Original Article

Effect of 12 Weeks Modified "Dantien-Salee" Yoga Training on Pulmonary Function, Functional Fitness, and Quality of Life in Elderly Thai

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Objective: To investigate the effect of 12 weeks Modified "Dantien-Salee" Yoga training (MDS) on pulmonary function, functional fitness, and quality of life (QoL) in elderly Thai.

Material and Methods: The quasi-experimental study was conducted using a sample of twenty-four elderly subjects with no previous experience of yoga training. They were equally divided into a MDS group and control group. The MDS group were asked to attend a 70-minite session of MDS training three times a week over 12 weeks. The control group was asked to continue their normal daily routine over the same period. Pulmonary function tests, functional fitness assessments, and QoL by SF-36 assessments, were all measured at baseline and after the 12 weeks study period. A two-way repeated measures ANOVA was used to evaluate differences between groups.

Results: There were no differences in spirometry and lung volumes over the intervention period. Both maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) showed tendency to improve in the MDS group but did not reach statistically significant level. Functional fitness and QoL improved significantly ($p<0.05$) over the 12 weeks period in MDS group.

Conclusion: MDS program led to improvement of functional fitness and enhance the QoL in the study group of elderly participants without significant change in pulmonary function parameters. The MDS program is safe and easy to practice. It should be considered as a mode for exercise prescription in the elderly.

Keywords: Yoga; Elderly; Functional fitness; QoL

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The intrinsic structure of the lung, as well as the supporting extrapulmonary tissues such as chest wall, spine, and respiratory muscles, change as people get older. Unfavorable respiratory mechanics are consequences of these alterations and lead to reduced pulmonary function and efficiency[1]. Lung function parameters such as forced expiratory volume in 1 second (FEV1) and Forced vital capacity (FVC) decline with age. In healthy male and female non-smokers, the rate of decline of FEV1 is approximately 30 mL and 23 mL per year, respectively[2]. In the elderly, alterations in lung anatomy and resting lung function have an impact on exercise physiology. Physical fitness is known to deteriorate as people age, resulting in muscle weakness, poor balance, and a higher chance of fall and injury. With the passage of time, all body systems deteriorate. Thailand is on the verge of becoming an ageing society. Obesity, hypertension, diabetes, cardiovascular disease, and other chronic disorders are becoming more common[3]. To preserve physical health and functional fitness, healthy elderly should engage in 30 minutes of regular moderate intensity activity five days a week or 150 minutes per week, as well as resistance exercise twice weekly, to prevent physical frailty and increase psychological well-being[4]. Elderlies struggle to meet the required minimal levels of physical activity. Common exercise activities, such as running, are considered hard for the elderly and have a degree

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of stress on the body's joints. Due to joint diseases, elderly people may find this sort of exercise difficult and less pleasurable. These reasons lead to reduce exercise adherence and hence nullify the health benefits of regular exercise. Scientific evidence suggests that elderlies who engage in low level physical activity still get significant health benefits[5,6]. The literature highlights the potential advantages of yoga for the aged, citing evidence of considerable increases in quality of life (QoL)[7] and improved mental depression[8]. Due to the low impact nature of yoga and Tai Chi, these exercises may be seen as more ideal fitness options for the elderly. However, there is a paucity of research on the impact of yoga exercises on senior people's ventilatory capabilities and respiratory muscle strength[9,10].

In the present study the authors investigated the effects of "Dantien-Salee" yoga, which is a combination of yoga and Tai Chi activity. "Dantien-Salee" yoga consisted of 20 forms of Dantien -Tai Chi and two series of yoga poses, which are shown to improve the strength and dynamic balance of the lower body, to improve cardiovascular circulation and flexibility, and to reduce fatigue and pain[11]. Originally, "Dantien-Salee" yoga was used to demonstrate increase flexibility and strength in elderly subjects[12]. Both Tai Chi and yoga are low intensity exercise. To the authors knowledge, effects of "Dantien-Salee" yoga on lung function has not been evaluated in this population. The aim of the present study was to develop a Modified "Dantien-Salee" yoga (MDS) program, which is less strenuous with postures that are easy and safe to perform for the sedentary elderly participants and determine the effect of 12 weeks of training on pulmonary function and functional fitness that is relevant to daily living and QoL in healthy elderly participants aged over 60 years old.

Materials and Methods

Subjects

The elderly participants were recruited from communities around Mahidol University, Salaya campus, and by advertisement circulars at the College of Sports Science and Technology, Mahidol University. The inclusion criteria for participating were age older than 60 years old, can regularly attend the class, which was three times a week for 12 weeks. The participants who had contraindication for exercise such as musculoskeletal disorders, neurological abnormalities, diagnosed cardiovascular diseases within three months, uncontrolled blood pressure with systolic blood pressure of 180 mmHg or more or diastolic blood pressure of 110 mmHg or more, or had practiced yoga or Tai Chi within the previous three months were excluded. A written informed consent was obtained before enrollment. The study protocol was approved by Mahidol University Central Institutional Review Board (MU-CIRB protocol number 2015/133.2808).

Study protocol

The present study was a controlled trial conducted using an age and gender-matched design. Twelve subjects were allocated to MDS program with a mean age of 64.3±4.0 years and 12 subjects were in a control group with a mean age of 65.6±5.4 years. All subjects completed baseline assessments including pulmonary function tests, functional fitness tests, and QoL and then were reassessed at 12 weeks, or after the study. Subjects in the MDS group performed a 12-week MDS exercise program, thrice weekly, which were supervised by single investigator, DP, who has expertise in yoga teaching. The control group resumed normal physical activity. Pulmonary function tests, functional fitness tests, and QoL at baseline and at 12 weeks were measured in both the MDS and the control groups were evaluated.

Pulmonary function tests

The subjects performed pulmonary function tests at Division of Respiratory Disease and Tuberculosis, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University using Vmax Encore 22, Care Fusion, Germany for spirometry, lung volume, and respiratory muscle strength measurement. The pulmonary function tests were performed by well-trained technician and followed the ATS/ERS Task Force statement on the standardization of lung function testing[13]. Spirometry measurements included FEV1, FVC, FEV1/FVC%, and maximal voluntary ventilation (MVV). Predicted normal spirometry values were determined using the equations reported by Dejsomritrutai et al[14]. Lung volume measurement contained total lung capacity (TLC), residual volume (RV), RV/TLC%, inspiratory capacity (IC), IC/TLC%, functional residual capacity (FRC), and FRC/TLC%. Respiratory muscle strength was assessed by maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP). MEP was measured at TLC and MIP at RV[15]. The highest of three valid consecutive efforts was recorded and results were expressed as absolute values (cmH_2O). Peak expiratory flow rate (PEF) was measured using

mini-Wright peak flow meter and the highest value of three procedures was recorded.

The functional fitness test

The functional fitness tests consisted of seven assessments of physical performance required for daily living[16]. They included assessments of lower and upper body strength as chair-stand, hand grip, and arm curl, lower and upper body flexibility as chair sit and reach and back scratch, agility and dynamic balance as an 8-foot up and go, and endurance as a 6-minute walk test. Each test was conducted individually by only one investigator.

QoL: SF-36

The QoL in the elderly group was assessed using a SF-36 form (Thai version). The SF-36 is a multi-purpose short-form health survey with 36 questions, divided in eight sections[17]. They are physical functioning (PF), physical role functioning (RP), emotional role functioning (RE), vitality (VT), mental health (MH), social role functioning (SF), bodily pain (PA), and general health perceptions (GH). The lower the score represented the more disability meanwhile the higher the score meant less disability.

Training program

To provide more safety and more acceptable loading to the elderly subjects, MDS was adapted from "Dantien-Salee" Yoga[11,12]. The program was validated by a panel of experts which included physical medicine and rehabilitation physician, orthopedic surgeon, and experienced yoga instructor. The original "Dantien-Salee" yoga program consisted of 20 forms of Dantien-Tai Chi and 30 yoga poses. MDS program was also divided into two parts. The first part used 20 forms of Dantien-Tai Chi, which were the same as original program, to improve muscle strength and endurance, dynamic balance, and the cardiovascular and respiratory system. Yoga poses in the second part were modified. It comprised of 28 yoga poses aiming to increase strength, flexibility, and balance. Static and dynamic stretching were also incorporated. Ten poses performed while standing, 10 poses sitting, and eight poses lying. The program concluded with three types of Pranayama to improve breathing, to increase respiratory muscle strength, and to reduce stress. Details of the program modifications are provided in Table 1, and Figure 1 and 2.

MDS program lasted approximate 70 minutes per session, three times a week, for 12 weeks, either as a group or individual depending on participants' convenience. It was taught by an investigator, DP, a qualified instructor. A session consisted of a 5-minute warm-up, 60 minutes of the program, and a 5-minute cool down. The program started with 20-movement Dantien-Tai Chi (TC) program suitable for older adults. Participants were expected to stand upright and adapt each movement according to their individual capability. Eight repetitions of each movement (form) were done for the first eight weeks, then increased to 10 repetitions per form. Each session lasted 18 to 20 minutes. The program was then followed by 28 yoga poses that included 10 standing position, 10 seated position, and eight final poses lying down. All postures were held for 10 seconds and repeated five times. Each class ended with 15 minutes of breathing exercise (Pranayama). Participants in the Control group were instructed to resume their regular activities during the 12 weeks study period.

Table 1. Modified "Dantien-Salee" Yoga program

Part 1: Dantien -Tai Chi 20 forms
1. Theppanom wandha
2. Pai ruerpa tuankrasae
3. Leawna laechan
4. Taewan shetang
5. Krayang boybin
6. Insee krapeupeek
7. Lobleak chokkokhu
8. Songmualu longpatapee
9. Pongpiree kankwaina
10. Dunmekha fha arkard
11. Krarean vadpeekkang
12. Nangnual binron
13. Kojon lompran
14. Mungkorn tayangfah
15. Panda plugmaukhoo
16. Yangfha sudin
17. Pinnha nowtanu
18. Archaku phajon
19. Vanonyaun salabkha
20. Yutita pounlompran
Part 2: Yoga 28 poses
Standing 10 poses
1. Side bend (S)
2. Back twist (D)
3. Forward-Backward bend (D)
4. Warrior I (D&S)
5. Reversed triangle (D)
6. Warrior II (D&S)
7. Single leg lift and tiptoe (D&S)
Part 2: Yoga 28 poses (continued)
8. Quadriceps stretch (S)
9. Wall push up (D)
10. Modified downward facing dog (S)
Sitting 10 poses
11. Head to knee (S)
12. Butterfly (S)
13. Modified boat (D)
14. Z-sit (S)
15. Seated knee to chest and extend (D)
16. Seated spinal twist (S)
17. Modified mountain (S)
18. Shoulder stretch (S)
19. Modified cow's face (S)
20. Trunk side stretch (S)
Lying 8 poses
21. Half cobra (S)
22. Locust (S)
23. Alternated arm and leg (S)
24. Half bridge (S)
25. Single knee to chest (S)
26. Bicycle (D)
27. Supine twist (S)
28. Corpse (S)
Pranayama: 3 types
1. Alternate nostril breathing 10 times
2. Abdominal breathing, 10 times
3. Ah, Uhu, and Ohm sound, 1 time per each breath

S=static, D=dynamic

Statistical analysis

A sample size of 12 subjects per group was

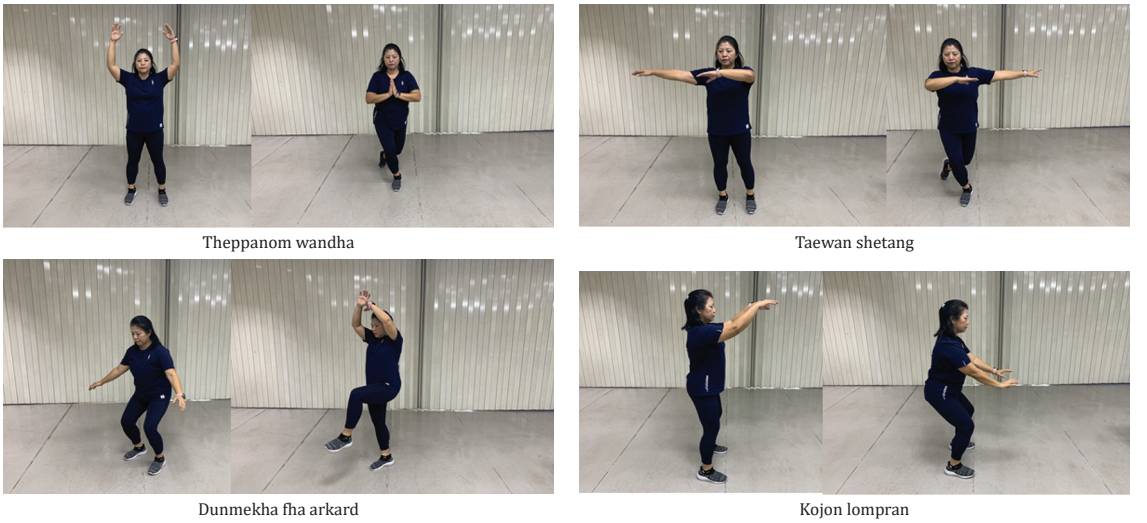

Figure 1. Example of Dantien-Tai Chi forms.

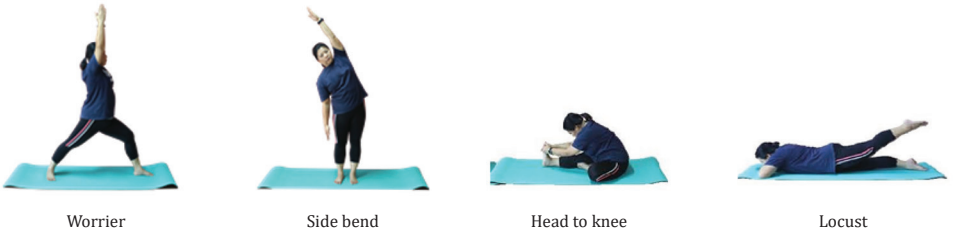

Figure 2. Example of Yoga poses.

required for a power of 0.80 to detect a difference between means with an alpha of 0.05. Categorical data were described as percentages. Continuous data were presented as mean and standard deviation (SD). Categorical and continuous variables were compared between baseline characteristics of MDS and control groups by using chi-square or unpaired t-test, respectively. Difficulty and pain were presented by mean and SD of VAS score in the MDS group. Upon establishing the normality of distribution using Shapiro-Wilk tests and QQ plots, pulmonary function and functional fitness performance data were compared using a two-way ANOVA [Group: (MDS and Control) × Time (baseline and week 12)] to evaluate treatment differences. In addition, a two-way ANOVA [Group: (MDS and Control) × Time (baseline and week 12)] was also used to compare differences in QoL scores. Where significant interaction between group and time was observed, differences were followed up using post hoc Bonferroni corrections. All data were analyzed using Jamovi statistical software, version 1.1.5.0 (https://www.jamovi.org).

Results

General characteristics

Fifty-eight elderly participants were initially screened but only 28 participants fulfilled the eligibility criteria and provided written informed consent. Fourteen subjects were allocated into the MDS group and 14 in the control group. In the MDS group, two participants dropped out due to loss of contact for one and failed to attend more than classes for the other. In the control group, two participants also dropped out due to loss of contact for one and purposely increased physical activity level from baseline for the other. Therefore, the analysis was undertaken with 12 subjects in each group. No significant differences were observed in the general demographic characteristics of the study participants between the two groups at baseline (Table 2), except the respiratory rate of the MDS group was significantly lower than the control group ($p<0.05$). There were also no significant differences in functional fitness tests (Table 2) and QoL between the two groups at baseline (Table 3).

Table 2. General data, functional fitness, and pulmonary function tests

Protocol	MDS (n=12); mean±SD		Control (n=12); mean±SD	
	Pre	Post	Pre	Post
Sex (female/male); n	12 (10/2)	12 (10/2)	12 (10/2)	12 (10/2)
Age (years)	64.3±4.0	64.3±4.0	65.6±5.4	65.6±5.4
RHR (breaths·minute^{-1})	75±10.0	67±7.0†	69±8.0	73±5.0
BMI (kg/m^2)	23.6±3.5	23.1±3.4	25.8±4.2	25.9±4.2
Body fat (%)	31.1±8.3	30.5±8.0	34.6±8.9	34.8±8.6
RR (breaths·minute^{-1})	18±2.0	15±3.0†	21±3.0	21±2.0#
Functional fitness data				
Chair stand (times/30s)	19.3±5.4	30.5±4.8†	17.9±3.8	20.4±4.1
Arm curl (times/30s)	17.4±3.0	33.0±3.5†	19.8±6.6	21.3±3.6#
Rt. hand grip (kg)	23.6±5.1	25.6±4.6†	23.1±6.6	23.4±6.2
Lt. hand grip (kg)	21.7±5.0	24.6±4.3†	20.8±6.4	21.6±7.1
Chair sit and reach (cm)	7.3±15.8	22.0±13.5†	12.7±16.5	14.1±19.2
Rt. back scratch (cm)	–9.4±15.1	–3.7±13.4†	–7.9±11.1	–4.4±8.4
Lt. back scratch (cm)	–16.3±14.3	–8.0±12.2†	–14.0±12.7	–11.4±10.5
8-foot up and go (seconds)	5.6±0.6	4.3±0.4†	6.3±0.8#	6.3±0.5#
6-minute walk distance (m)	506.9±33.5	611.8±37.5†	467.4±71.2	458.4±69.7#
Pulmonary function data				
FVC (L)	2.4±0.5	2.4±0.4	2.4±0.6	2.4±0.6
FEV1 (L)	1.9±0.4	1.9±0.3	1.9±0.5	1.9±0.5
FEV1/FVC (%)	79.5±4.9	79.5±4.0	79.6±4.5	79.3±4.7
PEF (L/minute)	385.0±51.6	393.3±63.2	362.5±61.1	382.5±81.6
MVV (L/minute)	85.5±26.9	86.9±25.6	75.0±23.3	81.8±26.5
TLC (L)	4.0±0.6	4.0±0.5	4.0±0.9	4.1±1.0
RV (L)	1.5±0.4	1.5±0.3	1.5±0.3	1.7±0.5
RV/TLC (%)	37.4±7.4	37.5±6.3	38.6±6.3	39.9±6.4
IC (L)	1.8±0.4	1.9±0.4	1.9±0.6	1.9±0.6
IC/TLC (%)	44.8±8.3	46.6±8.7	46.4±8.0	46.3±8.6
FRC (L)	2.1±0.5	2.1±0.4	2.1±0.5	2.2±0.6
FRC/TLC (%)	53.4±8.4	52.5±8.6	52.2±8.4	52.4±8.5
MEP (cmH_2O)	126.8±47.2	143.9±29.7	131.6±40.5	130.2±29.2
MIP (cmH_2O)	94.8±36.9	121.2±46.8	89.4±22.2	96.3±30.1

MDS=modified "Dantien-Salee" Yoga training; SD=standard deviation; RHR=resting heart rate; BMI=body mass index; RR=respiratory rate; FVC=forced vital capacity; FEV1=forced expiratory volume in one second; FEV1/FVC=forced expiratory volume in one second/forced vital capacity; PEF=peak expiratory flow; MVV=maximum voluntary ventilation; TLC=total lung capacity; RV=residual volume; RV/TLC=residual volume/total lung capacity ratio; IC=inspiratory capacity; IC/TLC=inspiratory capacity/total lung capacity ratio; FRC=functional residual capacity; FRC/TLC=functional residual capacity/total lung capacity ratio; MEP=maximum expiratory pressure; MIP=maximum inspiratory pressure

Significant was accepted for $p<0.05$, † Significant difference pre and post within group, # Significant difference post and post between groups

Effects of 12 weeks MDS program

Body fat or body mass index (BMI) were similar in both groups at baseline and did not change over time. Resting heart rate (RHR) was also similar between groups at baseline but decreased significantly after 12 weeks in the MDS group from 75.0±10.0 to 67±7 beats·minute^{-1} ($p=0.001$). At baseline, the respiratory rate (RR) was similar between groups with MDS at 18±2 breaths·minute^{-1} and the control at 21±3 breaths·minute^{-1} ($p=0.053$). In the MDS group, RR decreased after 12 weeks ($p<0.001$), with values significantly lower compared with the control with MDS at 15±3 and the control at 21±2 breaths·minute^{-1} ($p<0.001$) (Table 2). The majority of the measured pulmonary function parameters in the participants showed no differences ($p>0.05$) between the MDS and the control groups either at baseline or at the end of 12 weeks (Table 2). MIP at 94.8±36.9 to 121.2±46.8 cmH_2O and MEP at 126.8±47.2 to 143.9±29.7 cmH_2O showed tendency to improve in the MDS group but did not reach statistically significant level. The functional fitness tests showed no differences

Table 3. Quality of life (SF-36 score)

Quality of life	MDS (n=12); mean±SD		Control (n=12); mean±SD	
	Pre	Post	Pre	Post
Physical functioning	72.5±16.9	89.2±11.8*	61.3±25.2	65.0±22.5**
Role-physical	50.0±35.4	83.3±24.6*	66.7±38.9	60.4±43.3
Role-emotional	63.9±48.1	88.9±25.9*	72.2±44.6	80.6±38.8
Vitality	65.4±9.9	79.6±10.3*	57.5±12.7	54.6±13.1**
Mental health	72.3±9.9	89.7±5.8 *	73.0±9.8	67.0±12.3**
Social functioning	81.3±17.3	97.9±7.2*	86.5±16.4	83.3±18.7
Bodily pain	63.8±11.7	83.3±17.7*	57.3±11.6	55.8±8.4**
General health	61.7±6.9	81.7±6.9*	50.4±19.1	45.4±17.3**

MDS=modified "Dantien-Salee" Yoga training; SD=standard deviation

* Significant difference from baseline, ** Significant difference between groups

Table 4. Difficulty and pain of MDS group after 12 weeks training

VAS	Difficulty			Pain		
	Mean±SD	Range	Median	Mean±SD	Range	Median
0 to 10	2.41±0.66	2 to 4	2	0.42±0.79	0 to 2	0

VAS=visual analog scale; SD=standard deviation

Used VAS (0 to 10 point) after 12-week, 0=easy or no difficulty and no pain, 10=very difficult and severe pain

between the MDS and the control groups at baseline. The MDS group exhibited a significant improvement in cardiorespiratory fitness, strength, and range of motion at the end of the study (Table 2).

Overall QoL (SF-36) and all its subsets were similar between groups at study entry. QoL increased significantly with time in the MDS group for all subset parameters, which include functional, physical, emotional, vitality, mental health, social functioning, bodily pain, and general health (Table 3). MDS program was well tolerated and accepted by the participants as seen by difficulty and pain score (Table 4).

Discussion

The present study evaluated the hypothesis that pulmonary function, functional fitness, and QoL should improve after 12 weeks of MDS program training in elderly adults with no underlying specific disease or condition. The study showed that after 12 weeks program, the RHR and respiratory rate of the study subjects decreased significantly. Slow breathing of yoga increased the vagal activity and reduced the sympathetic activity, which might explain these findings[18]. Other studies in the literature also provide data to support that the practice of yoga produce a reduction in heart rate and respiratory rate[1,10,19]. Moreover, the subjects in the MDS group were submitted to a program that included both static and dynamic exercise positions, which could be viewed as an aerobic exercise. Therefore, the combination of these elements together contributed to the decrease in heart rate and respiratory rate at rest in the MDS group.

There were no differences in spirometry and lung volumes of the pulmonary function over the intervention period. Both MIP at 94.8±36.9 to 121.2±46.8 cmH_2O and MEP at 126.8±47.2 to 143.9±29.7 cmH_2O showed tendency to improve in the MDS group, even though it did not reach statistically significant level. This effect is likely to correlate with the adaptation of the respiratory muscles to the breathing exercise training (Pranayama), which was included in the program. The respiratory exercises used in this protocol (Pranayama) are specifically suited to the respiratory system, and exercise both inspiratory and expiratory muscles. The elderly subjects in the present study had MIP and MEP values in the normal range at study entry since they do not have underlying pulmonary disease. This may explain why the results of both groups' parameters did not improve significantly after the MDS program. The same explanation goes to negative effects on improving spirometry and lung volumes parameters in the subjects. Breathing practices in yoga program have shown to be beneficial in improving respiratory functions in elderly by reducing respiratory rate and increasing the tidal volume, vital capacity, minute ventilation, maximal inspiratory, and expiratory pressure[1,10]. Previous systematic reviews have provided evidence on the beneficial effects of yoga in older adults in terms of promoting cardiovascular health[20], balance and mobility[21], alleviating depression, and improving quality of sleep[22]. The literature is scarce and conflicting on the effects of yoga exercises on ventilatory capacities and respiratory muscle strength in the elderly with no underlying specific disease or condition. Yoga increased slow vital capacity (SVC), FVC, PEF, maximum voluntary ventilation (MVV), and DLCO (diffusion capacity) in coronary artery disease patients[23]. Twelve weeks yoga program improved pulmonary function including MIP and MEP pressures of aged women[10]. Four months of yoga training yielded significant increase in MIP and MEP in 76 healthy elderly subjects[1]. In the present study, both MIP at 94.8±36.9 to 121.2±46.8 cmH_2O and MEP at 126.8±47.2 to 143.9±29.7 cmH_2O, showed tendency

to improve in the MDS group but did not reach statistically significant level. As the sample size was small and the duration of the program was shorter than previous study at 12 weeks versus 16 weeks[1], the MDS program may be difficult to learn and practice especially at the beginning in this previous sedentary elderly population, which may partially explain the authors' findings.

Important findings were observed with respect to the effectiveness of MDS program on physical function relevant to activities of daily living and QoL in healthy adults aged over 60. The MDS group exhibited a significant improvement in cardiorespiratory fitness with the 6-minute walk test (6MWT), strength with the chair-stand, hand grip, and arm curl, agility and dynamic balance with the 8-foot up and go, and range of motion with the chair sit and reach and back scratch at the end of the study. In contrast, no significant changes in physical function were observed in control group. The 6MWT is a sub-maximal exercise test used to assess aerobic capacity and endurance. MDS program is recognized as a low intensity aerobic exercise but despite this light level of aerobic activity for three sessions per week is still enough to improve physical fitness in the MDS group. Physical fitness is known to be determinants of functional independence in the elderly. Long term regular Tai Chi exercise has favorable effects on the promotion of balance control, flexibility, and cardiovascular fitness in older adults[24,25]. The muscle strength of upper and lower body was significantly improved by increasing chair stand, arm curl number, and increased grip strength after 12 weeks in the MDS group. These findings corresponded to the prior study that practicing Tai Chi enhanced muscular strength and endurance of knee flexors and extensors in the elderly[26,27].

Tai Chi components in MDS program consisted of upper and lower body movements for 20 minutes and yoga components helped develop leg muscles strength such as Warrior and balance posture with one leg and both legs. Wall push up posture required effort against the wall and helping the arm muscles to work more to increase arm strength. Moreover. MDS training such as boat pose and seated knee to chest also built abdominal muscle strength. Half cobra, locust, alternative arm and leg, and half bridge poses enhanced back strength. Therefore, most parts of the body were strengthened. There is less muscle mass and decreased strength in most elderly people resulting in poor physical movement and balance, which increase the risk of falling in the elderly. Therefore, practicing yoga with Tai Chi not only helps the elderly to have more strength and endurance of the muscles, but also helps to prevent fall. Subjects in the MDS group showed marked flexibility improvement of upper body with the chair sit and reach and lower body with the back scratch test. These parameters increased almost three folds in MDS group after 12 weeks of training. Improvements appeared to have been made in both upper limb and in lower body flexibility. Other investigators have reported modest improvements or no change in flexibility[28]. While most studies reported that the improvements have been in lower body flexibility[29], the present studies showed improvements in both upper and lower flexibility. Liu and So used Tai Chi exercise for nursing intervention in the elderly and showed that enhancement of flexibility and balance decreased fall related perception and increased the health status[30]. This increase in flexibility is a result of MDS yoga practice that focused on stretching and holding motion, which is called static flexibility such as thigh stretching, butterfly posture, and head-to-knee posture. These postures increased the flexibility of the legs and back, while the modified mountain posture, shoulder stretch, and cow's face postures increased the flexibility of the upper muscles around the chest, shoulders, and arms. Tai Chi training also increased flexibility due to the movement of arms, legs, and torso, which provided dynamic flexibility. Flexibility is a component of health-related fitness that helps to increase mobility and reduce chronic pain from muscle tension. Most seniors have a decrease in muscle and joints flexibility, poor balance, and movement so there is a risk of injury to the muscles and joints when performing physical activities or exercise. Flexibility is improved through stretching and can relieve stress by releasing tension. Where the body goes, the mind follows. When the subject let go of physical tension, mental tension is also reduced. That is one of the reasons yoga is so good at reducing stress, alleviating insomnia, and increasing a sense of well-being especially in the elderly[31-33]. Agility and dynamic balance were assessed by the 8-foot up and go test. Agility and dynamic balance were improved in the MDS group compared to the control group. Yoga training has been shown to improve balance, mobility and reduce fear of fall in the elderly[34,35]. Tai Chi is a series of body movement with aims of improving balance and co-ordination together. Its movements also enhance dynamic balance, agility, coordination, and flexibility, while yoga provide static balance through holding the posture. Agility

is the ability to change body's position efficiently and requires the integration of isolated movement skills using a combination of balance, coordination, speed, reflexes, strength, and endurance. Flexibility might also contribute to agility. Strength, flexibility, and balance are all essential ingredients in agility. Therefore, the development of agility and balance in the elderly is one of the essentials skills that should be practiced since elderly people often have balance and movement problems and results in the elderly being harmed by falling.

All sections of SF-36 scores increased significantly in the MDS group. MDS program improved QoL by improvement in functional fitness, reduced stress and depression, which benefit mental health of the elderly. These findings were well supported from the previous studies with the same conclusion[36-38]. Tai Chi also appeared to be associated with improvements in psychological well-being including reduction of stress, anxiety, depression, mood disturbance, and increase self-esteem[39].

MDS program seemed to be safe and enjoyable in the present study group of subjects. No serious adverse events and two dropouts were reported. Meta-analysis suggested that the frequency and severity of adverse events associated with yoga in randomized trials are comparable to levels associated with physical activity or usual care. Recommending yoga to healthy or ill people should not be discouraged based on safety. This modality of intervention should follow strict recommendations and guideline to prevent yoga-associated adverse events[40].

Conclusion

Training effects of MDS program for 12 weeks in the elderly revealed positive health promotion outcomes. There were no differences in spirometry and lung volumes of the pulmonary function over the intervention period. Both MIP and MEP showed tendency to improve in the MDS group. However, MDS program significantly improve the functional fitness and QoL. Therefore, MDS program is an activity that will be suitable for elderly because it is safe and easy to practice. There was no report of the negative effects or complaints regarding the MDS program by participants. Therefore, it is recommended that MDS program should be incorporated in the elderly activity to promote physical and mental health.

What is already known on this topic?

Yoga and Tai Chi are exercise activity that promotes health and fitness, and having good physical fitness also helps to have a good quality of life in the elderly.

What this study adds?

MDS is an exercise program adapted from the MDS posture to suit the purpose of improving the pulmonary function and functional fitness, which affects the quality of life as well.

After 12 weeks of MDS training, pulmonary function was not different in lung volume. Both MIP and MEP showed tendency to improve. Functional fitness and quality of life were significantly improved.

These finding support that the MDS yoga program affected positively the functional fitness and quality of life in older adult. It is recommended that MDS program should be incorporated in the elderly activity to promote physical and mental health.

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Conflicts of interest

The authors declare that they have no conflict of interests.

References

1. Santaella DF, Devesa CR, Rojo MR, Amato MB, Drager LF, Casali KR, et al. Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: a randomised controlled trial. BMJ Open 2011;1:e000085.
2. Skloot GS. The effects of aging on lung structure and function. Clin Geriatr Med 2017;33:447-57.
3. Kumsuchat S. Health problems and health care needs among Thai elderly: policy recommendations. J Health Sci 2017;26:1156-64. [in Thai]
4. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, 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;116:1094-105.
5. Demakakos P, Hamer M, Stamatakis E, Steptoe A. 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;53:1877-85.
6. Resnick B, Spellbring AM. Understanding what motivates older adults to exercise. J Gerontol Nurs 2000;26:34-42.
7. Oken BS, Zajdel D, Kishiyama S, Flegal K, Dehen C,

Haas M, et al. Randomized, controlled, six-month trial of yoga in healthy seniors: effects on cognition and quality of life. Altern Ther Health Med 2006;12:40-7.
8. Krishnamurthy MN, Telles S. Assessing depression following two ancient Indian interventions: effects of yoga and ayurveda on older adults in a residential home. J Gerontol Nurs 2007;33:17-23.
9. Vyas R, Dikshit N. Effect of meditation on respiratory system, cardiovascular system and lipid profile. Indian J Physiol Pharmacol 2002;46:487-91.
10. Bezerra LA, de Melo HF, Garay AP, Reis VM, Aidar FJ, Bodas AR, et al. Do 12-week yoga program influence respiratory function of elderly women? J Hum Kinet 2014;43:177-84.
11. Supaporn S. Dantien-Salee yoga. Bangkok: Samlada; 2011. [in Thai]
12. Wongchuen P. A qualitative study of Dantien Yoga training on flexibility and strength [thesis]. Bangkok: Srinakharinwirot University; 2007. [in Thai]
13. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of spirometry 2019 update. An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med 2019;200:e70-88.
14. Dejsomritrutai W, Nana A, Maranetra KN, Chuaychoo B, Maneechotesuwan K, Wongsurakiat P, et al. Reference spirometric values for healthy lifetime nonsmokers in Thailand. J Med Assoc Thai 2000;83:457-66.
15. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis 1969;99:696-702.
16. Rikli RE, Jones CJ. Development and validation of a functional fitness test for community-residing older adults. J Aging Phys Act 1999;7:129-61.
17. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473-83.
18. Akhtar P, Yardi S, Akhtar M. Effects of yoga on functional capacity and well being. Int J Yoga 2013;6:76-9.
19. Cebrià i Iranzo M, Arnall DA, Igual Camacho C, Tomás JM. Effects of inspiratory muscle training and yoga breathing exercises on respiratory muscle function in institutionalized frail older adults: a randomized controlled trial. J Geriatr Phys Ther 2014;37:65-75.
20. Barrows JL, Fleury J. Systematic review of yoga interventions to promote cardiovascular health in older adults. West J Nurs Res 2016;38:753-81.
21. Youkhana S, Dean CM, Wolff M, Sherrington C, Tiedemann A. Yoga-based exercise improves balance and mobility in people aged 60 and over: a systematic review and meta-analysis. Age Ageing 2016;45:21-9.
22. Wang YY, Chang HY, Lin CY. Systematic review of yoga for depression and quality of sleep in the elderly. Hu Li Za Zhi 2014;61:85-92.
23. Yadav A, Singh S, Singh K, Pai P. Effect of yoga regimen on lung functions including diffusion capacity in coronary artery disease patients: A randomized controlled study. Int J Yoga 2015;8:62-7.
24. Hong Y, Li JX, Robinson PD. Balance control, flexibility, and cardiorespiratory fitness among older Tai Chi practitioners. Br J Sports Med 2000;34:29-34.
25. Lan C, Lai JS, Chen SY, Wong MK. 12-month Tai Chi training in the elderly: its effect on health fitness. Med Sci Sports Exerc 1998;30:345-51.
26. Lan C, Lai JS, Chen SY, Wong MK. Tai Chi Chuan to improve muscular strength and endurance in elderly individuals: a pilot study. Arch Phys Med Rehabil 2000;81:604-7.
27. Tran MD, Holly RG, Lashbrook J, Amsterdam EA. Effects of hatha yoga practice on the health-related aspects of physical fitness. Prev Cardiol 2001;4:165-70.
28. Takeshima N, Rogers NL, Rogers ME, Islam MM, Koizumi D, Lee S. Functional fitness gain varies in older adults depending on exercise mode. Med Sci Sports Exerc 2007;39:2036-43.
29. Noradechanunt C, Worsley A, Groeller H. Thai Yoga improves physical function and well-being in older adults: A randomised controlled trial. J Sci Med Sport 2017;20:494-501.
30. Liu M, So H. Effects of Tai Chi exercise program on physical fitness, fall related perception and health status in institutionalized elders. Taehan Kanho Hakhoe Chi 2008;38:620-8.
31. Mooventhan A, Nivethitha L. Evidence based effects of yoga practice on various health related problems of elderly people: A review. J Bodyw Mov Ther 2017;21:1028-32.
32. Song R, Lee EO, Lam P, Bae SC. Effects of tai chi exercise on pain, balance, muscle strength, and perceived difficulties in physical functioning in older women with osteoarthritis: a randomized clinical trial. J Rheumatol 2003;30:2039-44.
33. DiBrezzo R, Shadden BB, Raybon BH, Powers M. Exercise intervention designed to improve strength and dynamic balance among community-dwelling older adults. J Aging Phys Act 2005;13:198-209.
34. Tiedemann A, O'Rourke S, Sesto R, Sherrington C. A 12-week Iyengar yoga program improved balance and mobility in older community-dwelling people: a pilot randomized controlled trial. J Gerontol A Biol Sci Med Sci 2013;68:1068-75.
35. Schmid AA, Van Puymbroeck M, Koceja DM. Effect of a 12-week yoga intervention on fear of falling and balance in older adults: a pilot study. Arch Phys Med Rehabil 2010;91:576-83.
36. Halpern J, Cohen M, Kennedy G, Reece J, Cahan C, Baharav A. Yoga for improving sleep quality and quality of life for older adults. Altern Ther Health Med 2014;20:37-46.
37. Bankar MA, Chaudhari SK, Chaudhari KD. Impact of long term Yoga practice on sleep quality and quality of

life in the elderly. J Ayurveda Integr Med 2013;4:28-32.
38. Hariprasad VR, Sivakumar PT, Koparde V, Varambally S, Thirthalli J, Varghese M, et al. Effects of yoga intervention on sleep and quality-of-life in elderly: A randomized controlled trial. Indian J Psychiatry 2013;55 Suppl 3:S364-8.
39. Wang C, Bannuru R, Ramel J, Kupelnick B, Scott T, Schmid CH. Tai Chi on psychological well-being: systematic review and meta-analysis. BMC Complement Altern Med 2010;10:23.
40. Cramer H, Ward L, Saper R, Fishbein D, Dobos G, Lauche R. The safety of yoga: A systematic review and meta-analysis of randomized controlled trials. Am J Epidemiol 2015;182:281-93.