Original article

Effect of exercise with the ball on blood pressure and functional performance in female hypertensive patients

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Background: Hypertension is a cause of premature death. One of the treatments for high blood pressure is regular exercise. In addition, it is a safe exercise, less injuries and can be easily implemented. Exercise with the ball is a very interesting type of exercise to apply for health promotion that believed to improve blood pressure and functional performance in hypertensive patients.
Objective: To determine the effects of exercise with the ball on blood pressure and functional performance in female hypertensive patients.
Methods: In a randomized controlled trial, female hypertensive patients (n = 20; average age 50.8 ± 3.3 years) were randomly allocated into two groups. The experimental group performed exercise with the ball consisted of 55 minutes/time, 3 times a week for 6 weeks whereas the control group received education. Blood pressure measured by digital sphygmomanometers. Functional performance tests were assessed cardiovascular endurance measured by 6 minutes walk test, balance control, gait and lower extremity strength measured by timed up and go test, gait speed measured by 10-meter walk test and postural control measured by one leg stand test. Results were presented as means and standard deviations.
Results: At the end of the study, there were significantly differences between experimental and control group for systolic and diastolic blood pressure ($P < 0.05$), respectively. Functional performance in experimental group were improved for 6 minutes walk test ($P < 0.05$), time up and go test ($P < 0.05$), 10-meter walk test ($P < 0.05$) and one leg stand test ($P < 0.05$).
Conclusion: Exercise with the ball can reduce blood pressure levels and improve functional performance. These findings support the recommendations of exercise with the ball in hypertensive patients.

Keywords: Exercise with the ball, functional performance, hypertensive.

Hypertension (HT) is one of five major non-communicable diseases that include ischemic heart disease, stroke, chronic obstructive pulmonary disease, diabetes and hypertension, is the cause of premature death. The American Heart Association established in 2017 defied that anyone with blood pressure greater than 130/80 mmHg are hypertension. Hypertensive patients may not have any symptoms no warning signs and symptoms appear. Hypertension is often called silent killer. Possible symptoms are headache, numbness, dizziness, fatigue, drowsiness, dyspnea and arrhythmic. The complications in the body will lead to significant risk of stroke, heart disease, eye and kidney disease that can be fatal.[1] Hypertension is a common condition. According to the Bureau of Policy and Strategy Office of the Permanent Secretary, Ministry of Public Health founded the mortality rate with high blood pressure per 100,000 population in 2015 more than 3 times in 2013. According to a Thailand's health survey 60.0% of men and 40.0% of women with hypertension with no history of hypertension were diagnosed; 8.0 – 9.0% were diagnosed hypertension

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but untreated as a result the symptoms intensify. Only 1 in 4 of those treated and able to control blood pressure. It can be seen that most people with high blood pressure are not known to be hypertension. And when the blood pressure is high, most people are unaware of the absence of symptoms and symptoms that clearly do not pay attention. When symptoms or complications begin to develop, they were begin to focus on and treat. Sometimes it may not be as good as it should be.[2] The main treatment of hypertension is the use of antihypertensive drugs[3] and behavioral modification, all patients including those taking antihypertensive drugs need to modify behavior to let down blood pressure. Modified behavior is widely accepted to reduce blood pressure include smoking cessation, weight loss, alcohol abstinence, reduce salt intake, DASH diet (Dietary Approach to Stop Hypertension) is to increase the diet of fruits and vegetables and reduce saturated and regular exercise.[4]

Hypertension Association of Thailand recommends that all people whether or not with high blood pressure to regularly exercise and should stimulate the movement of the body, reduce sedentary habits to help weight control. For examples, exercises such as brisk walking, swimming, cycling and non-strenuous exercise, light aerobics dance, etc. Oriental exercises included qi gong, tai chi, or yoga as an alternative to referring patients, may be possible to lower blood pressure.[5] In addition, there are exercises with balls that are of interest to apply to exercise for health. Because ball exercise is a safe exercise, injury from exercise less or not, can be easily implemented. This is a great motivation for exercise and can be used as sustainable exercise.[6]

Exercise with the ball is more popular. The exercise of the ball is used in terms of health promotion, disease prevention including the treatment and rehabilitation of the body. Exercise with the ball can be done at all ages and all sex. Previous studies have found that exercise with the ball improves the ability to balance, improve joint position and movement, and lead to effective fall protection. In addition, exercise with the ball also helps strengthen muscles and elasticity and improve quality of life. However, there is no study of the possible mechanism of ball exercise in controlling blood pressure in hypertensive patients. It is possible that exercise with the ball can control blood pressure levels through the mechanism. For this reason, the researcher is interested in studying the effects of exercise with the ball on blood pressure and functional performance in female hypertensive patients in Sawang Daen Din District, Sakon Nakhon Province. The results of this study are expected to be an alternative approach to exercise regimens for hypertensive patients.

Materials and methods

Subjects

This research is a randomized controlled trial. Subject number was calculated using the variable resting systolic blood pressure[7] as the main variable in this study, a total of 20 subjects. The study assesses patients with hypertension with baseline activity recruited from Sawang Daen Din District, Sakon Nakhon Province.

Inclusion criteria[7 - 9] consisted of: 1) diagnosed with essential hypertension stage 2 (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg); 2) on anti-hypertensive drugs and get a fixed dose; 3) age between 45 - 55; 4) functionally independent; 5) independently ambulatory (can walk more than 10 meters without walking aid or other person); and, 6) not continues to exercise for at least 2 months.

Exclusion criteria[9 - 12] included; 1) serious neurological such as stroke, parkinson's disease, epilepsy, brain injury; 2) uncontrolled angina pactoraris or coronary or valvular heart disease; 3) uncontrolled metabolic disease such as diabetes mellitus; 4) lower extremity complications and suffering from musculoskeletal disorders such as fracture, dislocation, rheumatoid arthritis and myopathy; 5) severe pain VAS > 5 of lower extremity; 6) severe cognitive dysfunction rid of understanding the intervention protocols and informed consent (MMSE-Thai 2002); 7) pregnancy in either time or during the study period; 8) vestibular impairments (patients self-report); 9) medical complications during exercise such as chest pain, pain in the neck, jaw, and pain in the left upper arm armpit, drowsiness or headache, nausea and vomiting, blurred vision, uncomfortable and faint: and, 10) risk to fall (timed up and go test takes < 13.5 seconds).

All subjects were informed of the experimental protocol and possible risks involved. They were informed verbally and in writing before signing the consent form after receiving the data of experiment. This study has been certified by the Khon Kaen University's Ethics Committee for Human Research. Reference number HE612235 dated 22 August 2018.

Outcome measurement

Volunteer basic data record included gender, age, congenital disease, educational level and the physical measurements consisting of height, body weight, body mass index, waist-to-hip ratio, blood pressure and heart rate.

This research measures blood pressure and heart rate with digital sphygmomanometers calibrated from the medical instruments calibration unit. Volunteers were measured the blood pressure in the morning after taking the medicine. Before the measurement, subjects rested in a seated position for 5 minutes. Recorded the mean of two systolic and diastolic blood pressure measurements.

Functional performance of 4 tests: 1) cardiovascular endurance measured by 6 minutes walk test (6MWT) use to measures the distance can walk rapidly on a hard, flat surface in 6 minutes. 6MWT were conducted 30 meters in length; it was marked every 3 meters with a cone at the turnaround points. Marks the beginning and end on the floor using colored tape. Subjects were instructed to "walk as far as possible for 6 minutes" and were given standardized encouragement at 1, 3, and 5 minutes during the walk. The distance walked during each trial was recorded to the nearest meter and data from the second 6MWT trial was used to analysis; 2) balance control, gait and lower extremity strength measured by timed up and go test (TUGT). This test measures the time to stand up from an armchair, 3 meters walk, turn, walk back to the chair, and sit down. The test was begun with sit, back seat, arm lay in lap and put the foot behind the sign on the ground. Subjects were instructed to: "When heard that word 'go' stand up, walk safely and comfortably on the floor to the cone, go around the cone, walk back, and sit in your chair". The subjects were informed that the trial was timed. Timing began when heard that word "go" and ended when upon returning and back seat. A conduct trial was performed 2 recorded trials. Data obtained were then averaged; 3) gait speed measured by 10-meter walk test (10MWT) walks 10 meters without assistance and the time was measured for the intermediate 6 meters to allow for acceleration and deceleration. Timing began on the toes of the leading foot crosses the 2-meter mark and ended when the toes of the leading foot crosses the 8-meter mark. We collected and calculated the average of the three trials and; 4) postural control measured by one leg stand test (OLST). One leg stand test is an effective method, easy and simple to screen for balance impairments. To perform the test, the patient was instructed to stand on one leg without support of the upper extremities or bracing of the unweighted leg against the stance leg. We recorded the number of seconds that the patient is able to maintain their position. The test begins with the eyes open with gaze fixed straight ahead, practicing once or twice on each side, then instructed to close eyes and maintain balance for up to 30 seconds. We record a fail test or termination if hopping occurs, the arms touch something for support or the foot touches the support leg or the floor.

Exercise intervention

Ball exercise is aerobic activity or endurance activity or cardio activity with moderate intensity by consisted of continuous 55 - minute classes held 3 times a week for 6 weeks of the intervention period. Ball exercise session contained 10 - minute warm-up including body movements and stretching while get acquainted with the ball following 6 full-body stretching exercises. Then catch the ball to get acquainted with. Thirty-five minutes exercise training, ball exercise consisted of two parts with 12 positions. First, training in sitting position (the subjects sat on the ball and did the exercises): holding balance position on the ball, active movements (flexion, extension, abduction, adduction) of one upper extremity, active movement of two upper extremities, trunk movements (bending forward and rotation), raising heel, raising toes, raising heel and toes simultaneously and weight shifting on ball. Second, training in standing position: moving the ball up and down in a straight line with two upper extremities, moving the ball up and down in an oblique line with two upper extremities, moving the ball forward and backward with left and right lower extremities, moving the ball laterally with left and right lower extremities, throwing the ball against the wall with hand and throwing the ball against the wall with foot. All the exercises were performed in three sets of 10 repetitions. And 10 minutes of cool down activities including stretching of the muscles like warm-up and breathing exercise. Each session was led by a trained instructor who was experienced in ball exercise. All ball exercise programs were performed slowly to guarantee the safety of the subject and focus on good posture, as well as social interaction and pleasure. The supervisors did not force any participant to perform the ball exercise if the subject felt anxious

about doing so and encouraged them to walk out if the subject had difficulty in doing so.

The control group has no specific intervention but was provides advices for the benefits of the exercise programs and home programs in daily living.

Statistical analysis

The data analyses were executed using the SPSS program (version 17.0). Descriptive statistics means and standard deviations (SD) was applied to explain baseline demographics and blood pressure. student unpaired *t* - test (mean ± SD and 95% CI) to compare between groups and student paired *t* - test (mean ± SD and 95% CI) to compared in group was applied to explain functional performance. The level of significance was set up at $P < 0.05$.

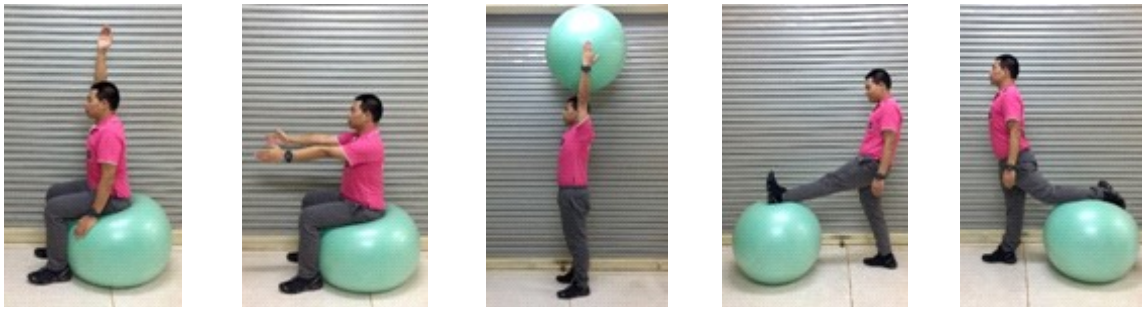

Figure 1. Pattern of exercise with the ball.

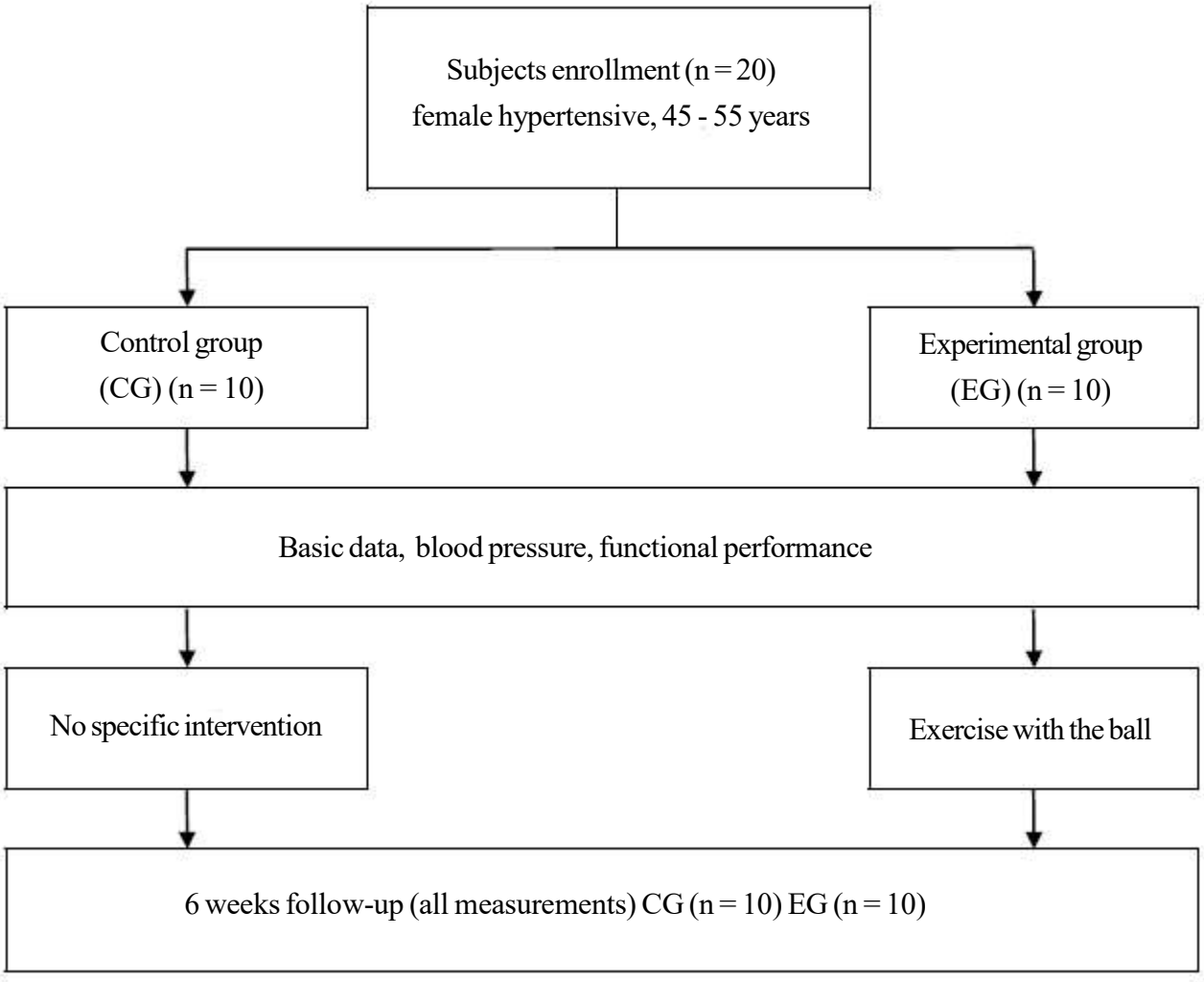

Figure 2. Overview of study methodology and flow of subjects through the study.

Results

Subjects

Twenty females volunteers were recruited in this study; they were divided into two groups: the first was the control group (CG) with 10 peoples of the subjects. The second group was the experimental group: they received ball exercise (EG) with 10 peoples of the volunteers.

Baseline characteristic

The general characteristics of the control and the experimental groups there were not statistically significant difference in anthropometric and baseline characteristics of both groups in Table 1.

Outcome variables

Blood pressure was found decreased from 153.1 ± 8.9 to 122.3 ± 8.3 for systolic blood pressure, decreased from 90.6 ± 6.8 to 72.2 ± 7.0; as for diastolic blood pressure, there was statistically significant compared to that ($P < 0.05$) in the experimental group.

Heart rate was found decreased from 81.4 ± 14.2 to 73.6 ± 11.3 and there was statistically significant compared to that ($P < 0.05$) in the experimental group.

The 6 - minute walk test was to test cardiovascular endurance for this study. The analysis was found distance increase from 365.4 ± 39.1 to 410.5 ± 40.4 and there was statistically significant compared to that ($P < 0.05$) in the experimental group.

Time up – and - go test determine balance control, gait and lower extremity strength measure three times to find the best value and analyze was found the score decreased from 8.6 ± 1.2 to 7.1 ± 0.5 and there was statistically significant compared to that ($P < 0.05$) in the experimental group.

The 10 - meter walk test measure gait speed was found score increase from 5.6 ± 1.3 to 6.4 ± 1.3 in the control group and was found score decreased from 6.1 ± 1.4 to 4.5 ± 0.7 in the experimental group and there was statistically significant compared from before ($P < 0.05$).

One-leg stand test (OLS) was an effective method, easy and simple to screen for postural control was found score decrease from 6.7 ± 4.2 to 5.2 ± 3.1 for left side in the control group. As for the experimental group, it was found score increased from 6.6 ± 4.0 to 15.5 ± 11.5 for left side and increased from 8.6 ± 9.7 to 19.8 ± 11.3 for right side and there was statistically significant compared from before ($P < 0.05$).

Table 1. Anthropometric and baseline characteristics of subjects.

Data	Control group (n = 10)	Experimental group (n = 10)	*P* - value
Age (years)	50.1 ± 3.4	51.5 ± 3.1	0.350
Height (centimeters)	154.5 ± 7.3	152.2 ± 4.8	0.441
Weight (kilograms)	63.2 ± 8.0	63.2 ± 7.7	0.993
BMI (kilogram per square meter)	26.6 ± 3.3	27.2 ± 3.1	0.646
WHR	0.9 ± 0.1	0.9 ± 0.0	0.626

Note: Data are presented as mean ± standard deviation, BMI; body mass index, WHR; waist-to-hip ratio

Table 2. Blood pressure and functional performance after 6 weeks compared within group and between groups.

Variables	Group	Before	After	Difference	95%CI	*P* - value
SBP	CG	151.3 ± 9.1	151.0 ± 9.7	0.3 ± 4.7	- 3.1 to 3.7	0.846
(mmHg)	EG	153.1 ± 8.9	122.3 ± 8.3	30.8 ± 6.8	26.0 to 35.6	0.000#*
DBP	CG	90.3 ± 6.0	89.1 ± 7.7	1.2 ± 6.3	- 3.3 to 5.7	0.561
(mmHg)	EG	90.6 ± 6.8	72.2 ± 7.0	18.4 ± 7.1	13.3 to 23.5	0.000#*
HR	CG	84.7 ± 10.6	87.2 ± 9.2	- 2.5 ± 11.0	- 10.4 to 5.4	0.492
(BPM)	EG	81.4 ± 14.2	73.6 ± 11.3	7.8 ± 7.1	2.7 to 12.9	0.007#*
6MWT	CG	366.3 ± 39.1	363.7 ± 39.2	2.6 ± 14.9	- 8.0 to 13.2	0.593
(meters)	EG	365.4 ± 39.1	410.5 ± 40.4	- 45.1 ± 21.7	- 60.6 to - 29.6	0.000#*
TUG	CG	8.1 ± 0.9	8.2 ± 1.0	- 0.1 ± 0.5	- 0.4 to 0.3	0.637
(seconds)	EG	8.6 ± 1.2	7.1 ± 0.5	1.5 ± 1.0	0.8 to 2.2	0.001#*
10MWT	CG	5.6 ± 1.3	6.4 ± 1.3	- 0.8 ± 1.0	- 1.5 to - 0.1	0.031#
(seconds)	EG	6.1 ± 1.4	4.5 ± 0.7	1.5 ± 1.7	0.3 to 2.8	0.019#*
OLS (left)	CG	6.7 ± 4.2	5.2 ± 3.1	1.5 ± 1.5	0.4 to 2.5	0.011#
(seconds)	EG	6.6 ± 4.0	15.5 ± 11.5	- 8.9 ± 9.7	- 15.8 to - 1.9	0.018#*
OLS (right)	CG	8.2 ± 6.5	5.3 ± 2.8	2.9 ± 4.1	- 0.1 to 5.8	0.055
(seconds)	EG	8.6 ± 9.7	19.8 ± 11.3	- 11.1 ± 5.9	- 15.4 to - 6.9	0.000#*

Note: Value are mean ± SD, CG; Control group, EG; Experimental group, mmHg; millimeter of mercury, SBP; systolic blood pressure, DBP; diastolic blood pressure, HR; heart rate, BPM; beat per minute, 6MWT; 6 minute walk test, TUGT; time up and go test, 10MWT; 10 meter walk test, OLS; one-leg stand test, CI; confidence interval and *P* - value compare between before and after within groups ($P < 0.05$).

Significant difference corresponding from before

* Significant difference corresponding from control group

Discussion

The aim of this study was to investigate the effects of exercise with the ball on blood pressure and functional performance in female hypertensive patients. The mean age of volunteers ranged from 50.8 ± 3.3 years. The main outcome was blood pressure and secondary outcome perform functional performance tests measure the cardiovascular endurance (6 - minute walk test), measurement of balance control, gait and lower extremity strength (timed up and go test), gait speed (10-meter walk test) and postural control (one - leg stand test). Pre- and post-test measurements were performed at 0 and 6 weeks. Volunteer groups were diagnosed with essential hypertension stage 2 (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg) frequency of receiving ball exercise program takes 55 minutes, exercise 3 times a week for 6 weeks.

After the end of 6 weeks, the study found that blood pressure and all variables of functional performance were statistically significant differences for compared within group and between groups.

Previous studies related to the use of exercise for hypertensive patients. Cultural dance improves hypertension[9], this study was conducted to determine the traditional dance of Hawaii would improve both physical and social functioning and that these improvements would be associated with blood pressure reductions. Experimental selection of the use of training consisting of two 60-minutes classes per week. The results showed that reduction in systolic blood pressure significantly. That associated with the present study the use of ball exercise. The frequency of exercise refers to the aerobic exercise pattern experimental results showed statistically significant changes in the blood pressure variables used in the experiment. The study found that exercise with the ball have a decreases in both systolic blood pressure and diastolic blood pressure, with the systolic blood pressure drop as high as 30.8 ± 6.8 mmHg and decreasing 18.4 ± 7.1 mmHg for diastolic blood pressure. Ruivo JA, *et al.*[13] explained that aerobic exercise to lower systolic blood pressure falling by 5 - 15 mmHg in patients with hypertension. The results of this study can be explained by an improvement in cardiopulmonary fitness brought about by ball exercise which is a form of aerobic exercise that has both physical and emotional benefits.[14] That exercise improves the circulation of the heart muscle and metabolism, which in turns

protects the heart from hypoxic stress and also improves the glycolytic capacity. This condition improves the oxygen supply in the heart and its contractility during a specific challenge, therefore the heart rate and blood pressure have decreased satisfactorily, so that the work of heart muscle is significantly reduced at rest and during exercise.[15]

The current study shows that anyone who has received a ball exercise program can reduce blood pressure levels from stage 2 to stage 1, all being 100.0%. Also, can lower pressure levels from stage 2 to elevated blood pressure up to 40.0% and can lower blood pressure levels from stage 2 to normal blood pressure up to 30.0%.

Functional performance tests measure the ability to do specific physical activities of daily living.[16] 6MWT to measure cardiovascular endurance. Marcelo MC, *et al*.[17] showed the effect ball exercises improve muscle strength and walking performance in a randomized controlled trial study for twice a week in 50 minutes sessions, and they found 6MWT was longer in ball exercise group than the control group. Similarly the present study found that the cardiovascular endurance in the intervention groups were increased when compared within group were statistically significant different at the same time whereas statistically significant difference when compared between group. The result of the intervention may be related exercise of large muscle on the legs during a certain period. Improving the efficiency of the 6MWT has a direct relationship with improved muscle strength, especially in the dynamic movements of legs during ball exercise, which shows that the increase in strength in the lower limbs could determine the amount of improvement in the walking performance.

Timed up – and - go test measures the time in seconds for a person to rise from sitting from a standard arm chair, walk three meters, turn back, walk back to the chair, and sit down.[18] Bischoff HA, *et al*.[19] have shown that older people with a score of less than 10 seconds are considered good balanced. The risk increases with a score of 11 - 12 seconds and a high risk of fall is 20 seconds in which one must receive proper care. Because both groups have an average of less than 10 seconds from the initial assessment, both groups are considered as freely mobile. However, this study found statistically significant difference of timed up and go test was lower in ball exercise group than the control group. Due to the patients showed good work independence at the base line, it is possible that improvements in the test have not been detected at the end of six weeks.

The 10 - meter walk test in the present study our compared within group and found significance in the control group by the volunteers in the group spent more time walking 10 meters up to two seconds, while in the ball exercise group were statistically significant difference. Volunteers in the group can walk faster up to three second. This effect of the outcome may be explained from the action of ball exercise to promote strength of lower extremities and speed movement of knee joint and ankle joint thus resulting in a faster walking speed.

One - leg stand test in present study found that ball exercise group were statistically significant difference. By volunteers in the group increasing the time for one - leg stand with eye closed, while compared within group and found significant difference in the control group by the volunteers in the group reduce time for one - leg stand. The study has shown that improving balance and postural problems in hypertensive patients due to the action of the exercise with ball. As a result of the gestures used to ball exercise can probably lead to balance improvement. Similar results were also obtained by Song CH, *et al*.[20] who disclosed that exercise with ball increased proprioception of trunk that resulted in balance improvement. Consistently, Kawano I, *et al*.[6] have shown that impairment of balance can be improved by increasing peripheral afferents, which help reduce sensory impairments and the risk of falling.

Conclusion

The exercise of the ball is used in terms of health promotion, disease prevention including the treatment and rehabilitation of the body. Ball exercises are safe, injury from exercise less or not, can be easily implemented. This is a great motivation for exercise and can be used as a sustainable exercise. Finally, ball exercise are choice as well to preserve for hypertensive patients and to be used in all ages and to create a sustainable exercise in the future. In this research, only female volunteers were present. Also, the literature review found more incidence of hypertension in males. In addition, males also have better physical performance than females. Therefore, further studies should be conducted in males to determine how exercise affects blood pressure.

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Conflict of interest

The authors, hereby, declare no conflict of interest.

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