. No significant between-group differences were observed for the Tai Chi and control groups (Figure 2A). With respect to upper-body strength, Thai Yoga training resulted in significantly greater improvement in the 30-second arm curl test compared with the

control group at 12 weeks. This improvement increased at 24 weeks and showed significantly greater improvement compared with the Tai Chi group and the control group. In contrast, no significant between-group differences for the Tai Chi and control groups were observed (Figure 2B).

At 12 weeks, the Thai Yoga group had a significantly greater improvement in lower-body flexibility than the control and Tai Chi groups. The relative change of the chair sit-and-reach test score from baseline for the Thai Yoga group was significantly greater than the control group and the Tai Chi group. No similar changes existed between the Tai Chi and control groups over the study period (Figure 2C). Regarding to upper-body flexibility, the Thai Yoga group showed a significantly greater improvement in the back scratch performance than the Control group over time (Figure 2D).

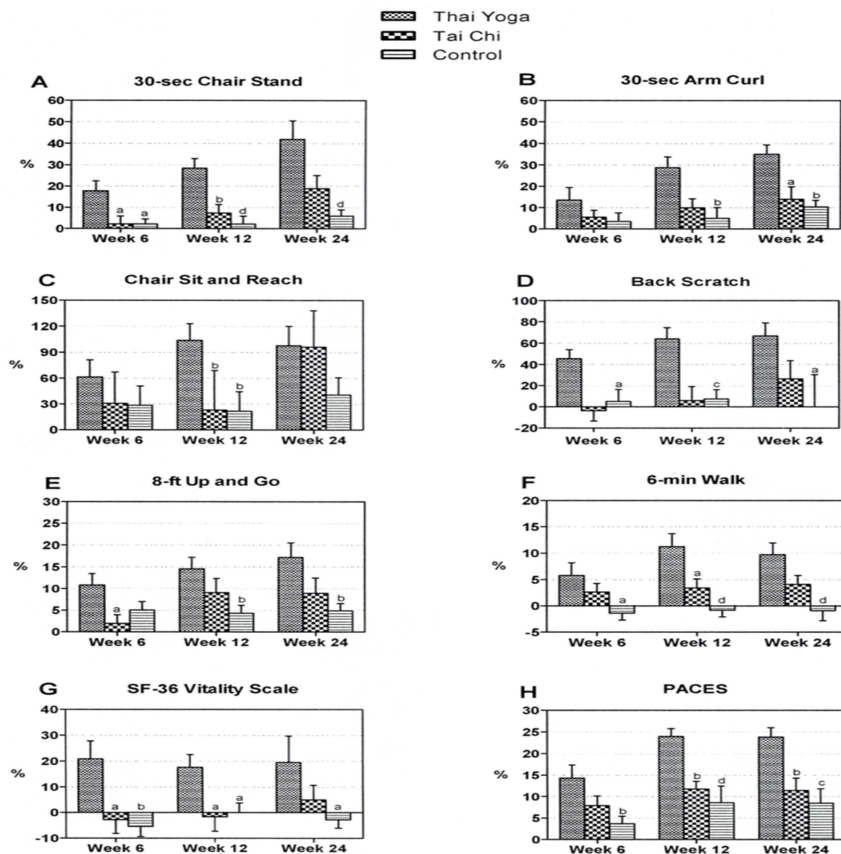


Figure 2 Relative change of outcome measures from baseline to 6, 12 and 24 weeks

Remark PACES, Physical Activity Enjoyment Scale. The values shown are relative change; I bars indicate 95% confidence intervals. P values were calculated with repeated-measures ANOVA. Letters denote significant between-group differences from Thai Yoga group: a, P values significant at $P < 0.05$; b, P values significant at $P \leq 0.01$; c, P values significant at $P \leq 0.005$; d, P values significant at $P \leq 0.001$.

The Thai Yoga group showed significantly greater improvements in dynamic balance and agility, as measured by the eight-foot up-and-go test. The relative changes of the test score over time for the Thai Yoga group were significantly greater than those for the control group. In contrast, no similar changes between the Tai Chi and control groups were observed (Figure 2E).

Aerobic endurance estimated via six-minute walk test scores improved significantly in the Thai Yoga group throughout the study period. Significant between-group differences from baseline to 6, 12 and 24 weeks were observed for the Thai Yoga group and the control group. At 12 weeks, the improvement in aerobic endurance in the Thai Yoga group was significantly greater than that in the Tai Chi group. However, similar improvement in the Tai Chi and control groups were not found (Figure 2F).

Changes in Self-Report Quality of Life

There were no statistically significant improvements in self-reported physical activity levels, subjective health, and depression in any study groups. However, significant improvements in vitality and enjoyment of physical activity participation were observed for the Thai Yoga group, as shown in Table 2, Figure 2G, and Figure 2H.

Discussion

We observed participants who completed a 12-week Thai Yoga intervention made significant improvements in their functional ability, vitality and enjoyment in participating in physical activity. Furthermore, these improvements were sustained 12 weeks after the completion of the intervention.

The maintenance of muscular strength is essential for older adults to maintain their capacity to independently perform activities of daily life (ADLs). Previous investigations have observed increased lower-extremity strength after 24 weeks of yoga exercise, with no change in upper-body strength (Chen et al., 2008) and a 10-week strength and balance training regimen significantly improved lower-body and upper-extremity strength (Di Brezzo et al., 2005). Within our investigation, lower-body strength gains in the Thai Yoga appeared as early as six weeks, indicating that some of these early strength gains may have been due to neural adaptations (Gabriel et al., 2006).

Balance and agility are critical physical attributes for the performance of ADLs in older adults. Low-intensity exercise regimen has been associated with an improvement in these physical attributes (Takeshima et al., 2007). A recent yoga study showed an increase in balance and agility after 8 weeks of yoga exercise (Zettergren et al., 2011). Enhanced lower body strength gains for the Thai Yoga intervention, may result from the progressive but repetitive unilateral weight bearing activities that

generated deviations in center of gravity away from the base-of-support (Rogers et al., 2003).

It is well documented that flexibility decreases approximately 15% per decade after 20 years of age. In the current study, flexibility significantly improved after the 12 weeks of Thai Yoga training. The greatest relative effect was observed on lower-body flexibility, which increased 103.8% compared with an increase of 93% on lower-body flexibility after 12 weeks of aquatic exercise (Alves et al., 2004), whereas only few studies (Di Brezzo et al., 2005) demonstrated a significant improvement in upper-body flexibility as reported in our study. This illustrates the specificity of the Thai Yoga training on improving flexibility in older adults.

The maintenance of satisfactory levels of cardio respiratory fitness may extend life expectancy free from functional limitations. In the current study, cardio respiratory fitness improved after the 12-week Thai Yoga training. Many studies that verified the effects of other aerobic modalities and functional exercises on cardio respiratory fitness observed a wide range of improvements (Alves et al., 2004; Takeshima et al., 2007). Therefore, it seems that the dose-response training effect on cardio respiratory fitness of older individuals may be dependent of considerable factors, such as exercise modality, gender, age, initial fitness level, and specially exercise intensity.

One of the unique aspects of this investigation was the inclusion of 12-week monitoring period after the completion of the exercise intervention to assess the durability of gains from participating in the exercise regimen. While previous studies suggest that the functional performance benefits of exercise programs decline within two weeks after cessation of exercise (Hallage et al., 2010), we found the physical performance gains from a Thai Yoga intervention were maintained up 12 weeks after the completion of the intervention. It is possible that Thai Yoga appeared to be easier and desirable to learn and practice at home (Au-Yeung et al., 2009). Thus, older people continued to practice the principles of Thai Yoga afterwards.

The results suggest that recommended level of physical activity may not be required initially in sedentary older adults to improve physical function. The relative simplicity of a low intensity exercise appears to be important attribute to encourage home-based exercise when working with older adults. Therefore, Thai Yoga may be a useful way to introduce older people in the community to regular exercise which could be extended in intensity over time. However, further research would be beneficial to examine this not only in healthy elderly people but also in physically frail older people. Because Thai Yoga and Tai Chi are both holistic arts encompassing the body, mind, and spirit, it would be interesting in further research to examine the role of Thai Yoga and Tai Chi on cognitive functioning in those with mild to moderate

impairment, particularly given the increasing rate of dementia and Alzheimer's disease in this population (Frye et al. 2007).

Conclusion

The results indicate that low-intensity exercise has beneficial physical and psychological effects in older people. The results highlight the important physical and psychological benefits that regular practice of Thai Yoga for 6 to 12 weeks can have on sedentary yet healthy older adults. With its lasting effect beyond the training period, it is recommended that the Thai Yoga program should be incorporated as an effective strategy to promote improvements in the functional fitness and quality of life of apparently healthy older adults in any community center.

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References

- Alves RV, Mota J, Costa CM. et al. Health related physical fitness in the elderly: The influence of water exercise, *Revista Brasileira de Medicina do Esporte*. 2004; 10: 31-37.
- American College of Sports Medicine (ACSM). *ACSM's Exercise Management for Persons With Chronic Diseases and Disabilities*. USA: Human Kinetics; 1997.
- Au-Yeung SS, Hui-Chan CW, Tang JC. Short-form Tai Chi improves standing balance of people with chronic stroke, *Neurorehabilitation and Neural Repair*. 2009; 23: 515-522.
- Buranruk O, La Growy S, Ladawanz S. et al. Thai Yoga as an Appropriate Alternative Physical Activity for Older Adults, *Journal of Complementary and Integrative Medicine*. 2010; 7(1): 1-14.
- Chen CH, Yen M, Fetzer S. et al. The effects of Tai Chi exercise on elders with osteoarthritis: A longitudinal study, *Asian Nursing Research*. 2008; 2(4): 235-241.
- Demakakos P, Hamer M, Stamatakis E. et al. Low-intensity physical activity is associated with reduced risk of incident type 2 diabetes in older adults: Evidence from the English Longitudinal Study of Ageing, *Diabetologia*. 2010; 53: 1877-1885.
- Di Brezzo R, Shadden BB, Raybon BH. et al. Exercise intervention designed to improve strength and dynamic balance among community-dwelling older adults, *Journal of Aging and Physical Activity*. 2005; 3: 198-209.
- Frye B, Scheinthal S, Kemarskaya T. et al. Tai Chi and low impact exercise: effects on the physical functioning and psychological well-being of older people, *Journal of Applied Gerontology*. 2007; 26(5): 433-453.
- Gabriel DA, Kamen G, Frost G. Neural adaptations to resistive exercise: Mechanisms and recommendations for training practices, *Sports Medicine*. 2006; 36: 133-149.

- Hallage T, Krause MP, Haile L. et al. The effects of 12 weeks of step aerobics training on functional fitness of elderly women, *Journal of Strength and Conditioning Research*. 2010; 24: 2261-2266.
- Healey GN, Dunstan DW, Salmon J. et al. objectively measured light-intensity physical activity is independently associated with 2-h plasma glucose, *Diabetes Care*. 2007; 30(6): 1384-1389.
- Kolt GK, Schofield GM, Kerse N. et al. Effect of telephone counseling on physical activity for low-active older people in primary care: A randomized, controlled trial, *Journal of the American Geriatrics Society*. 2007; 55: 986-992.
- Lam P, Horstman J. *Overcoming arthritis: A holistic plan including a unique tai chi programme to relieve pain and restore mobility*. Victoria: Dorling Kindersley Pty Limited; 2002.
- Motl RW, Dishman RK, Saunders R. et al. Measuring enjoyment of physical activity in adolescent girls, *American Journal of Preventive Medicine*. 2001; 21: 110-117.
- National Institute of Thai Traditional Medicine (NTTM). *Thai Physical Exercise Style Rusie Dotton 15-Posture Basic form*, Nonthaburi, Thailand: Department of medical service, ministry of public health; 1997.
- Nelson ME, Rejeski WJ, Blair SN. et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association, *Circulation*. 2007; 116: 1094-1105.
- Radloff LS. The CES-D scale: A self-report depression scale for research in the general population, *Applied Psychological Measurement*. 1977; 1: 385-401.
- Resnick B, Spellbring AM. Understanding what motivates older adults to exercise, *Journal of Gerontological Nursing*. 2000; 26: 34-42.
- Rikli R, Jones CJ. Assessing physical performance in independent older adults: Issues and guidelines, *Journal of Aging and Physical Activity*. 1997; 5: 244-261.
- Rogers ME, Rogers NL, Takeshima N. et al. Methods to evaluate and improve the physical parameters associated with fall risk in older adults, *Preventive Medicine*. 2003; 36: 255-264.
- Song R, Lee EO, Lam P. et al. Effects of tai chi exercise on pain, balance, muscle strength, and perceived difficulties in physical functioning in older women with osteoarthritis: A randomised clinical trial, *Journal of Rheumatology*. 2003; 30: 2039-2044.
- Takeshima N, Rogers NL, Rogers ME. Et al. Functional fitness gain varies in older adults depending on exercise mode, *Medicine & Science in Sports & Exercise*. 2007; 39(11): 2036-2043.
- Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36): concept framework and item selection, *Medical Care*. 1992; 30(6): 473-483.
- Washburn RA, Smith KW, Jette AM. et al. The Physical Activity Scale for the Elderly (PASE): Development and evaluation, *Journal of Clinical Epidemiology*. 1993; 46(2): 153-162.
- World Health Organization (WHO). Prevalence of insufficient physical activity. Available at: http://www.who.int/gho/ncd/risk_factors/physical_activity_text/en/index.html. Accessed March 19, 2016.
- Zettergren KK, Lubeski JM, Viverito JM. Effects of a yoga program on postural control, mobility, and gait speed in community-living older adults: A pilot study, *Journal of Geriatric Physical Therapy*. 2011; 34: 88-94.