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The efficiency of Ram Thai with Nine Square dance on physical performance and cognitive functions: a model for elderly school

La eficiencia de Ram Thai con Nueve Cuadrados de baile en el rendimiento físico y funciones cognitivas: un modelo para la escuela de personas mayores

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Abstract. Age-related declines in health-related physical fitness and cognitive function can be mitigated by a multi-movement exercise program. Therefore, the aim of this study was to determine the efficiency of Ram Thai with nine square dances on physical performance and cognitive functions in the elderly. Participants were randomly assigned into an experimental or control group. The Montreal cognitive assessment-basic (MoCA-B, Thai version) were chosen from screened volunteers and randomly assigned into 2 groups; Ram Thai with nine square dances (RTND:33) and brisk walking exercise (BWE:34) aged 65.3±2.4 years old, body mass index (BMI) 25.5±11.9 kg/m^2. The physical performance parameters assessed were as follows: Back-scratch test (BST), Chair sit and reach test (CSRT), Chair stand test (CST), 30-second arm curl test (ACT), 6-minute walk test (6-WT) and timed up and go test (TUG) were conducted respectively. Our results showed the physiological revealed a reduction in body fat percentage, while significant increase in VO^{2max} test scores observed in both groups ($p \leq .05$). Additionally, there was an improved lower limb strength, as evidenced by statistically significant increases in scores for the CST, 6-WT, and TUG compared to pretest values ($p \leq .05$). In terms of BST performance, the RTND group showed significantly better results compared to the BWE group ($p \leq .001$). Moreover, we discovered that significantly superior results indicate increased variability in MoCA-B scores (24.11≈26.37) among elderly participants in the RTND group ($p \leq .001$). The data indicates that RTND effectively enhances physiological aspects, physical performance control, and overall cognitive function in elderly individuals with mild cognitive impairment (MCI).
Keywords: physical performance, cognitive function, mild cognitive impairment, elderly

Resumen. Los declives relacionados con la edad en la aptitud física relacionada con la salud y la función cognitiva pueden mitigarse mediante un programa de ejercicio de múltiples movimientos. Por lo tanto, el objetivo de este estudio fue determinar la eficacia de Ram Thai con nueve bailes cuadrados en el rendimiento físico y las funciones cognitivas en personas mayores. Los participantes fueron asignados al azar en un grupo experimental o de control. La evaluación cognitiva básica de Montreal (MoCA-B, versión tailandesa) se eligió de voluntarios seleccionados y se asignaron al azar en 2 grupos; Ram Thai con nueve bailes cuadrados (RTND:33) y ejercicio de caminata rápida (BWE:34) con una edad de 65.3±2.4 años, un índice de masa corporal (BMI) de 25.5±11.9 kg/m^2. Los parámetros de rendimiento físico evaluados fueron los siguientes: prueba de rasguño de espalda (BST), prueba de estiramiento de silla (CSRT), prueba de levantamiento de silla (CST), prueba de curl de brazo de 30 segundos (ACT), prueba de caminata de 6 minutos (6-WT) y prueba de levantarse y andar cronometrado (TUG) se realizaron respectivamente. Nuestros resultados mostraron que los aspectos fisiológicos revelaron una reducción en el porcentaje de grasa corporal, mientras que se observó un aumento significativo en las puntuaciones de la prueba VO^{2max} en ambos grupos ($p \leq .05$). Además, hubo una mejora en la fuerza de las extremidades inferiores, como lo demuestran aumentos estadísticamente significativos en las puntuaciones para CST, 6-WT y TUG en comparación con los valores previos a la prueba ($p \leq .05$). En cuanto al rendimiento de BST, el grupo RTND mostró resultados significativamente mejores en comparación con el grupo BWE ($p \leq .001$). Además, descubrimos que los resultados significativamente superiores indican una mayor variabilidad en las puntuaciones de MoCA-B (24.11≈26.37) entre los participantes mayores en el grupo RTND ($p \leq .001$). Los datos indican que RTND mejora eficazmente los aspectos fisiológicos, el control del rendimiento físico y la función cognitiva general en personas mayores con deterioro cognitivo leve (MCI).
Palabras clave: rendimiento físico, función cognitiva, deterioro cognitivo leve, personas mayores

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Introduction

Everyone gets older, and it's happening faster than ever around the world. The number of people over 65 is projected to grow dramatically, from 8.5% of the global population in 2015 to 16.7% by 2050 (He et al., 2016). Thailand is no exception – it became an "aging society" in 2005 and is predicted to be a "complete aged society" by 2021, with over 20% of its population being 60 or older (NESDC, 2019). This growing elderly population presents new challenges. As people age and become less active, they may struggle with daily tasks, leading to anxiety, depression, and confusion (Phillips et al., 2004). Lack of exercise can also worsen chronic health conditions and decrease functional mobility due to changes in body composition, shoulder flexibility (Lima et al., 2021), muscle strength (Thaqi et al., 2023), and dynamic balance (Ferragut et al., 2023).

Cognitive impairment and obesity are two major health issues that can affect the elderly, resulting in diminished quality of life and increased mortality rates (Santamaría-Ulloa et al., 2022). Cognitive impairment is highly prevalent among the elderly, with an estimated 11% of individuals aged 65 years or older affected by dementia, and approximately one-third of those aged 85 years or older experiencing significant cognitive decline (Guerrero-

González et al., 2024). There is evidence suggesting that the relationship between mobility and cognition in older adults, with the associations generally increasing with age (Demnitz et al., 2018). Among older adults, cognitive deficits (especially executive function impairments) likely interfere with lower extremity mobility impairment, especially in older adults (Tolea & Galvin, 2016).

Cognitive decline may be related to a low level of education, poor health, small social network, unwholesome lifestyle, and insufficient exercise (Rosenberg et al., 2018). Human and animal studies suggest that physical exercise can stimulate improvement in cerebrovascular function, perfusion, and neuroplasticity in the brain, which may prevent the progressive loss of cognitive function associated with aging and disorders such as dementia (Davenport et al., 2012). Mild cognitive impairment (MCI) often precedes dementia and is considered a transitional stage of normal aging and early dementia. A study reported that general exercise training can give rise to small to moderate improvements in cognitive function. So, aerobic exercise, strength training, balance training, coordination training, and sensitivity training might be one approach to improve the cognitive function of the elderly with MCI (Nunes Nora de Souza et al., 2024; Ahn & Kim, 2018).

Regular aerobic exercise is crucial for maintaining both physical health and brain function, helping to prevent chronic diseases (Mahindru et al., 2023). Traditional slow-paced dances are a popular form of aerobic exercise for older adults because they emphasize rhythm and balance in a safe and enjoyable way. Ram Thai dance, a national treasure, is a perfect example. It combines movement expertise with balance and engages the entire body. This approach strengthens core muscles, which are essential for balance (Noopud et al., 2019). To achieve optimal movement, the nervous system and muscles need to work together effectively. Studies have shown that training with varied movements can improve cognitive function by stimulating the frontal lobe and limbic system of the brain (Fuster, 2002). Similar findings come from research by Shigematsu et al. (2008) who developed the Square Stepping Exercise (SSE) specifically for older adults. This gentle aerobic program, similar to brisk walking, has been shown to be safe and effective in improving leg function, balance (both static and dynamic), and agility (Teixeira et al., 2013).

Nine-square training model, designed to stimulate brain development by engaging in systematic, sequential movements. Initially focusing on refining perceptual reactions and coordinating movements (Krabuanrat, 2007). The nine-square method facilitates the synchronization of movement rhythms through cognitive and motor processes. Given that traditional Thai dance predominantly emphasizes arm movements, integrating foot movements into patterns within the nine-square structure presents an intriguing avenue. Thus, hypothesizing that the Ram Thai combind with nine square dance may offer advancements over traditional aerobic dance seems reasonable. Consequently, this research aims to employ exercise model to support both physical perfomance and cognitive functions in older adults.

Materials and Methods

Participants

All participants are elderly people residing in Loei Province, Thailand. This research set the sample group to be a total of 70 subjects (male n = 21 and female n = 49) aged 60-79 years old (65.3±2.4), body mass index (BMI 25.5±11.9 kg/m^2), The simple random sampling technique was applied to select the samples that were divided into two groups; the first group consisted of 35 participants performing Ram Thai with nine square dances (RTND) and 35 participants were Bisk walking exercise (BWE).

Research Design

This research is a quasi-experimental research design with two groups pre-test/post-test design. During the intervention period, all subjects were advised to maintain their usual lifestyle, including food consumption and daily activities. The participants understood the details of practice during the experiment and signed consent letters before participating in the research. The research was approved and supervised by the Ethics Committee in Human Research, Loei Rajabhat University, Thailand (H 015/2566, Dated 20 June 2023).

Exercise Intervention

The researchers designed both patterns of exercise as parts of a health promotion activity for the elderly school. Both groups exercised for a 45-minute period, three times a week; totally 12 weeks. All participants put on heart rate monitors (Polar Team Pro, Finland), intensity was controlled, 60-80% of maximum heart rate throughout the duration of exercise. The experimental group performed, RTND including dynamic warm-up for 5 minutes, then began to work out for 35 minutes. There were 8 track music of Ram Thai exercise postures, using 90-135 beats per minute (bpm) with background music, and practiced static stretching for 5 minutes, The nine square layout uses a size of 30*30 cm. Each compartment is numbered in order from 1-9. Each track of the song determines the direction of movement of the feet and different numbers. The intervention will progress through the first six weeks up to the next level. Similarly, participants will start with simple movement patterns (e.g., one or two-step) forming patterns resembling letters I, V, Y, L, they add on of their shoulder and fingertips in Thai dance poses, after 6 weeks also progress to increasingly complex patterns (larger steps per sequence e.g. T, X, +, O). When the subjects were confident in their foot movements respectively (figure 1). Control participators will continue with their typical lifestyle and routine. throughout the duration of the experiment they received regular community health instruction, such as receiving lessons lasting one hour three

times a week including how to keep fit, are shown in Table 1.

Table 1.
Ram Thai with nine square dances progression for intervention.

Weeks	Frequency (Days a Week)	Session Time (min)	Varity of feet movement	Arm part (shoulder-fingertip)
		Ram Thai with nine square dances (RTND)		
1-6	3	45	I – V – Y – L - Lower part of body (Leg to tiptoe) - Kao Thao or Kao Na - Kao Khang - Yok Thao	- The Upper Wong or Wong Bon - The middle Wong or Wong Klang - The lower Wong or Wong Lang - Chip Ngai or the upward Chip - Chip Khwam - Chip Prok Na - Chip Lang or Tang Wong
Progress period				
7-12	3	45	T – X – + – O	
		Brisk walking exercise (BWE)		
1-12	3	60	- Continue with their typical lifestyle and routine.	- Received regular community health instruction.

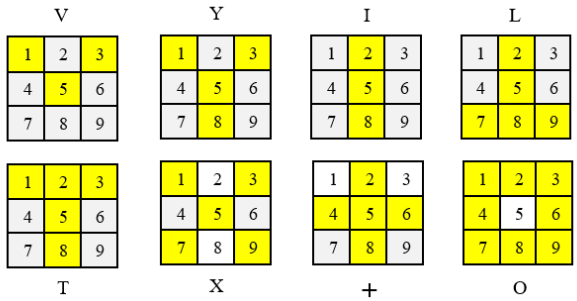

Figure 1. The nine square direction of feet movement.

Figure 2. The Ram Thai with nine square dances practice.

Assessment Protocol

The data collection was conducted to test the variables regarding health at sports and exercise science laboratory in the Faculty of Science and Technology, Loei Rajabhat University. Tools for screening dementia in the elderly by the Montreal cognitive assessment-basic (MoCA-B Thai version). Physiological variables assessment: were body composition using Bioelectrical Impedance Analysis (BIA), in body 220 model, including body weight (Kilograms) and body mass index (BMI; kg/m^2).Moreover, Maximum oxygen consumption (VO^{2max}) was indirect assessment method with Polar Team Pro device. Physical perfomance, they will be assessed with the following tests of the Senior fitness test battery (Rikli & Jones, 2013) were as follows: Upper-limb flexibility, the Back-scratch test (BST) will be performed. Measures the motion range of the shoulder joint through the distance or overlapping the middle fingers behind the back. Lower-limb flexibility, the Chair sit and reach test (CSRT) will be applied. Upper-body strength, Arm curl test (ACT) by flexing and extending the arm for 30 second (2.3 kg for women and 3.6 kg for men). Lower-limb strength, we use 30 second Chair stand test (CST). The 6-minute walking test (6-WT), This assessment determines the highest distance each participant can walk for 6 minutes around a 45.7-meter rectangle. Agility and dynamic balance by sitting, standing, walking was tested Timed up and go test (TUG). Finally, cognitive domains will be performed MoCA-B (executive function, immediate recall, fluency, orientation, calculation, abstraction delayed recall, visuoperception, naming and attention) respectively.

Statistical analysis

Descriptive analyses were generated to present the demographic characteristics of the participants. The normality of the data set was assessed using the Shapiro Wilk test. An independent t-test was used to explore the effects of the RTND on physical performance and cognitive function of the experimental group when compared with the control group. A paired t-test was applied to compare outcome measures before and after both interventions. Statistical analyses were performed using the statistical package for the social sciences (SPSS) version 21.0. Statistical significance was set at p value ≤0.05.

Results

There were 70 participants in this study divided into two groups. Initially, the basic data analysis results of the participants in both groups were of average age. Descriptive statistics related to the participants' age and their sociodemographic structure are presented in Table 2. Male and female subsamples did not differ in terms of their age In terms of marital status, 52 participants were married, 5 were single, and 10 were widowed or divorced. Regarding educational attainment, 2 participants had no formal education, 54 had completed primary school, and 9 had completed high school. Sixty-one participants were undergoing medical treatment for chronic diseases, while 6 were without any known disease. Additionally, five years ago, 7 participants were identified as smokers and 20 as alcohol drinkers. There was no reported history of the cases. Most of the female groups in both groups were overweight by referring to the BMI (Asian people was

ranged from 18.50 to 22.99 kg/m^2). The general data of the volunteers before exercise showed that there was no significant difference. In terms of adherence to the training programs, RTND group attended 34.1±0.3 sessions (89.16%), BWE attended 34.7±0.6 sessions (90.61%) out of a total 36 sessions in the program. Most of the sample groups attended more than 80% of their exercise classes. Finally, the three participants disappeared during the experiment, in which each group did not complete the program as specified.

Table 2.
Socio-demographic variables of the study paticipant.

Socio-demographic variables	Research design		*p-value*
	Ram Thai with nine square dances (RTND = 33)	Brisk walking exercise (BWE = 34)	
Gender (male: female)	9: 24	9: 25	-
Age (year)	65.64±2.6	65.10±2.5	.611
Height(cm)	157.61±4.2	156.14±4.5	.682
Weight (kg)	64.13±10.0	63.90±9.7	.456
Percent body fat (%)	38.60±9.3	38.13±5.3	.502
Body mass index (kg/m^2)	25.49±3.1	25.54±2.5	.721
Average Heart Rate (%AVG^{HR})	73.21±11.9	74.06±12.4	.225
Maximum Heart Rate (%AVG^{HRmax})	76.12±13.0	76.40±13.4	.605
Expenditure of Exercise (Kcal)	342.71±21.4	337.20±20.7	.371
VO^{2max} (ml/kg/min)	28.05 ± 1.4	28.43 ± 1.8	.373
MoCA-B (Thai version)	24.11±2.0	24.17±2.16	.303
Marital status [n (%)]			
- single	2 (6.0)	3 (8.8)	
- married	25 (75.7)	27 (79.4)	
- separated	6 (18.1)	4 (11.7)	
Educational level			
- no formal education	2 (6.0)	2 (6.0)	
- elementary school (primary or secondary)	28 (84.8)	26 (76.4)	
- high school	3 (9.0)	6 (17.6)	
Underlying medical conditions			
- yes (diabetes, hypertension, dyslipidemia)	30 (90.9)	31 (91.1)	
- no	3 (9.0)	3 (8.8)	
Smoking (within 5 year)			
- yes	4 (12.1)	3 (8.8)	
- no	29 (87.8)	31 (91.1)	
Drinking (alcohol)			
- yes	11 (33.3)	9 (26.4)	
- no	22 (66.6)	25 (73.5)	

Note: Values are expressed as means ± standard deviations, Montreal Cognitive Assessment-Basic (MoCA-B Thai version), Maximum oxygen consumption; VO2^{max} (ml/kg/min)

Results for comparisons of protocol variable are observed in table 3. Following a 12-week period, a significant decrease was observed in physiological variables, specifically percent body fat (p=.012), while there was an increase in VO^{2max} across all groups (p=.029). Comparisons between study groups indicated significantly improved motor function, as demonstrated by the 6-WT (p=.046), CST (p=.043), and TUG (p=.037), In contrast to the BWE, the experimental group experienced significant improvements in the BST (p= .037), indicating increased range of motion in the shoulder joint, and cognitive function due to the RTND intervention. This was demonstrated by the enhanced MoCA-B scores (p= .022) compared to those participating in BWE.

Table 3.
Intervention effect on motor perfomance and cognitive function.

Protocol measures	Ram Thai with nine square dances (RTND = 33)		Brisk walking (BWE = 34)		*p-value*
	Pretest	12 weeks	Pretest	12 weeks	
Physiological					
Weight (kg)	64.13±10.0	62.94±8.0	63.90±9.7	62.22±9.0	.481
Body mass index (kg/m^2)	25.49±3.1	25.15±2.9	25.54±2.5	25.62±2.3	.513
Percent body fat (%)	38.60±9.3	36.33±4.3	38.13±5.3	36.02±4.8	.012*
Maximum oxygen consumption; VO^{2max} (ml/kg/min)	27.27 ± 1.3	29.07±2.9	27.40±1.1	29.29±3.1	.029*
Physical performance					
Back-scratch test (cm)	-10.6±7.0	-8.5±6.4	-10.9±7.6	-10.1±6.4	.001*†
Chair sit and reach test (cm)	8.3±7.1	8.5±7.7	8.1±5.1	8.4±5.8	.211
Chair stand test 30 second (reps)	14.83±1.2	16.47±1.9	15.17±1.6	16.20±1.8	.046*
Arm curl test 30 seconds (reps)	18.07 ± 0.8	19.50 ± 1.3	18.47 ± 0.8	19.27 ± 1.6	.611
6-Minute walk test (meter)	469.23 ± 51.3	485.85± 54.9	476.07 ± 49.9	488.70± 53.0	.043*
Timed up and go test (second)	7.52 ± 2.3	7.07 ± 2.1	7.49 ± 2.4	7.31 ± 2.8	.037*
Cognitive function					
MoCA-B (Thai version)	24.11±2.0	26.37±4.1	24.17±2.1	25.16±3.8	.001*†

Note: Values are expressed as means ± standard deviations, Montreal Cognitive Assessment-Basic (MoCA-B Thai version), Maximum oxygen consumption; VO^{2max} (ml/kg/min), *$p \leq 0.05$ statistically significant difference when compared within group, mean scores at point comparisons from baseline and †$p \leq 0.001$ when comparing the difference between experimental groups.

Discussion

Ram Thai dance, a traditional Thai athletic art form, is the foundation for this new exercise program. The program combines Ram Thai movements with a nine-square grid pattern. It starts slow and gradually increases the pace as participants improve. Previous research (Hamacher et al., 2015; Braun Janzen et al., 2022) focused on how different music affects physical outcomes like balance and endurance. This study, however, investigates the nine-square

movements themselves. These movements may improve motor function because they follow balance exercise principles, such as shifting weight and changing speed (Krabuanratana, 2007). This study found that RTND improved visual-spatial thinking, attention, and memory in older adults with MCI. The broader goal is to promote physical activity among older adults in Loei, Thailand, and this study compared the new program to BWE, a common exercise recommendation.

During the studied, we observed that older adults have continued to develop their mechanical skills. Attend events regularly. For this reason, this study has been effective for the better. The data suggest that both forms of exercise, aerobic, directly affect neurotransmitters that respond to health related physical fitness and cognition improved. After 12 weeks showed that physiological in relation to the body composition, consisting of body weight and BMI compared to before the experiment has a tendency to decrease there was not found to be significantly different after exercise. However, there was a statistically significant reduction in the percentage of body fat observed in both groups compared to pre-test measurements. It can be said that this form of exercise is aerobic exercise, which is a process that uses the energy system of the body at a time level as well as the right weight to use energy from fat for combustion as energy, which is related to weight loss (Aloko et al., 2023). Sufficiently long maintaining 60-80% of intensity of exercise duration, positive influence of aerobic training was also observed in participants. Results clearly suggest benefits of RTND on cardio-respiratory fitness of elderly population. While there was an increase in VO^{2max} across all groups. The RTND was using the rhythm of the music which has the relationship of the rhythm of body movement continuously. Before training the participants were advised for how to breathe and manage fatigue while exercising. Those who practiced exercise can control the intensity of heart rate continuously. This is consistent with the recommendations of Palmieri et al. (2005) who described that the benefits of breathing exercises while exercising can affect the efficiency of the breathing and the cardiac muscles that help with compression. This is related to the function of controlling the baroreceptor system.

Ram Thai dance offers several benefits for older adults. The rhythmic arm movements, swinging front and back and overhead, work the shoulder and arm muscles while the core muscles maintain balance. This study confirms that Ram Thai dance improves shoulder joint flexibility as measured by the BST. Previous research supports this, showing better shoulder mobility leads to improved overall stability (Brandao-Loureiro et al., 2024; Bailey et al., 2023) and faster walking speeds (Stathokostas et al., 2013). While flexibility naturally declines with age, older adults can still improve their range of motion through exercise programs (Matos-Duarte et al., 2022; Li et al., 2023). Footwork in Ram Thai dance, specifically Kao Thao, Kao Khang, and Yok Thao poses, engages the core muscles to maintain balance on both sides of the hips, these various gestures have a positive effect on stimulation proprioception (Chalapud Narváez et al., 2023). This study found that participants had better movement control after training, as evidenced by a 30-second CST. However, both RTND and BWE improved participants' endurance and leg strength, as shown by increased walking distance in the 6-WT and faster completion times in the TUG (which measures how long it takes to stand up, walk a short distance, turn around, walk back, and sit down) (Morales Paredes et al., 2024).

This study supports the idea that combining physical and mental exercise benefits older adults' thinking skills (cognitive function), specifically executive functions which involve planning and decision making. Our findings link physical strength to better executive function. This aligns with past research by Falck et al. (2017) who found a connection between good mobility and strong executive function. The goal is to maintain good mobility and physical ability to keep executive function sharp. The earlier study measured mobility through tasks like gait speed and CST, while cognitive function was assessed using a specific test (MoCA-B). This study showed statistically significant improvements in different areas of cognitive function measured by the MoCA-B test. Memory improved the most, followed by executive function, then visuospatial skills and attention. Interestingly, participants showed the best improvement in spatial orientation compared to other areas. Since RTND is considered a moderate-intensity exercise program, this suggests it can be a valuable tool for improving cognitive function in older adults. The highlight of using a nine square grid in this study was that training did not require a period of time, distance, or much space. The movement under nine conditions is a pattern that stimulated thinking processes, memory, and commands when starting while moving. When Ram Thai dance patterns were used to accompany movements in a nine square grid together with slow and fast music rhythms, stepping on a given number helped seniors maintain focus, develop imaginative memory, foresight, and planning leading to creativity when stepping while moving in different directions. This study supports other research, like Van der Lubbe et al. (2018), which showed exercise training can improve both thinking and physical abilities in adults with early-stage MCI. This study used a new approach with a multi-part exercise program to potentially delay the progression of MCI to dementia. The program included exercises that challenge reaction time and hand-eye coordination, like fast foot tapping (Shigematsu et al., 2008) and table tennis (Yamasaki et al., 2022). These exercises may improve attention and visual-spatial thinking skills by potentially increasing connections between brain cells. This could be caused by a growth in nerve cell branches and increased blood flow to the brain, similar to findings by Davenport et al. (2012). Exercise is well-established for its health benefits and promoting social interaction among older adults (Suryadi et al., 2024, Flores Tena

et al., 2024). Integrating exercise into activities at senior centers is a promising idea.

This study highlights the potential of a program using a nine-square pattern with additional movements. This program requires minimal space and can be easily adapted for home use. It can benefit both body and mind, potentially delaying cognitive decline in older adults. A limitation of this study is that both groups came from the same community. While participants were instructed not to communicate before the intervention, there's a chance of some information sharing (contamination) that could have influenced the results.

Conclusions

Exercising with RTND is a form of exercise that blends upper body movements, including arms and hands, harmonized with the rhythmic movements designated in the nine square grid. The movement conditions are set in eight patterns to stimulate cognitive processes while moving. With consistent practice over a period, Ram Thai exercises also help increase shoulder flexibility, leg strength, and enhance motor movement efficiency. Additionally, they have been shown to improve cognitive function in the elderly. Exercising with a nine square grid can be done at home independently. In this study, it is suggested that the elderly adapt the exercise format by designing movements starting from easy to more challenging, dividing exercises between right and left sides, front and back sides, or incorporating activities that involve adding and subtracting numbers on a table to encourage computational thinking. The number of repetitions for each pattern or timing may be used to prompt faster movement, aiming to stimulate cognitive processes and mitigate cognitive decline in the elderly.

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