Effects of Different Durations of 9-Square Dance Exercise Versus Treadmill Exercise on the Physical Fitness and Quality of Life of Healthy Volunteers: A Pilot Randomized Controlled Trial

Sarunthorn Puttipaibool, B.ATM.*, Pravit Akarasereenont, M.D., Ph.D.*, Summon Chomchai, M.D., Yuthana Udomphorn, M.D.***, Apichat Asavamongkolkul, M.D****

**Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, **Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, ***Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, ****Department of Orthopedic Surgery and Physiotherapy, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.*

ABSTRACT

Objective: To evaluate the impact of 9-square dance exercise (9SDE) on physical fitness and quality of life compared to traditional treadmill exercise (TME).

Materials and Methods: In total, 33 healthy volunteers (10 men, 23 women) were recruited and randomly assigned into three groups: 9 square dance exercise for 8 minutes (9SDE-8), 9 square dance exercise for 30 minutes (9SDE-30), or treadmill exercise (TME). Exercises were done three times a week for 12 weeks and physical fitness tests were performed for all the groups at weeks 0, 6, and 12. Participants were assessed using the European Quality of Life Measure 5 Domains and 5 Levels questionnaire (EQ-5D-5L).

Results: Significant improvements in cardiorespiratory endurance, leg strength, and flexibility were demonstrated in the 9SDE-30 group ($p<0.05$). There was no significant difference in physical fitness between the 9SDE-30 and TME groups. The 9SDE-8 group showed a significant improvement in utility in the EQ-5D-5L questionnaire ($p<0.05$), while the TME group showed a significant improvement in directly evaluated health status ($p<0.05$). 9SDE-30 and TME showed similar improvements in cardiorespiratory endurance and leg strength.

Conclusion: Considering its low-resource requirement and overall utility, coupled with its effectiveness in promoting cardiovascular fitness and leg strength, 9SDE represents a viable exercise alternative for those with limited time and resources.

Keywords: 9 square dance exercise; physical fitness; aerobic exercise; Thai traditional exercise; quality of life (Siriraj Med J 2022; 74: 883 -890)

INTRODUCTION

Exercise is defined as a form of physical activity that involves continuous movements in specific patterns for the purpose of maintaining or increasing physical fitness and overall wellness.[1] Aerobic exercise uses larger muscle groups and increases oxygen consumption.[2] The benefits of aerobic exercise include increased cardiorespiratory fitness and insulin sensitivity; besides its well-known benefits of preventing a myriad of chronic conditions, such as hypertension, heart disease, and metabolic syndrome.[3-4]

Correspondence to: Apichat Asavamongkolkul
E-mail: apichat.asa@mahidol.ac.th
Received 26 July 2022 Revised 26 October 2022 Accepted 13 November 2022
ORCID ID:http://orcid.org/0000-0002-7868-7426
http://dx.doi.org/10.33192/Smj.2022.103

Consequently, regular exercise is associated with increased physical and mental wellness and quality of life.[5-6]

Despite all the stated benefits, survey results from the department of physical education ministry of tourism and sports of Thailand revealed that in 2020, only 41.8% of the Thai population over 15 years old exercised or played sports regularly. The most frequently cited reasons for not exercising included not having enough time (54.34%), having underlying conditions that preclude exercise (8.93%), being unmotivated (6.91%), and inadequate urban living spaces (3.98%). In addition, the need for subsidies and support for purchasing sports equipment and the provision of facilities remained significant barriers to exercise, with 61.08% requiring support and 39.61% requiring additional facilities.[7] In that regard, exercise routines that are culturally based, such as Qigong or Tai Chi, represent good options and have been shown to decrease fatigue and improve the quality of life. In particular, traditional dances, such as folk or swing or square dances, can help to improve the physical and emotional states of an individual.[8]

Traditional dances as part of an exercise routine have been shown to offer varying degrees of cardiovascular, flexibility, and strength training compared to more modern modes of exercise. For example, after Indonesia adopted the traditional Legong dance as exercise. Griadhi et al. measured changes in aerobic capacity and muscle strength between Legong dancers and conventional aerobic training and found that the back and leg muscle strengths were better, when measured using a dynamometer, in the Legong group than in the aerobics group.[9] Other examples include a study comparing a Korean traditional dance group to a no exercise group, in which the Korean traditional dance group experienced statistically significant improvements in grip strength and flexibility, as measured by a back scratch test, and leg strength, as measured by the chair stand test.[10]

Thai culture, with its rich history of Thai traditional medicine practice that emphasizes the mind–body connection or Dhammanamai, also offers traditional dance as a form of exercise. Using its core principle, which stresses caring for one's body through purposeful movements, such as stretching and dance, the 9-square-dance exercise (9SDE) was conceived. This Thai traditional square dance requires continuous, coordinated walking movements and is considered to be an ideal type of exercise for balance and neuromotor coordination.[11-12] A study by Atipas et al. examined the effects of performing 9SDE, in conjunction with the 9-square step exercise (9SSE) in patients with balance disorders, such as vestibular neuritis, dizziness, and vestibulopathy. The group which practiced the dance exercise experienced an increase in the average composite equilibrium scores and a decrease in the abnormal equilibrium scores as well as a balance of symptom severity after 8 weeks.[13]

In addition, the routines for performing 9SDE require very little space, as a 3 feet by 3 feet area will suffice. Further, its low demand for specialized resources means that it can be carried out in situations where space is limited, such as for people living in urban housing or even in work offices. In addition, both its traditional nature and its versatility mean that it potentially has great appeal for the elderly, who may not be attracted to traditional exercise and who also may have limited means of travel. However, despite the very physically active nature of 9SDE, its ability to quantitatively increase physical fitness remains unexplored. Consequently, the purpose of this research was to quantify and compare the impacts of 9SDE with exercise performed on a treadmill on various aspects of physical fitness and quality of life.

MATERIALS AND METHODS

This study recruited 33 healthy volunteers aged between 18–59 years old with a body mass index (BMI) of 18.5–24.9 kg/m^2 who have no regular exercise habits, defined as exercising less than 2 times per week. Exclusion criteria were current or past smokers, regular alcohol use of more than 120 mg per day, difficulties with ambulation, or the use of any cardiovascular medications or nutritional supplements. Eligible volunteers were randomly assigned to one of three groups, namely 9 square dance exercise for 8 minutes (9SDE-8), 9 square dance exercise for 30 minutes (9SDE-30), or treadmill exercise (TME), by computer stratified randomization according to the consort diagram in Fig 1. The protocol for this study was approved by the Siriraj Institutional Review Board (Si 269/2018) and TCTR 20211010001. Informed consent was obtained from each participant prior to their enrollment in the study.

All three groups of participants were asked to perform their respective exercises 3 times per week for 12 weeks. They were supervised by experienced instructors and their exercise and any occurrence of adverse events were recorded in their personal logbook. The 9SDE-8 and 9SDE-30 groups were assigned to a specific room at the Ayurved Clinic of Applied Thai Traditional Medicine in Mahidol University where standard 9SDE squares had been prepared. The TME group conducted their exercise sessions at Siriraj Hospital fitness center at the Faculty of Medicine Siriraj Hospital, Mahidol University. All the exercise groups were closely supervised before, during, and after their exercise sessions. All participants had

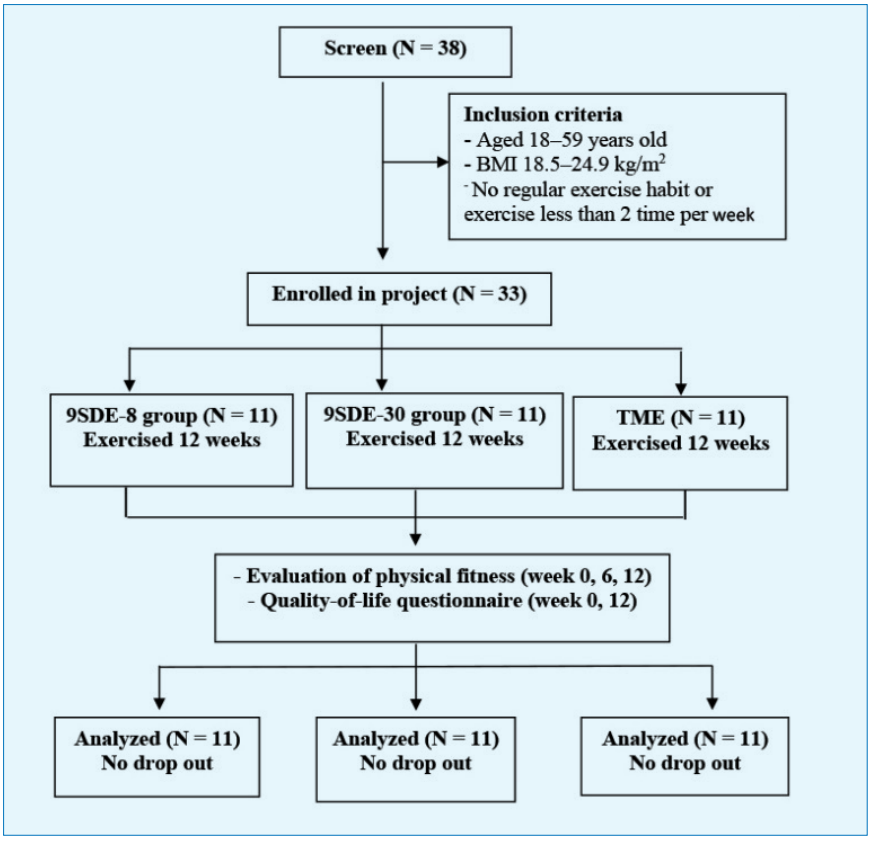

Fig 1. Consort diagram of the study

5–10 minutes of rest, followed by stretching exercises consisting of 8 exercise postures, comprising 2 arms and shoulder stretches and 6 back, legs, hips, and calves stretches with 3 repetitions of 10 seconds each. The warm-up and cool-down periods were 15 minutes.

The 9SDE was conducted according to the original protocol by Professor Dr. Ouay Ketusinh.[12] Participants were taught to perform a 9SDE exercise routine by a group of experienced applied Thai traditional medicine instructors. The 9-grid pattern for 9SDE was made by taping off a 120 × 120 cm area on the floor. The rhythm of the dance was 130 steps per minute. Participants were asked to perform the 9SDE routine according to the detail in Fig 2.[11] The 9SDE-8 group performed 4 minutes of exercise on both the left and right sides, whereas the 9SDE-30 group similarly performed 15 minutes of exercise on either side. After completing the exercise sessions, the sessions were recorded in each participant's personal logbook.

The TME group were advised and closely monitored by an experienced sport scientist. Before the first session, the participants were taught how to use the treadmill according to a TME protocol until the instructor was confident that they could execute the session safely and properly. Participants were told to increase the speed of the treadmill gradually according to the protocol in Table 1.[14] After completing the exercise, each participant had a cool-down period and then recorded the activity in his/her personal logbook.

The physical fitness of all the participants was evaluated at 0, 6, and 12 weeks from the start of the enrollment period. The evaluator was blind to the group assignment of each participant. The physical fitness test for all the participants included cardiorespiratory endurance, muscle strength, flexibility, and total body composition. Interpretations of the physical fitness tests were done according to the manual of tests and standard of physical fitness for Thai people.[15]

The self-assessed quality of life questionnaire was done at weeks 0 and 12 using the Thai version of the European Quality of Life Measure 5 Domains and 5 Levels (EQ-5D-5L) questionnaire, which was divided into 2 parts. The first part was a health satisfaction assessment across 5 health dimensions. This utility score ranged from +1 (healthy) to 0 (death) and -1 ("worse than death"). The second part for directly evaluating the health status was a direct measure of health, with a scale from 0 to 100, where 0 represents the worst health, and 100 is the best.[16]

Statistical analysis

Only those who attended >70% of the training sessions were included in the analysis. One-way ANOVA and Pearson chi-square test were used for analyzing the

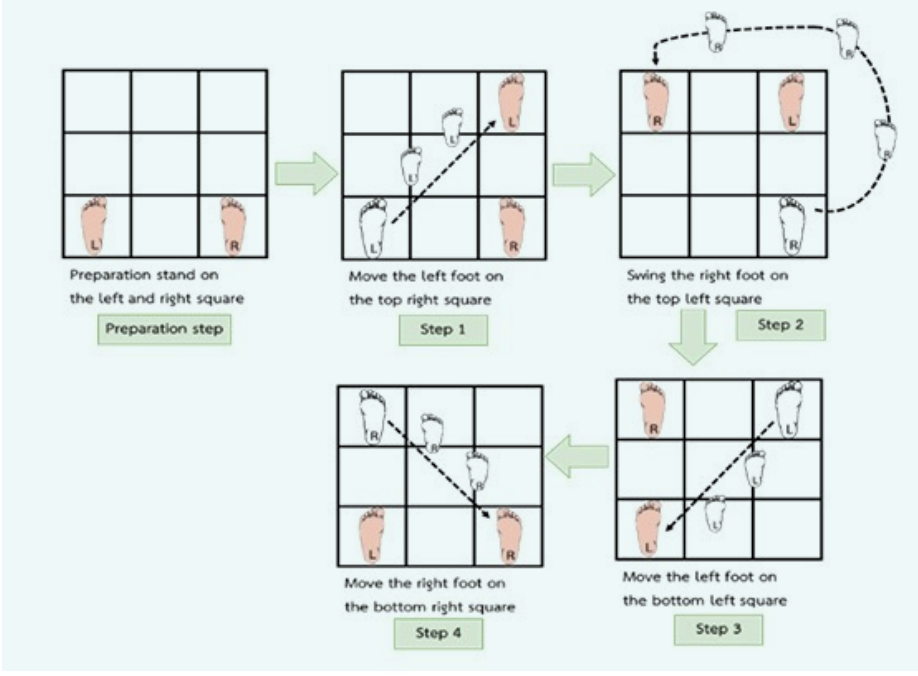

Fig 2A.

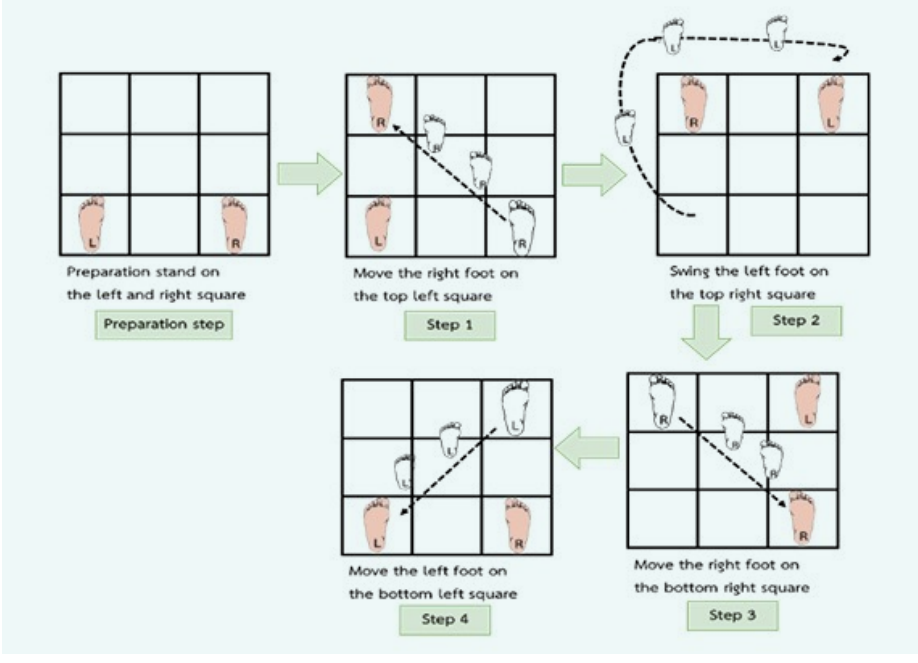

Fig 2B.

Fig 2. 9 Square dance exercises
Fig 2A. 9 Square dance exercises (Kao-ten) on the left side
Fig 2B. 9 Square dance exercises (Kao-ten) on the right side

TABLE 1. Treadmill exercise protocol

Time (minutes)	1	1-2	2-3	3-4	4-5	5-25	25-26	26-27	27-28	28-29	29-30
Speed (km/h)	3	3.5	4	4.5	5	5.5 ± 0.5	5	4.5	4	3.5	3

continuous and categorical variables, respectively. Post-hoc pairwise comparisons between the interventions were done. Changes from baseline to week 6 and week 12 post-intervention in each group were calculated as the mean and standard deviation. Repeated measure analysis of covariance (ANCOVA) was used to compare the between-group differences in the mean change from baseline to week 12. The statistical analysis was performed using SPSS ver 18.0 (SPSS Institute). The Kolmogorov–Smirnov test was used for the normal distribution of data, and p-value < 0.05 was considered statistically significant.

RESULTS

Overall, 33 participants attended more than 99.3% of their total exercise sessions. Women comprised 69.7% of the participants initially included in the study. The mean age of the participants was 32.42 ± 7.91 years old. The average BMI was 21.83 ± 1.82 kg/m^2. There were no significant differences in age and BMI between the groups. The mean age and BMI for each group are shown in Table 2.

Physical fitness

Physical fitness testing demonstrated within group differences in the step test for 9SDE-30 group from baseline to 6 and 12 weeks (8.64 ± 2.45 time/min, $p < 0.05$ and 13.27 ± 3.41 time/min, $p < 0.01$), and in the TME group at baseline to 6 and 12 weeks (8.09 ± 2.79 time/min, $p < 0.05$, and 14.00 ± 3.09 time/min, $p < 0.01$). Lung capacity changes were statistically significant in both the 9SDE-30 and TME groups from baseline to 12 weeks (-6.45 ± 1.25 cm^3/BW, $p < 0.01$ and -6.34 ± 2.17cm^3/BW, $p < 0.05$) respectively. Leg strength changes were also significant in both the 9SDE-30 and TME groups from baseline to 12 weeks (-0.26 ± 0.89 kg/BW, $p < 0.05$ and -0.55 ± 0.16 kg/BW, $p < 0.05$, respectively). All the groups also showed significant differences in the flexibility. The changes in physical fitness test parameters for each group of exercise at baseline, 6 and 12 weeks are shown in Fig 3.

The quality of life

The utility score for the 9SDE-8 group showed a significant difference (0.30 ± 0.03, $p < 0.01$) between baseline and week 12. The TME group showed a significant difference in directly evaluated health status (VAS) (13.55 ± 3.87, $p < 0.01$) between baseline and week 12, but there was no significant difference between 2 groups. The results from the EQ 5D 5L questionnaire are summarized in Table 3.

DISCUSSION

Our study demonstrated significant changes in cardiovascular fitness, lower body strength, and flexibility among participants in the 9SDE-30 and treadmill groups. The fact that both of the groups that required exercise duration of 30 minutes demonstrated more consistent cardiovascular changes helps to highlight the wisdom of American College of Sports Medicine (ACSM) 's

TABLE 2. Baseline characteristics of the participants: comparisons among the groups

Variable	9SDE-8	9SDE-30	TME	*P*-value
Participant (N)	11	11	11	
Gender (% women)	7 (63.6%)	8 (72.7%)	8 (72.7%)	0.866
Age (year)	32.55 ± 6.91	33.82 ± 11.08	30.91 ± 4.97	0.701
Min (year)	24	23	24	
Max (year)	44	59	38	
BMI (kg/m^2)	21.71 ± 1.96	21.36 ± 1.23	22.41 ± 2.14	0.397
Weight (kg)	57.37 ± 7.37	56.80 ± 6.24	59.68 ± 6.64	0.578
Height (cm)	162.35 ± 5.26	162.95 ± 8.33	163.18 ± 6.37	0.956

Values are presented as number (%) or mean ± standard deviation.
9SDE-8, 9 Square dance 8 minutes; 9SDE-30, 9 Square dance 30 minutes; TME, Treadmill exercise.

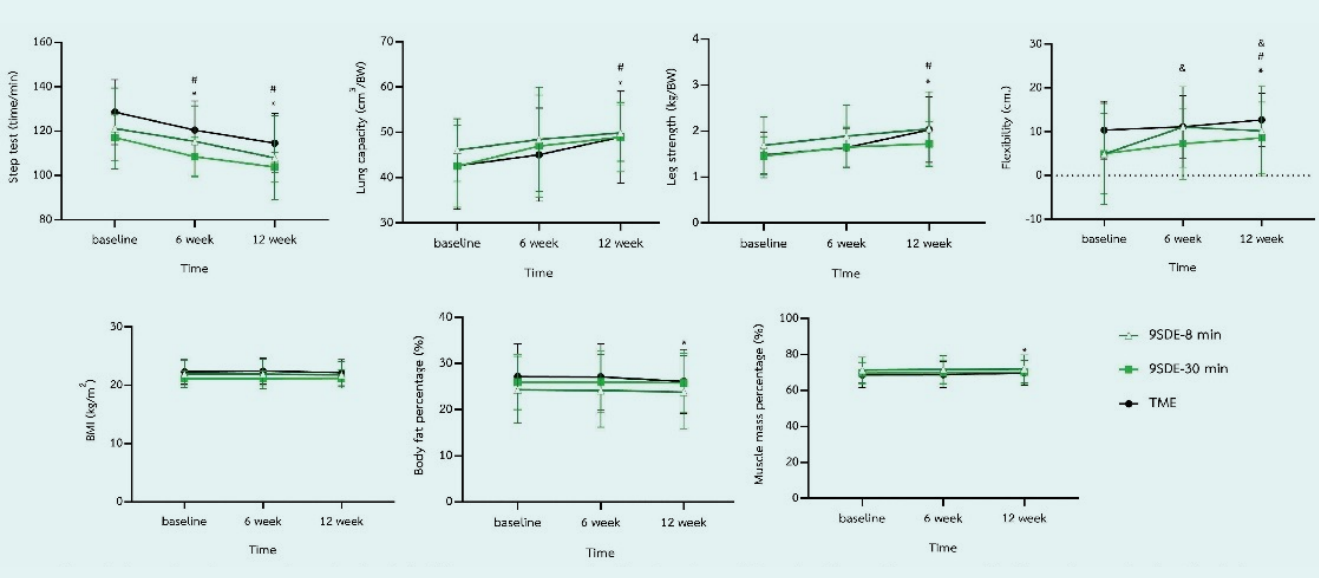

Fig 3. Comparisons between changes in the physical fitness parameters at baseline, 6 weeks, and 12 weeks. Superscripts represent significant changes from baseline in the 9SDE-8 group (&), 9SDE-30 group (#), and TME group (*). No significant between-group differences were demonstrated.

TABLE 3. EQ-5D-5L questionnaire results

Variable	Baseline	12-week	P-value Baseline to 12 weeks	P-value Baseline to group at 12 weeks
Utility				
9SDE-8	0.96 ± 0.04	0.99 ± 0.01	(0.009)**	
9SDE-30	0.98 ± 0.03	0.99 ± 0.03	(0.170)	0.666
TME	0.97 ± 0.04	0.98 ± 0.03	(0.103)	
Directly evaluated health status (VAS)				
9SDE-8	76.82 ± 15.54	82.73 ± 13.67	(0.096)	
9SDE-30	77.73 ± 9.58	79.55 ± 14.57	(0.717)	0.653
TME	64.09 ± 10.68	77.64 ± 10.27	(0.006)**	

Values are presented as the mean ± standard deviation.
9SDE-8, 9 Square dance 8 minutes; 9SDE-30, 9 Square dance 30 minutes; TME, Treadmill exercise.
** significant at $p \leq 0.01$.

recommendation that the optimal duration for exercise sessions should be at least 30 minutes in order to obtain the maximum health benefits.

This study showed that the 9SDE improved physical fitness including cardiorespiratory endurance, leg strength, flexibility, and lung capacity. The 9SDE form of exercise can lead to improved muscle strength because of the nature of its square-stepping routines. Other types of exercises that incorporate similar square-stepping routines can also lead to increased leg strength. For instance, Shigematsu et al. studied subjects who underwent square step exercise (SSE), while the participants in Ronnarithivichai et al.'s study used a 9-square table aerobic exercise with the addition of rubber ring stretching. Both studies reported significant increases in cardiorespiratory endurance and the leg strength of subjects after the study periods.[17-18]

Other exercise routines that utilize traditional dance have also been associated with an increase in flexibility. For instance, Douka et al. reported increased flexibility in subjects who took part in Greek traditional dance compared to before the exercise period ($p < 0.001$).[19] Similarly, Ronnarithivichai et al. found an increase in flexibility of 1.84 centimeters.[17] It is worth noting that these exercises were accompanied by both a warm-up and cool-down period. However, when none was provided, as in a study by Ghriadi et al., where young women were asked to perform aerobic exercises without any warm up or cool down, no change in flexibility was found.[9]

In this study, the 9SDE improved quality of life in the EQ-5D-5L questionnaire. Besides the significant improvements in physical health, there is extensive research regarding the association between traditional dance as a form of exercise and improvements in mental health and well-being. Traditional dance, such as Greek or Turkish folkloric dance, also tends to be an important part of cultural heritage, which can help individuals maintain social connections and promote a sense of community. One study demonstrated that Turkish folkloric dancing was associated with significant improvements in the SF-36 subscale, namely physical functioning, general health, and mental health.[20] In another study, Greek traditional dance performed by patients with chronic heart failure class II–III resulted in significant improvements in SF-36 physical health, mental health, and total score, as well as the life satisfaction inventory when compared to formal exercise training and a no exercise group. Moreover, only the Greek traditional dance group experienced significant changes in the intrinsic motivation inventory.[21]

Traditional dance as a form of exercise may also have special appeal for women. Most of our study participants were females and the adherence among this group was extremely high (99.3%). Publications pertaining to traditional dances as a source of exercise have also found that they are particularly attractive to women. Filippou et al. studied the attendance motives of participants in Greek traditional dancing classes and found that women were more likely to attend the activities and cited the main reasons as needing to leave the house and to have a break away from the monotony of everyday life.[22]

Our study has several limitations to note. The requirement for on-site exercises in all groups may have limited the participants to only those without regular working hours. The self-evaluation nature of the questionnaire also means that there may be recall biases. Future directions for this research include the possibility of conducting similar research for online 9SDE classes and study of the appropriate 9-square size in relationship to the height of the participants.

CONCLUSION

The use of 9SDE as an exercise routine can lead to an improvement in cardiorespiratory endurance and leg strength. Its traditional nature can also help improve the individual's sense of well-being, while also allowing a more feasible form of exercise for space and resource-limited individuals.

ACKNOWLEDGMENTS

The authors gratefully thank Mr. Suthipol Udompuntrurak for assistance with the statistical analysis, and Mr. Yonworanut Jrerattakon of Siriraj fitness center for his assistance with the volunteer exercises and fitness tests. Also, Asst.Prof. Dr. Suksalin Booranasubkajorn and Ms. Manmas Vannabhum for investigating the results and for providing writing guidance; Prof. Chulathida Chomchai for giving writing advice and helping to check our English; and Mrs. Aunsaya Theeraparppotchanakul, Mrs. Saranyatorn Lertphadungkit, and Mrs. Sopapan Wongchai for their contributions to this study. We also appreciate the grant from the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (granted no. R016135053) for funding this research.

Conflict of interest: All the authors declare they have no personal or professional conflicts of interest relating to any aspect of this study.

REFERENCES

1. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-31.
2. Wilmore JH. Aerobic exercise and endurance: improving fitness for health benefits. Phys Sportsmed. 2003;31(5):45-51.
3. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43(7):1334-59.
4. Evans WJ. Exercise training guidelines for the elderly. Med Sci Sports Exerc. 1999;31(1):12-7.
5. Berger BG, McInman A. Exercise and the quality of life. J Sport Exerc Psychol 2011:483-505.
6. Martin CK, Church TS, Thompson AM, Earnest CP, Blair SN. Exercise dose and quality of life: a randomized controlled trial. Arch Intern Med. 2009;169(3):269-78.
7. Department of Physical Education, Ministry of Tourism and Sports. Report on the results of the survey of people's exercise or playing sports for the year 2020 [July 15, 2022]. Available

from: https://www.dpe.go.th/manual-preview-432891791793
8. Ruddy KJ, Stan DL, Bhagra A, Jurisson M, Cheville AL. Alternative Exercise Traditions in Cancer Rehabilitation. Phys Med Rehabil Clin N Am. 2017;28(1):181-92.
9. Griadhi IPA, Adiatmika IPG, Tirtayasa IK. Traditional Lègong Dance Training Is Superior to Moderate Aerobic Training on Physical Fitness Improvement Among Young Girls. J Phys Act Health. 2021;18(7):826-31.
10. Kim SM, Park HJ, Min BJ, So WY. Effects of a Korean Traditional Dance Program on Health-related Fitness and Blood Lipid Profiles in Korean Elderly Females. Iran J Public Health. 2018;47(1): 127-9.
11. Ayurved Thamrong School, Center of Applied Thai Traditional Medicine. 9-Square Step Exercise. In: Tawee Laohapand, Uapong Jaturatamrong, editors. Thai Traditional Medicine in the Faculty of Medicine Siriraj Hospital. 2nd ed. Bangkok: Supavanich Press, 2014.p.67-70.
12. Ketusinh O. Kao-Ta, Kao-Ten, Kao-Ma, Kao-Sung in exercise. In: Niyomporn B, et al, editor. Ouay Ketusinh innovation. Bangkok, Thaimitr Print, 1988.p.141-6.
13. Atipas S, Chongkolwatana C, Suwannutsiri T, Thongyai K, Henggrathock S, Akarasereenont P. Effect of Kao-Ta (9-Square Step Exercise) and Kao-Ten (9-Square Dance Exercise) on Balance Rehabilitation in Patients with Balance Disorders. Siriraj Med J. 2019;71(1):1-7.
14. Bonoy S. A Comparison of The Effect of Exercise Training by Treadmill and Eliptical Cross Trainer upon VO2max [Thesis]. Bangkok: Srinakharinwirot University; 2005.
15. Sport Science Bureau, Department of Physical Education, Ministry of Tourism and Sports. Physical fitness test and criteria for Thai people aged 19 - 59 years [June 18, 2020]. Available from: https://dl.parliament.go.th /handle/lirt/ 575780
16. Pattanaphesaj J. Health-related quality of life measure (EQ-5D-5L): measurement property testing and its preference-based score in Thai population [Dissertation]. Nakornpathom, Thailand: Mahidol University; 2014.
17. Shigematsu R, Okura T, Sakai T, Rantanen T. Square-stepping exercise versus strength and balance training for fall risk factors. Aging Clin Exp Res. 2008;20(1):19-24.
18. Ronnarithivichai C, Thaweeboon T, Petchpansri S, Sujijantararat R, Boonchan N, Kridiborworn C. The evaluation of physical fitness before and after 9-square-table aerobic exercise and rubber ring stretching of elders in the health promotion program for the elderly, Faculty of Nursing, Mahidol University. J Nurs Sci Vol. 2009;27(3):68-77.
19. Douka S, Zilidou VI, Lilou O, Manou V. Traditional Dance Improves the Physical Fitness and Well-Being of the Elderly. Front Aging Neurosci. 2019;11:75.
20. Eyigor S, Karapolat H, Durmaz B, Ibisoglu U, Cakir S. A randomized controlled trial of Turkish folklore dance on the physical performance, balance, depression and quality of life in older women. Arch Gerontol Geriatr. 2009;48(1):84-8.
21. Kaltsatou AC, Kouidi EI, Anifanti MA, Douka SI, Deligiannis AP. Functional and psychosocial effects of either a traditional dancing or a formal exercising training program in patients with chronic heart failure: a comparative randomized controlled study. Clin Rehabil. 2014;28(2):128-38.
22. Filippou F, Goulimaris D, Baxevanos S, Genti M. Adult attendance in Greek traditional dancing classes. Exercise Quality Lif. 2010;2(1):15-28.