Original Article

A Randomized Controlled Trial Comparing the Effects of an Arm Swing Exercise and Low Sodium Intake Education Program with Low Sodium Intake Education Alone on Cardiovascular Outcomes in Postmenopausal Women with Prehypertension

Tantiprasoplap S, RN, MEd[1,2], Piaseu N, RN, PhD[2], Kanungsukkasem V, PhD[3], Taneepanichskul S, MD[1]

[1] College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand

[2] Ramathibodi School of Nursing, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

[3] Faculty of Sport Science, Chulalongkorn University, Bangkok, Thailand

Objective: To investigate the effects of an arm swing exercise program and to compare them with standard treatment outcomes in post-menopausal women with pre-hypertension.

Materials and Methods: A randomized controlled trial was conducted with two treatment groups (n=42 each) for 12 weeks. The arm swing exercise program was performed by the experimental group. Eighty-four post-menopausal women with pre-hypertension underwent an examination to measure their blood pressure, heart rate, and cardiorespiratory fitness at the beginning of the study and after three months and six months in training.

Results: After completing the arm swing exercise program, systolic blood pressure in the experimental group was significantly lower than that of the control group ($p<0.05$) at three months and, six months. Heart rate and cardiorespiratory fitness improved, although there were no significant differences when both treatments were compared. The effects of time and interaction of treatment in systolic blood pressure, heart rate, and cardiorespiratory fitness were significantly different at different time points in the experimental group ($p<0.01$, <0.01, and <0.01, respectively).

Conclusion: The arm swing exercise program had an effect on systolic blood pressure reduction and cardiorespiratory fitness improvement in post-menopausal women with pre-hypertension.

Keywords: Arm swing exercise, Post-menopausal women, Blood pressure, Cardiorespiratory fitness

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Hypertension is a serious public health problem in both economically developing and developed countries because it is one of the leading causes of global mortality and morbidity(1). People with pre-hypertension are more likely to develop full-blown hypertension, which is more likely to change in accordance with associated health problems. Additionally, hypertension is a major risk factor resulting in high burden of circulatory diseases. More importantly, hypertension has an impact on patients' quality of life, limit their activities, and lead to an increase in health care costs(2). Thus, early prevention of hypertension is very important to decrease the burden of diseases. Particularly for post-menopausal women who have experienced changes in the hormonal system are more susceptible to risks

Correspondence to:

Taneepanichskul S.

College of Public Health Sciences, Chulalongkorn University, Institute Building 2-3, Soi Chulalongkorn 62, Phayathai Road, Pathumwan, Bangkok 10330, Thailand.

Phone: +66-2-2188194, **Fax**: +66-2-2556046

Email: surasak.t@chula.ac.th

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of cardiovascular diseases[3]. Alternatively, reducing blood pressure (BP), which means a lower risk of drug interactions and more chances of long-term health benefit sustainment, is much required. There is one exercise that people with pre-hypertension living in rural areas can perform more easily. It is arm swing exercise (ASE), a kind of Chinese exercise that may effectively and appropriately improve BP reduction. However, there has been no study concerning the mechanisms and effects of this mode of ASE on BP reduction in post-menopausal with pre-hypertension. Therefore, the present study aimed to examine the effects of an ASE and low sodium intake education program in post-menopausal women with pre-hypertension on BP, heart rate (HR), and cardiorespiratory fitness by comparing them with those of post-menopausal women with pre-hypertension who received a low sodium education program alone.

Materials and Methods

Study design

A randomized clinical trial of post-menopausal women with pre-hypertension was conducted using two arms, 1) the ASE program plus low sodium intake education, and 2) the low sodium intake education alone (control). The present study hypothesis was that the ASE program would provide significantly more changes in BP, HR, and cardiorespiratory fitness than those of the control. Prior to recruitment of the study participants, the study proposal was approved by the Institutional Review Board on Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University, Thailand (COA No.232/2015), and the present study was registered with the Clinical trials.gov (TCTR20170718001). The authors estimated the study would need 84 participants (30% expected drop out rate) to achieve 90% power to observe changes in systolic BP between the two groups.

Study participants

The participants were recruited through flyers and advertisements distributed to the local community. The study was described as a "Getting good health program for women". The inclusion criteria were as followed, post-menopausal women with pre-hypertension as determined by permanent cessation of menstruation, dated by the last menstrual period followed by 12 months of amenorrhea, post-menopausal women whose recorded systolic BP level was between 120 and 139 mmHg or diastolic BP level was between 80 and 89 mmHg at least two times before entering the program, post-menopausal women with no intake of any hypertensive medications, those who passed the Physical Activity Readiness Questionnaire (PAR-Q), and those who were able to communicate verbally in the Thai language. Additionally, the participants were required to be available during the expected class time periods. The exclusion criteria were post-menopausal women with physical barriers to participate in the intervention or with specific conditions such as post-surgical operation of breast cancer or chronic inflammation at the shoulder or arm, and those unable to participate in the training program more than 80% of the training period.

The participants were informed that the study compared two potentially beneficial interventions for BP reduction. The participants in both groups were asked to attend a 60-minute class per month for three months. Those in the intervention group were asked to perform ASE for more than 30 minutes per day at least three days per week for 12 weeks by following the guideline of protocol. They could perform ASE by themselves at home each month as described in detail below. The participants received token of appreciation for completion of all phases of the study including at baseline, follow up 1, and follow up 2, with their total performance equal to 80% of the intervention sessions or greater. They were also required to complete the activity logbook.

Prospective participants who met the inclusion criteria via an interview screening and agreed to participate in the study were invited to take the BP screening and PAR-Q screening at Donsai Health Promoting Hospital in Paktor district where clinical measures of BP (e.g., automatic BP monitor) were used to determine if the participants' BP was in the range of the inclusion criteria. If the clinical measures were within the specified range, the participants were then invited to participate in the present study.

Outcomes and assessments

Primary outcomes were systolic-diastolic BPs, HRs, and cardiorespiratory fitness. The same automatic BP monitor was used to measure BPs at baseline, follow up 1, and follow up 2 (Omron blood pressure 903). This device had been validated in accordance with internationally recognized standards. BP measurements were repeated three times for an average value for each measurement. BP was measured 15 minutes apart. All participants were measured for BP by health care team from other hospital who were blinded to the study. The researcher scheduled an

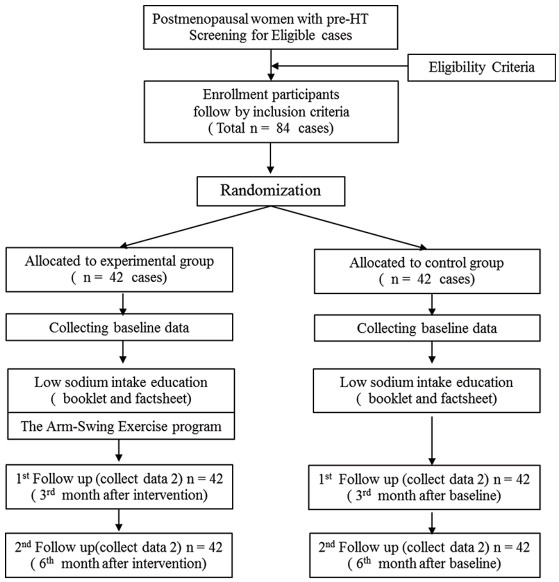

Figure 1. Flow chart of allocation hierarchy.

appointment for BP measurement at the same time for all measurements. In addition, cardiorespiratory fitness was measured using estimated maximal oxygen consumption (VO_{2max}) calculation. The estimated VO_{2max} value was measured by means of a six-minute walk test, as well as measurement of body weight, HR, and age, to calculate the result based on the selected formula. Socio-demographic characteristic data of the participants including age, education, occupation, income, as well as height and weight, were collected at baseline. Sodium intake behaviors were assessed using a questionnaire that had previously been validated by a panel of experts. Before starting the ASE in the experimental group, the researcher provided sodium intake education to both the study and control groups. The research assistants supervised the ASE of the participants in the experimental group by monitoring their performance and assisting them with recording the activities onto the logbook.

Sample size

The present study was conducted at Paktor district, Ratchaburi province, which is a rural community approximately about 110 kilometers from Bangkok Metropolis. The researcher found that this area had a high prevalence rate of hypertension based on the online report of Paktor Hospital, Paktor District Health Office(4). In a 2012 study, hypertension had the highest incidence rate compared to other non-communicable diseases, thus its selection as the research site in the present study(4).

The population of the present study consisted of post-menopausal women that lived in Paktor district, Ratchaburi province for over six months, and had been diagnosed with pre-hypertension from the screening medical record of Health Promoting Hospital. Their systolic BP was between 120 and 139 mmHg or their diastolic BP was between 80 and 89 mmHg at least twice from repeated measurements, and they had not been treated with any type of anti-hypertensive medication. The participants were excluded if they participated in the training program less than 80% of the training period or had been injured at the shoulder or arm. The appropriate sample size was expected to detect the differences in primary outcomes between the experimental and control groups with minimal errors. The power analysis with G*Power 3 was used to determine the sample size(5), which was equal to 42 participants in the control group and 42 in the experimental group, totaling 84 participants.

Randomization

Eighty-four participants took part in the present study. They were randomly assigned into the experimental group and the control group. Forty-two participants in the experimental group received the arm-swing exercise plus low sodium intake education program, whereas the other 42 participants in the control group received low sodium intake education alone. A randomization scheme was generated by using closed envelopes that were designed to represent the experimental group and the control group. The participants were assigned in an unordered, closed envelope, with 42 going to the experimental group and the other 42 to the control group (Figure 1). All outcome assessors remained blinded to the assignment of intervention throughout the study. The participants in the arm swing intervention were not blinded to the intervention assignment.

Intervention

The research team, health staffs, and village health volunteers in the community were prepared for the ASE program by undergoing the training before the intervention commenced. The researcher further divided the participants in the experimental group into four subgroups of 10 to 11 participants, and one village health volunteer was assigned to assist and supervise each subgroup. The ASE was performed at least three days per week, for 30 to 40 minutes, starting from mild to moderate intensity levels, for 12 weeks. The self-regulation theory was applied in the ASE program. All of the participants received an arm swing handbook, an activity logbook, and a HR monitoring watch to use during the program. The researchers asked the participants not to take any other forms of exercise, except for the ASE during the study. The participants conducted this exercise at home and recorded their exercise in their activity logbooks. There was one village health volunteer to help the participants in each subgroup and give advice on ASE including how to record the activities in the logbook. The researchers and her team motivated the participants and their families to join the activities and offered rewards for being able to continue the ASE and accomplish the program goal. The village health volunteers and health staffs in the community also helped monitor the participants in this program using checklist when visiting the participants at home; therefore, compliance was supported. The research team and village health volunteers asked the participants if they experienced any injuries during the program, so that appropriate assistance could be provided.

The research team introduced the program to all participants in the experimental group and educated them on the ASE program, which lasted approximately two hours per session per month, at the Health Promotion Hospital within the first three months. Moreover, the researcher gave advice and made an appointment with all participants for parameter outcomes measurements including BPs, HRs, and estimated VO_{2max} at baseline, the three-month follow-up, and the six-month follow-up.

Arm swing exercise arm: Arm swing was generally described as a practice that incorporated two elements, heaviness and strengths. The ASE was based on Chinese traditional medicine, which was an ancient cultural heritage of China. This exercise focused on promoting an adaptive skeletal muscle fiber, especially 12 skeletal muscles of the lower extremities. The program was explicitly designed to allow adaptation of poses as needed for participants who were to be post-menopausal women. All research assistants in the present study had attended a training course conducted by a sport science trainer.

Control arm: The control participants were provided with standard treatment, including low sodium intake education and non-aerobic exercise.

Data analysis

As regards to data analyses, means and standard deviations (SDs) for all sociodemographic and primary outcomes were calculated. The primary outcomes of interest were means of systolic and diastolic values, HRs, and cardiorespiratory fitness. The independent t-test was performed on expectation of efficacy to determine if this factor varied across groups at baseline and on measures of adherence at post-test. Equivalency of the interventions relative to clinical output was determined by means of independent t-test of the mean systolic BP and diastolic BP values obtained with indirect cardiorespiratory fitness.

The primary analysis of the paired t-test was used to assess changes within group during pre-to-post-intervention. Separate repeated measures ANOVAs (time × group) were used to determine significant differences relative to the intervention.

Results

The sample comprised of 84 participants, divided half, 42 participants in the experimental group and 42 participants in the control group. With regard to age, the largest group of the participants in both groups were 50 to 59 years old, making up 40.5% in the control group and 38.1% of the experimental group. Their mean age was 55.15 years old (SD 7.01). Sixty-seven percent of the participants in the experimental group and 71% of the participants in the control group were married, and most of the participants in both groups were primary school graduated. Moreover, 57% of the participants in the control group and 38% of the participants in the experimental group were farm laborers, with 55% and 36% of the participants in both groups having personal income ranging from 5,000 to 10,000 baht per month. Finally, nearly all participants in both groups exercised no more than two days a week. The results revealed no significant differences in socio-demographic characteristics of all participants (Table 1). In addition, the demographic characteristics of the subjects in both groups were not significantly different (Table 2). The results showed that before starting the ASE program, there was no significant difference in the baseline of systolic BP, diastolic BP, HR, and cardiorespiratory fitness (VO_{2max}) between the two groups (Table 3). In other words, the subjects in both groups had similar health parameters before starting the ASE program.

Table 4 showed at three months and six months after completing the ASE program, the mean systolic BPs of the experimental group were significantly lower than those of the control group ($p<0.05$), but the mean diastolic BPs of the experimental group were not significantly different from those of the control group. The results also indicated that the mean HRs and cardiorespiratory fitness of the experimental

Table 1. Comparison of baseline characteristics between the two groups

General characteristic	Control (n=42) n (%)	Experimental (n=42) n (%)	p-value
Age (year)			0.890
40 to 49	11 (26.2)	13 (31.0)	
50 to 59	17 (40.5)	16 (38.1)	
60 to 69	14 (33.3)	13 (31.0)	
Mean±SD	55.9±7.3	54.4±6.7	
Status			0.853
Single	5 (11.9)	5 (11.9)	
Married	30 (71.4)	28 (66.7)	
Widowed/divorced	7 (16.7)	9 (21.4)	
Education level			0.200
Lower or equal primary	35 (83.3)	29 (69.0)	
Higher or equal secondary	7 (16.7)	13 (31.0)	
Occupational			0.212
Unemployed	5 (11.9)	8 (19.0)	
Agriculturist	13 (31.0)	18 (42.9)	
Farm laborer	24 (57.1)	16 (38.1)	
Personal income (baht)			0.155
≤5,000	16 (38.1)	20 (47.6)	
5,001 to 10,000	23 (54.8)	15 (35.7)	
≥10,001	3 (7.1)	7 (16.7)	
Frequency of exercise (day)			0.239
≤2	32 (76.2)	25 (59.5)	
3 to 4	5 (11.9)	10 (23.8)	
≥5	5 (11.9)	7 (16.7)	
History of HT in family			0.890
No	21 (50.0)	19 (45.2)	
Yes	21 (50.0)	23 (54.8)	
Time since determination of HT risk (month)			0.355
0 to 6	25 (59.5)	31 (73.8)	
>6 to 12	8 (19.0)	6 (14.3)	
>12	9 (21.4)	5 (11.9)	
Alcohol consumption			-
No	42 (100)	42 (100)	
Yes	0 (0.0)	0 (0.0)	
Cigarette smokinga			1.000
No	41 (97.6)	41 (97.6)	
Yes	1 (2.4)	1 (2.4)	
Sodium intake behavior			0.071
Good	36 (85.7)	28 (66.7)	
Poor	6 (14.3)	14 (33.3)	

SD=standard deviation; HT=hypertension

[a] Fisher's exact test

Table 2. Comparison of demographic characteristics between the experimental group (n=42) and the control group (n=42) at baseline

Characteristic	Min-max	Mean±SD	p-value
Body weight (kg) (n=84)	40 to 81	58.00±9.3	0.053
Experimental group	43 to 81	59.95±9.5	
Control group	40 to 76	56.05±8.7	
Body mass index (kg/m^2) (n=84)	17.5 to 33.3	24.28±3.7	0.214
Experimental group	18.1 to 33.3	24.78±3.5	
Control group	17.5 to 31.1	23.78±3.8	
Waist circumference (cm) (n=84)	57 to 107	81.73±9.6	0.359
Experimental group	57 to 103	82.69±9.3	
Control group	58 to 107	80.76±9.8	
Sodium intake behavior (n=84)	28 to 53	41.56±4.9	0.073
Experimental group	32 to 53	40.60±4.7	
Control group	28 to 50	42.52±5.0	

SD=standard deviation

Significance at p<0.05

Table 3. Comparison of clinical characteristics between the experimental group and the control group at baseline

Variables	Control (n=42) Mean±SD	Experimental (n=42) Mean±SD	p-value
Systolic BP (mmHg)	134.26±14.23	131.38±13.35	0.421
Diastolic BP (mmHg)	75.33±9.36	72.48±8.85	0.154
Heart rate (bpm)	77.79±8.74	78.48±8.85	0.753
Cardiorespiratory fitness (VO_{2max}) (ml/kg/minute)	30.73±4.00	31.2±3.98	0.589

SD=standard deviation; BP=blood pressure

Significance at p<0.05

diastolic BPs, HRs, and cardiorespiratory fitness of the experimental group were not significantly different from the control group. Nevertheless, the direct effects of time and interaction effects of the treatment on systolic BPs, HRs, and cardiorespiratory fitness were observed as the experimental group were statistically significantly different from the control group. Similarly, Pan et al had found that systolic BP of patients with essential hypertension decreased after participating in a 12-week Tai Chi exercise program, but their diastolic BP reminded unchanged[8], which is consistent with the present study. The aforementioned meta-analysis has also reported that aerobic exercise was related to a significant decrease in systolic BP

Table 4. Comparisons of outcome parameters before and after intervention between the experimental group (n=42) and the control group (n=42)

Parameter	Month 0 (1st time) n (%)	Month 3rd (2nd time) n (%)	Month 6th (3rd time) n (%)	Within group p-value	Between group p-value
Systolic BP (mmHg)					0.035
Experimental	134.3 (14.2)	126.4 (9.1)	123.6 (10.7)	Ft 0.001	
Control	131.8 (13.3)	131.9 (11.8)	135.4 (11.5)	Fi 0.000	
Diastolic BP (mmHg)					0.229
Experimental	75.3 (9.4)	73.7 (7.4)	74.4 (8.0)	Ft 0.531	
Control	72.5 (8.9)	70.6 (9.4)	74.6 (8.9)	Fi 0.105	
Heart rate (bpm)					0.069
Experimental	77.8 (8.7)	76.9 (7.3)	71.7 (6.2)	Ft 0.009	
Control	78.5 (11.2)	77.4 (10.1)	80.2 (9.8)	Fi 0.000	
Cardiorespiratory fitness (VO_{2max}) (ml/kg/minute)					0.173
Experimental	30.7 (4.0)	33.4 (5.4)	33.7 (3.5)	Ft 0.000	
Control	31.2 (4.0)	31.6 (3.8)	31.6 (4.0)	Fi 0.000	

BP=blood pressure; Ft=value effect of time; Fi=value effect of intervention

Significance at p<0.05, using repeated measures ANOVA

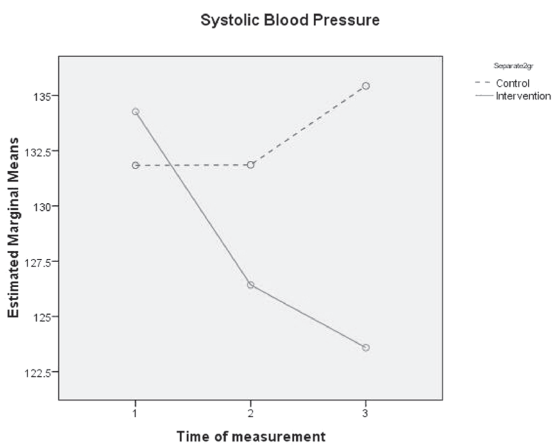

Figure 2. Mean of systolic BP between the experimental and control groups.

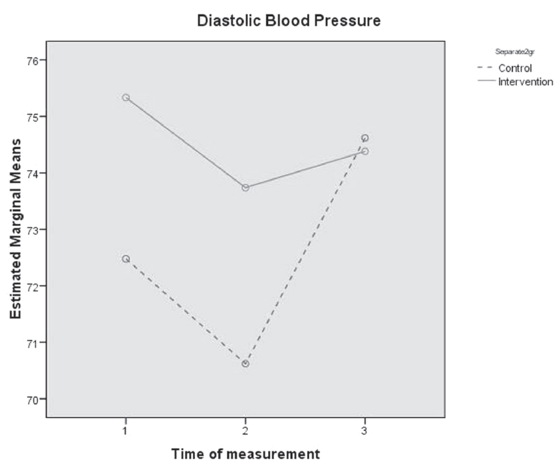

Figure 3. Mean of diastolic BP between the experimental and control groups.

group were not significantly different from those of the control group. However, it is noteworthy that when considering the direct effects of time and interaction effects of treatment on systolic BPs, HRs, and cardiorespiratory fitness, it was found that there were statistically significant differences between the experimental group and the control group (Figure 2-5).

Discussion

The present randomized controlled trial examined the effects of the ASE program on post-menopausal women with pre-hypertension. It was discovered that the ASE program improved systolic BP. The present finding was similar to the previous studies undertaken by Halbert et al(6) and Hagins et al(7). The results also indicated that moderate intensity exercise could help reduce BP of post-menopausal women with pre-hypertension(8-11). Abdullah et al(12) have recommended that moderate intensity aerobic exercise is highly effective of lowering BP compared to low and high intensity exercise. Likewise, a previous meta-analysis comprising of 30 studies involving persons with hypertension has reported that, aerobic endurance training could decrease BP by 6.9/4.9 mmHg(13). However, after completing the ASE program,

Figure 4. Mean of HR between the experimental and control groups.

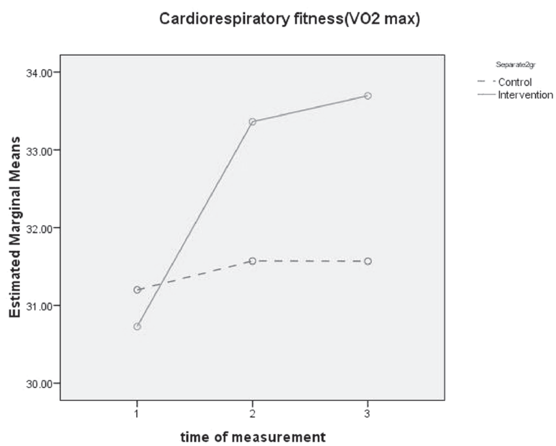

Figure 5. Mean of CRF between the experimental and control groups.

and diastolic BP, the reduction of diastolic BP was less than that of systolic BP(14). In the present study, diastolic BP was higher in the intervention group, which was opposite from systolic BP. It was possible that measuring BP in a different time can result in variability of BP(7). In addition, it was found in the geriatric study showing no improvement in aortic stiffness in experimental group, indicating that there may be a resistance that cause no reduction of BP in older adults(19).

It is noteworthy to state that the ASE program was designed following the principle of the American College of Sports Medicine (ACSM)'s exercise prescription (FITT-VP) composed of six important components including frequency, intensity, time, type, volume, and progression for improvement of health and fitness. In addition, the ASE protocol of the present study was defined as a moderate intensity exercise program that took calculation of the heart rate reserve (%HRR) and maximum heart rate (%HRmax) into consideration following the ACSM's guidelines for exercise prescription(15). This is the strength of this program. It contributed to the effectiveness of the program to reduce BP in clinical practice(16). In the present study, the results showed that ASE program could significantly improve systolic BP ($p<0.05$). This could be explained as the ASE was easy to follow and practice. Furthermore, the participants received encouragement and suggestions from village health volunteers who were research assistants. In general, healthcare providers play an important role in assisting patients' health behavior changes(17). Such results yielded support to the study carried out by McMahon et al(18), which has suggested that interpersonally oriented behavior change strategies combined with evidence-based physical activity protocol could increase older adults' physical activity and functional strength. However, contradictory findings have been reported by Stewart et al who found that long-term aerobic exercises could reduce diastolic BP but not systolic BP in older adults with mild hypertension(19). Another plausible explanation is that the ASE program had moderate intensity. If an exercise program had heavy intensity, it may cause fatigue or injury, and adversely affects the patients' adherence to the program(20). In addition, a geriatric study had pointed out that elderly people may be resistant to exercise-induced BP reduction(19), while another study has suggested that reduction in BP with salt restriction may lead to a decrease in the stiffness of the large elastic arteries(21). Before intervention, the researcher measured baseline sodium intake behavior in both groups to control for confounding factors, which might have an effect on BP. However, the sodium intake behavior was not different between the control and experimental groups. Therefore, future research should explore other strategies to reduce BP in post-menopausal women with pre-hypertension such as moderate diet intake or sodium restriction to increase its effectiveness to reduce BP.

When comparing HRs and cardiorespiratory fitness of the subjects in both groups, it could be seen that even though some improvements could be detected in the experimental group, the differences between the experimental group and the control group were not statistically significant. Nevertheless, it could be observed that the HRs and cardiorespiratory fitness of the participants in the control group seemed to worsen. As previously mentioned, cardiovascular outcome of the participants in the experimental group was better after the intervention. From baseline, their mean, HR decreased by 6.08 bpm and cardiorespiratory fitness increased by 2.96 ml/kg/minute when compared to a previous study(22). In fact, a number of previous studies(23-25) have reported that there were no significant differences in HRs after exercise interventions, similar to the present study. However, a meta-analysis has found that Tai Chi exercise could improve cardiovascular efficiency by reducing BP and HR in healthy adults(26). Moreover, prior studies have suggested that aerobic exercise with moderate intensity was related to a decline in cardiovagal baroreflex sensitivity in healthy men(27,28). A review of literature has shown that several studies have explored the effects of exercise training in older adults, but most of the participants were either mixed or all male(25,29). It is suspected that gender differences may have influenced sympathetic nerve activities, particularly in older people(30,31). The current study was conducted with post-menopausal women with pre-hypertension, and this may have resulted in the findings that were inconsistent with those of previous studies that were mostly conducted with healthy people or with only male participants. Thus, improvement of HRs and cardiorespiratory fitness may be affected by intensity level, gender, and health status of the study participants.

Regarding sustainability of the ASE program, most of the participants expressed their satisfaction with the program, explaining that they greatly enjoyed it. Part of the success of the program employed in this research may have resulted from integrating self-regulation theory into the ASE program. Self-regulation was provided to the participants in the experimental group who received a HR monitoring watch, were trained in self-monitoring and feedback skills, and received social support to monitor their exercise behavior after the end of the program. Such efforts may have made all participants able to maintain adherence to the ASE program continuously until the end of the program. Likewise, previous studies have confirmed that self-regulation had a great effect on physical activity(32,33). Another aspect of the ASE program that the experimental participants enjoyed was the fact that it was easy to follow. They liked exercising together in a small group every week and in a large group for all participants at the meeting organized at the Health Promoting Hospital every four week. Basically, Thai people, especially those who are older, prefer doing activities that they find to be entertaining and easy to do as well as activities that allow them a chance to socialize with other members of the community. This may have helped explained the effectiveness of the ASE program to reduce BP in post-menopausal women with pre-hypertension.

Limitation

Most of the participants in the present study were older adults who took care of themselves and were not highly educated. For these reasons, using a HR monitoring watch may have been difficult for them as some discontinued its use before the program ended. Furthermore, the present research could not be blinded, which may have contributed to an intervention bias.

Conclusion

The ASE program had effects on systolic BP reduction and cardiorespiratory fitness improvement in post-menopausal women with pre-hypertension. Thus, the ASE has health benefits for post-menopausal women with pre-hypertension. The self-regulated ASE program can support post-menopausal women with pre-hypertension to conduct ASE on a regular basis to reduce high BP level and raise their cardiorespiratory fitness. This intervention program consisted of knowledge and practical protocols that integrated the self-regulation concept into the exercise program. Nurses and other healthcare providers can apply this program in post-menopausal women with pre-hypertension to help them control their BP to prevent onset of full-blown hypertension and to ensure their quality of life.

What is already known on this topic?

ASE can reduce cardiovascular risk through a decrease blood HbA1c concentrations in patients with type 2 diabetes mellitus.

What this study adds?

ASE integrated with self-regulation effectively improve cardiovascular outcomes in post-menopausal women with pre-hypertension.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. Whitworth JA. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens 2003;21:1983-92.
2. Centers for Disease Control and Prevention, The Merck Company Foundation. The state of aging and health in America 2007. Whitehouse Station, NJ: The Merck Company Foundation; 2007.
3. Kannel WB, Hjortland MC, McNamara PM, Gordon T. Menopause and risk of cardiovascular disease: the Framingham study. Ann Intern Med 1976;85:447-52.
4. Ministry of Public Health, Thailand. Medical report online of Pak-tho hospital [Internet]. 2013 [cited 2013 Apr 10]. Available from: http://pthosp.net/20opd/report-NCD.php.
5. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 2007;39:175-91.
6. Halbert JA, Silagy CA, Finucane P, Withers RT, Hamdorf PA, Andrews GR. The effectiveness of exercise training in lowering blood pressure: a meta-analysis of randomised controlled trials of 4 weeks or longer. J Hum Hypertens 1997;11:641-9.
7. Hagins M, Rundle A, Consedine NS, Khalsa SB. A randomized controlled trial comparing the effects of yoga with an active control on ambulatory blood pressure in individuals with pre-hypertension and stage 1 hypertension. J Clin Hypertens (Greenwich) 2014;16:54-62.
8. Pan X, Zhang Y, Tao S. Effects of Tai Chi exercise on blood pressure and plasma levels of nitric oxide, carbon monoxide and hydrogen sulfide in real-world patients with essential hypertension. Clin Exp Hypertens 2015;37:8-14.
9. Cornelissen VA, Buys R, Smart NA. Endurance exercise beneficially affects ambulatory blood pressure: a systematic review and meta-analysis. J Hypertens 2013;31:639-48.
10. Duncan JJ, Farr JE, Upton SJ, Hagan RD, Oglesby ME, Blair SN. The effects of aerobic exercise on plasma catecholamines and blood pressure in patients with mild essential hypertension. JAMA 1985;254:2609-13.
11. Conceição LS, Neto MG, do Amaral MA, Martins-Filho PR, Oliveira C, V. Effect of dance therapy on blood pressure and exercise capacity of individuals with hypertension: A systematic review and meta-analysis. Int J Cardiol 2016;220:553-7.
12. Abdullah MR, Eswaramoorthi V, Musa RM, Maliki ABHM, Kosni NA, Haque M. The effectiveness of aerobic exercises at difference intensities of managing blood pressure in essential hypertensive information technology officers. J Young Pharm 2016;8:483-6.
13. Cornelissen VA, Fagard RH. Effects of endurance training on blood pressure, blood pressure-regulating mechanisms, and cardiovascular risk factors. Hypertension 2005;46:667-75.
14. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann Intern Med 2002;136:493-503.
15. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 9th ed. Philadelphia: Wolters Kluwer and Lippincott Williams & Wilkins; 2014.
16. Ferguson B, Rev. ACSM's guidelines for exercise testing and prescription. 9th ed. 2014. J Can Chiropr Assoc 2014;58:328.
17. Atreja A, Bellam N, Levy SR. Strategies to enhance patient adherence: making it simple. MedGenMed 2005;7:4.
18. McMahon SK, Lewis B, Oakes JM, Wyman JF, Guan W, Rothman AJ. Assessing the effects of interpersonal and intrapersonal behavior change strategies on physical activity in older adults: a factorial experiment. Ann Behav Med 2017;51:376-90.
19. Stewart KJ, Bacher AC, Turner KL, Fleg JL, Hees PS, Shapiro EP, et al. Effect of exercise on blood pressure in older persons: a randomized controlled trial. Arch Intern Med 2005;165:756-62.
20. van Waart H, Stuiver MM, van Harten WH, Geleijn E, Kieffer JM, Buffart LM, et al. Effect of low-intensity physical activity and moderate- to high-intensity physical exercise during adjuvant chemotherapy on physical fitness, fatigue, and chemotherapy completion rates: results of the PACES randomized clinical trial. J Clin Oncol 2015;33:1918-27.
21. Seals DR, Tanaka H, Clevenger CM, Monahan KD, Reiling MJ, Hiatt WR, et al. Blood pressure reductions with exercise and sodium restriction in post-menopausal women with elevated systolic pressure: role of arterial stiffness. J Am Coll Cardiol 2001;38:506-13.
22. Blumenthal JA, Emery CF, Madden DJ, George LK, Coleman RE, Riddle MW, et al. Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. J Gerontol 1989;44:M147-57.
23. Dantas FF, da Silva SF, da Silva TS, Cucato GG, Farah BQ, Ritti-Dias RM. Acute effects of T'ai Chi Chuan exercise on blood pressure and heart rate in peripheral artery disease patients. J Altern Complement Med 2016;22:375-9.
24. Jones SM, Guthrie KA, Reed SD, Landis CA, Sternfeld B, LaCroix AZ, et al. A yoga & exercise randomized controlled trial for vasomotor symptoms: Effects on heart rate variability. Complement Ther Med 2016;26:66-71.

25. Hartaigh O, Lovato LC, Pahor M, Buford TW, Dodson JA, Forman DE, et al. Effect of a long-term physical activity intervention on resting pulse rate in older persons: results from the lifestyle interventions and independence for elders study. J Am Geriatr Soc 2016;64:2511-6.
26. Zheng G, Li S, Huang M, Liu F, Tao J, Chen L. The effect of Tai Chi training on cardiorespiratory fitness in healthy adults: a systematic review and meta-analysis. PLoS One 2015;10:e0117360.
27. Monahan KD, Dinenno FA, Tanaka H, Clevenger CM, DeSouza CA, Seals DR. Regular aerobic exercise modulates age-associated declines in cardiovagal baroreflex sensitivity in healthy men. J Physiol 2000;529 Pt 1:263-71.
28. Okazaki K, Iwasaki K, Prasad A, Palmer MD, Martini ER, Fu Q, et al. Dose-response relationship of endurance training for autonomic circulatory control in healthy seniors. J Appl Physiol (1985) 2005;99:1041-9.
29. Moraes WM, Souza PR, Pinheiro MH, Irigoyen MC, Medeiros A, Koike MK. Exercise training program based on minimum weekly frequencies: effects on blood pressure and physical fitness in elderly hypertensive patients. Rev Bras Fisioter 2012;16:114-21.
30. Narkiewicz K, Phillips BG, Kato M, Hering D, Bieniaszewski L, Somers VK. Gender-selective interaction between aging, blood pressure, and sympathetic nerve activity. Hypertension 2005;45:522-5.
31. Joyner MJ, Charkoudian N, Wallin BG. Sympathetic nervous system and blood pressure in humans: individualized patterns of regulation and their implications. Hypertension 2010;56:10-6.
32. Anderson ES, Wojcik JR, Winett RA, Williams DM. Social-cognitive determinants of physical activity: the influence of social support, self-efficacy, outcome expectations, and self-regulation among participants in a church-based health promotion study. Health Psychol 2006;25:510-20.
33. Janssen V, De Gucht V, van Exel H, Maes S. A self-regulation lifestyle program for post-cardiac rehabilitation patients has long-term effects on exercise adherence. J Behav Med 2014;37:308-21.