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Marching exercise on balance and blood pressure among Thai community-dwelling older adults at risk of falling

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ABSTRACT

Falls are a major cause of death among older people, and they are becoming a bigger problem as people lose their balance. A quasi-experimental study was conducted to examine the effects of marching exercises on the balance abilities of community-dwelling Thai seniors at risk of collapsing. Thirty-five participants were randomly assigned to the experimental or control group. The experimental group engaged in a 12-week marching exercise program that included a continuous foot-turning phase. The control group did not engage in any form of exercise. Compared to the control group, the experimental group demonstrated significant improvements in their ability to maintain their balance. The experimental group's timed up and go test (TUG) score decreased by 3.54 seconds, 95%CI: (2.13 to 4.95), p<0.001 while the functional reach test (FRT) score increased by 4.80 centimeters, 95%CI: (2.34 to 7.25), p<0.001. The systolic blood pressure decreased by 8.62 mmHg, the diastolic blood pressure by 6.48 mmHg, and the heart rate by 4.04 beats per minute. These findings imply that regular marching exercise may improve balance in at-risk older adults. Further research is necessary to clarify the effects of marching exercise on people diagnosed with chronic diseases.

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1. INTRODUCTION

The worldwide population's life expectancy has experienced substantial growth, leading to a bigger and more aged global population. This trend of aging has been observed in every nation, with the number and percentage of elderly people increasing. Projections indicate that by 2030, one in six people will be 60 or older [1]. The global population of adults aged 60 and above witnessed a notable increase, rising from one billion in 2020 to 1.4 billion in 2030. Projections suggest that this trend will continue, with a projected doubling by 2050, resulting in an estimated population of 2.1 billion. It is worth noting that emerging nations are projected to house around two-thirds of the global population aged 60 and above by the year 2050 [2]. By 2050, ten Asia-Pacific nations will be classified as aging societies, an increase from eight in 2020. Conversely, the number of nations classified as aged societies decreased from six in 2020 to five. In contrast to the sole instance of Japan in 2020, it is expected that an additional eleven nations will attain the status of super-aged civilizations by the year 2030, signifying a notable escalation. Among the twelve nations that satisfy the conditions for super-aged societies, it is projected that Papua New Guinea will be the sole country meeting this criterion by 2030. Specifically, the proportion of individuals aged 65 and above in Papua New Guinea's population is anticipated to be fewer than 7% of the overall total. Projections suggest that Vietnam's older population will double by 2050, while Brunei Darussalam's senior population has the potential to double [3]. Thailand witnessed a rapid rate of population aging, with over 12 million people categorized as old out of a total population of 67 million. In 2005, Thailand was defined as an 'aged society' due to the fact that 10% of its population was 60 years old or older. Projections indicated that Thailand's elderly population would reach 28% within the next decade, positioning the country as a super-aged society [4]. Age-related dysfunction is the consequence of the physiological changes occurring during the process of getting older [5]. The cardiovascular system alters physiologically as people age, and these changes include decreased vascular flexibility and arterial hypertrophy in the thoracic and cardiac areas [6], [7]. Increased cardiac output and the emergence of hypertension are both results of these modifications [8]. Additionally, the musculoskeletal system undergoes discernible changes as we age, including a decline in muscle mass and bone mineral density [9]. Moreover, there is a decrease in muscle nerve function, which results in sensory impairments that can cause postural instability and balance issues [10]. Reduced mobility and a loss in functional capacity are the combined effects of these age-related changes [11].

The chance of falling and one's functional independence decreases as people age due to a steady reduction in balance [12]. According to a study that examined falls among senior citizens using CCTV cameras in two Canadian senior care homes, a total of 130 older people had balance loss over a three-year period, out of which 227 instances were recorded. In addition, a review of odor data from 646 senior housing facilities in Canada found a total of 2,377 occurrences. Between April 20, 2007, and June 23, 2010, this study was done. After conducting an examination, experts in human movement came to the conclusion that the main cause of falls was a 521-fold imbalance [13]. This data showed that embodiment was essential for the elderly, to carry out a variety of tasks.

Several common workout techniques were used, such as walking on your heels and side slide walking, to improve older people's ability to maintain their balance. The timed up and go test (TUG) completion times were quicker in the exercise training groups compared to the comparison groups, demonstrating that individuals had improved fitness abilities. This difference was statistically significant [14]. Alternative workouts like Tai Chi, which improved balance and gained popularity, were also available [15]. Similar to standard methods of balance training, Tai Chi helps seniors enhance their ability to balance while moving [16]. Both workout strategies, though, had their drawbacks. The conventional techniques require certain training areas and amenities, which create logistical difficulties. Additionally, there was a chance that training might be disrupted, which called for vigilant supervision. On the other hand, senior residents of the community found it difficult to train for Tai Chi since it was a sophisticated postural activity. In this study, we explored the potential impact of marching step exercise on older people's ability to balance. The objective was to create a simple, easy-to-train exercise regimen that would provide the desired health advantages, similar to the earlier techniques. The primary aim of this research is to enhance individuals' ability to maintain a state of balance. The technique used entailed practicing marching steps, which involved a variety of bodily motions, postures, and operations involving the stomato-sensory functions, joints, muscles, and skeletal systems.

2. METHOD

2.1. Study design

A quasi-experimental, two-group pretest-posttest design to investigate how a marching exercise program improved the ability of elderly people who are at risk of falling to maintain their balance. The study will be carried out within the Na Fai sub-district health promotion hospital administrative boundaries, with a particular emphasis on the Phuphaman region of Khon Kaen province. Between October 1, 2022, and December 30, 2022, the study will be conducted.

2.2. Research subjects

Study utilized an established methodology to calculate the required sample size for the purpose of comparing mean differences [17]. The aforementioned equation is consistent with statistical information obtained from prior scholarly investigations. The balance ability and standard deviation of the experimental group were reported as 7.85±0.53, whereas the control group had values of 8.34±0.64. The value of alpha was 0.05, while the value of beta was 0.1 [18]. Consequently, an initial sample size of 31 participants was determined for each group, which was then augmented by 5%, yielding an adjusted sample size of 35 individuals per group. We then chose two villages with comparable senior populations and geographic attributes. The experimental group was chosen at random from one of these towns, and the comparison group was chosen at random from the other. Based on the expected sample size, older persons who satisfied the inclusion and exclusion criteria were chosen for the study. The participants were chosen based on the following standards, people who are 60 years of age or older and the TUG fall risk period of 12 seconds. The exclusion criteria were medical recommendations against exercising and unstable health conditions or situations.

2.3. Intervention

The experimental group engaged in a targeted exercise program that prioritized the positioning of their legs. The workout sessions occurred from 17:00 to 18:00 pm. The program was implemented on a weekly basis for a duration of three months, encompassing five days per week. Each session had a duration of 30 minutes. The exercise program's specific procedural features were as outlined:

i. The participants in the experimental group engaged in a 10-minute warm-up prior to commencing their exercise program.
ii. The exercise program also included a phase of uninterrupted foot-turning activity. Participants were instructed to maintain a consistent tempo of 80 to 90 steps per minute during this phase. One can perform exercises while listening to music, starting with leg swings on both the left and right sides. Participants were directed to maintain a 90˚ angle between their shoulders, arms, and thighs and to retain their hips at a 70˚ angle with their thighs during the foot twists. The foot-twisting exercise was performed continuously for approximately thirty minutes, see Figure 1.
iii. There was a ten-minute cool-down after the exercise session for participants. This phase was specifically designed to facilitate the body's gradual return to its pre-exercise condition by reducing the intensity of the activities. The cool-down phase may have involved moderate motions, stretching exercises, or leisurely walking as a means to relax and facilitate healing.

The control group continued their usual activities, serving as a benchmark for evaluating the other groups. They were excluded from receiving any information or being included in any discussions pertaining to the experimental exercise regimen. Moreover, this ensured that their acts remained unaltered by the program's influence.

Figure 1. Participants participated in marching exercises involved executing shoulder flexion at a 90˚ angle and hip flexion at a 70˚ angle

2.4. Measurement tools and materials

Measurement tools included: i) The Extech 365510-NIST stopwatch and the Omron HEM 7121 automatic digital blood pressure monitor, both of the devices are calibrated every six months. ii) The TUG, a study compared TUG test scores in 38 elderly individuals aged 60–92 years, revealing an acceptable ICC score of 0.97 in community-dwelling elderly [19]. iii) The functional reach test (FRT), was administered again seven to ten days later to ascertain its test-retest reliability. The ICC was 0.84 to 0.86, indicating excellent reliability [20]. A case report form is used in studies to collect the following specific data: i) demographic characteristics, such as gender, age, status, levels of education, and occupation; ii) results of the TUG; iii) results of the FRT; and iv) monitoring of blood pressure and heart rate.

2.5. Data collection

Data was collected at the health promotion hospital in the morning. Participants over the age of 60 are asked to sit for 10 minutes to unwind when they arrive. A study board made up of four registered nurses then oversees the process of gathering data. The information was acquired using three different methods, the first of which was a brief interview for general information that lasted only two minutes. Second, static and dynamic balance are assessed using the TUG and the FRT, respectively. In the TUG, the subject moves back and forth under the control of a chair that keeps time. The elderly person walks away from the chair along a 3-meter path, signals "start," and then immediately moves around it. The timing is noted, and the relevant data is collected for analysis. In the FRT, the participant is instructed to stand up and extend their arm at a 90-degree angle as the examiner directs. The participant is then directed to lean forward, keeping their arms at their original levels, and to reach as far as they can without moving. The examiner notes the final value when the subject finishes the movement and marks the initial location as the default value.

Final part is the assessment of blood pressure and heart rate, a registered nurse takes measurements of blood pressure and heart rate. The participant sits as the nurse takes three one-minute blood pressure measurements on their right arm. After that, the average of these readings is derived and noted. It takes approximately six minutes to complete this procedure.

2.6. Data analysis

The Shapiro-Wilk test was used to confirm that continuous variables followed a normal distribution. STATA Version 16 (StataCorp.2019) was used for data analysis. With a license from the Praboromarajchanok Institute, Stata Statistical Software: Release 16 was produced by StataCorp LLC in College Station, Texas. The analysis includes descriptive statistics and demographic data. An independent t-test was used to compare the baseline variables and outcome parameters between the experimental and control groups. A paired t-test was used to compare result variables within groups. The p-value was considered significant when it was equal to or less than 0.05.

2.7. Research ethics

The study endeavor received formal permission from the Sirindhorn College of Public Health Human Study Committee Office after undergoing a thorough examination. The authenticity of it is supported by the accompanying documents. The order is identified by the number HE652082, and the certification document is identified by the number SCPHKKIRB822565.

3. RESULTS AND DISCUSSION

3.1. Results

The study reveals a gender distribution of 15 male participants in the treatment group (Tx) and 12 male participants in the control group (CON). The majority (68.58%) belong to the 65-69 age range, while a smaller proportion (51.43%) fall within this age range. The majority (54.29%) of participants in the Tx group achieved primary school education, while 62.86% in the CON group had comparable educational backgrounds, see Table 1. The TUG in the Tx group averaged 15.51±1.96 seconds on average, whereas the CON group averaged 15.94±2.02 seconds. The mean difference was -0.43 seconds, 95% CI: (-1.38 to 0.52) seconds, demonstrating no statistically significant difference between the two groups, p-value=0.370. Similarly, the FRT for the Tx and CON groups exhibited mean distances of 18.06±4.92 cm and 18.00±5.71 cm, respectively. The mean difference was 0.06 cm, 95% CI: (-2.49 to 2.60) cm, proving no statistically significant difference between the groups (p-value=0.960). All other variables, including blood pressure and heart rate, showed no statistically significant changes between the groups, see Table 2.

Table 1. Demographic characteristics of participants

Characteristics		Tx group		CON group	
		n=35	%	n=35	%
Sex	Male	15	42.86	12	34.29
	Female	20	57.14	23	65.71
Age	65-69	24	68.58	18	51.43
	70-74	9	25.71	13	37.14
	75-79	2	5.71	4	11.43
Education	Uneducated	15	42.86	12	34.29
	Primary school	19	54.29	22	62.86
	High school	1	2.85	1	2.85

Table 2. A comparison between the Tx group and the CON group before experiment

Variables	Mean±SD		Mean difference	95% CI		p-value
	Tx group	CON group		Lower	Upper	
TUG	15.51±1.96	15.94±2.02	-0.43	-1.38	0.52	0.370
FRT	18.06±4.92	18.00±5.71	0.06	-2.49	2.60	0.960
Systolic blood pressure	142.34±11.83	143.57±7.67	-1.23	-5.98	3.52	.0608
Diastolic blood pressure	.8463±7.85	86.49±5.86	-1.86	-5.17	1.45	0.267
Heart rate	82.49±7.09	81.63±4.74	0.86	-2.02	3.74	.0555

The study compared the Tx and CON groups across various measures. The Tx group demonstrated significant improvements compared to the CON group; notably, in the TUG assessment, the Tx group performed faster by 3.54 seconds (p<0.001), 95% CI: (2.13 to 4.95). Additionally, the Tx group had a better

FRT score by 4.80 cm (p<0.001), 95% CI: (2.34 to 7.25). Moreover, the Tx group exhibited lower systolic and diastolic blood pressure compared to the CON group (p<0.001), and differences in heart rates were also noted between the groups, see Table 3.

Table 3. A comparison between the Tx group and the CON group after experiment

Variables	Mean±SD		Mean difference	95% CI		p-value
	Tx group	CON group		lower	upper	
TUG	12.17±2.73	15.71±3.15	-3.54	-4.95	-2.13	<0.001
FRT	22.57±4.32	17.77±5.86	4.80	2.34	7.25	<0.001
Systolic blood pressure	137.43±10.78	146.06±8.26	-8.63	-13.21	-4.04	<0.001
Diastolic blood pressure	80.23±7.23	86.71±5.79	-6.48	-9.61	-3.35	<0.001
Heart rate	76.77±5.70	83.43±5.21	-6.66	-9.26	-4.04	<0.001

After three months, the Tx group demonstrated notable enhancements in many measures. There was a significant decrease in the average time it took to complete the TUG test, from 15.51 seconds to 12.17 seconds. This indicates a mean difference of 3.34 seconds (p<0.001), 95% CI: (2.76 to 3.92). In addition, there was a substantial increase in the FRT range, with a mean difference of 4.51 cm (p<0.001), 95% CI: (3.58 to 9.91). In addition, the systolic blood pressure decreased by 4.91 mmHg, the diastolic blood pressure declined by 4.40 mmHg, and the heart rate decreased by 5.72 beats per minute (p<0.001). However, the control group did not exhibit significant alterations in TUG time or FRT distance after a period of three months, despite large elevations in systolic blood pressure and heart rate as shown in Table 4.

Table 4. A comparison within the Tx group and the CON group after experiment

	Variables	Mean±SD		Mean diff.	95%CI		p-value
		Baseline	After 3 months		Lower	Upper	
Tx group	TUG	15.51±1.96	12.17±2.73	3.34	2.76	3.92	<0.001
	FRT	18.06±4.92	22.57±4.32	-4.51	-3.58	-9.91	<0.001
	Systolic blood pressure	142.34±11.83	137.43±10.78	4.91	4.08	5.74	<0.001
	Diastolic blood pressure	84.63±7.85	80.23±7.23	4.40	3.82	4.97	<0.001
	Heart rate	82.49±7.09	76.77±5.70	5.72	4.02	7.40	<0.001
CON group	TUG	15.94±2.02	15.71±3.15	0.23	-0.29	0.74	0.379
	FRT	18.00±5.71	17.77±5.86	0.23	-0.08	0.46	0.058
	Systolic blood pressure	143.57±7.67	146.06±8.26	-2.49	-3.86	-1.11	0.001
	Diastolic blood pressure	86.49±5.86	86.71±5.79	-0.22	-1.73	1.27	0.760
	Heart rate	81.63±4.74	83.43±5.21	-1.80	-2.96	-0.64	0.003

3.2. Discussion

The objective of this study is to investigate the impact of marching exercises on the balance capabilities of older persons residing in the community. The findings of this study had an impact on individuals' balance and led to a reduction in blood pressure levels. The sequence of discussion will encompass balance ability, blood pressure, and heart rate.

3.2.1. Balance ability

According to the study, there was a 3.54 second improvement in balancing ability between the Tx and CON groups as measured by the TUG. Additionally, a statistically significant result was observed in the FRT measurement between the Tx and CON groups, with a mean difference of 4.80 cm. The current study is consistent with Dejvajara *et al*. [21] investigation into the effectiveness of nine-square-step exercises carried out at home to prevent falls among senior adults residing in the community of Thailand during a COVID-19 lockdown. Participating in the study were 46 elderly individuals who were at risk of collapsing. Eight weeks were devoted to performing nine-square-step exercises. The study found that the TUG test indicated a progressive improvement in the balance of elderly individuals [21]. The findings of this research align with those of Britten *et al*. [22], who observed a significant reduction in the time required to complete the TUG from 10.2 seconds to 7.7 seconds in a sample of 38 individuals who participated in an 8-week dance intervention. In relation to the impact of marching exercise on the balancing system, it seems that by augmenting ground reaction force [23], this form of exercise may enhance the functionality of proprioceptors and mechanoreceptors located in the feet. Constituting essential elements of the posture regulation system, these receptors facilitate posture correction via striding motion [24].

3.2.2. Blood pressure and heart rate

The Tx group demonstrated statistically significant decreases in systolic blood pressure of 8.63 mmHg, diastolic blood pressure of 6.48 mmHg, and heart rate of 6.66 beats per minute compared to the CON group.

Based on previous studies, implementing a six-week exercise program for individuals in the middle to later stages of life showed a notable decrease in systolic blood pressure by 9 mmHg and diastolic blood pressure by 2 mmHg [25]. The results presented are consistent with the findings of research, which provided evidence that exercise training has a statistically significant effect on reducing systolic blood pressure by 6.4 mmHg and diastolic blood pressure by 3.7 mmHg [26]. The potential mechanism that underlies the effects of marching exercise on blood pressure could be attributed to the functioning of the sympathetic autonomic nervous system (SNS). The SNS is a complex system that regulates several physiological functions, such as heart rate, blood pressure, and blood flow [27]. Norepinephrine, a neurotransmitter, is primarily responsible for its action [28]. The SNS can inhibit muscular sympathetic nerve activity (MSNA), resulting in a reduction in blood pressure and heart rate [29], [30]. The MSNA induces vasoconstriction, which constricts blood vessels, raising blood pressure and heart rate. Regular exercise can improve MSNA function by changing the neural circuits that control the SNS and boosting the production of nitric oxide, a gas that makes blood vessels dilate [31], [32]. Consequently, the SNS is indispensable for blood pressure and heart rate regulation.

4. CONCLUSION

Engaging in marching exercise led to an enhancement of physical balance, decrease in blood pressure, and resting heart rate. The aforementioned positive outcomes suggest that healthcare professionals should consider incorporating marching exercise routines into treatment procedures, especially for older adults who are more prone to falls. Further research is required to assess the viability of utilizing marching exercise as a preventative intervention for elderly individuals with chronic illnesses who are susceptible to falls.

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