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Original Article

Effect of healthful physical training on functional status in physically inactive middle-aged women with hypertension.

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Abstract.
Background: Arterial hypertension (AH) is one of the most common diseases in the world. Individuals, who have AH, face with an increased risk of various diseases. Health professionals note some lack of knowledge about the effect of physical activity of certain people' age groups with AH. This study aimed to investigate the impact of the different healthful physical activity interventions in physically inactive middle-aged women, who have AH. **Methods:** A total of 57 subjects participated in the study. All subjects were randomly assigned to two groups: group 1 (n=29) and group 2 (n=28). A total of 16 weeks of healthful physical activity intervention was conducted three times a week for 50-60 minutes per session. Both groups performed the same preparatory (adequate warm-up and stretching) and strength exercises in each session. Group 1 performed walking/jogging in outdoor, group 2 performed walking uphill (treadmill walking/jogging with incline feature of treadmill – 1-3%). The aerobic sessions were performed with a progressive duration of 20-30 minutes and 120-155 bpm intensity of heart rate. The next tools for estimated by the functional status of study subjects: BMI, IPAQ (modified version of the long form), measurement of the pulse, measurement of the blood pressure, six-minute walk test (6MWT), were in this study. **Results:** All subjects reported they were following the recommendation for physical activity improvement, and performed healthful physical activity for 150 minutes per week or more in intervention period. There were significant ($p \leq 0.05$) differences among the groups with regard to body weight, BMI, measurements of pulse rate and blood pressure, 6MWT values in post-intervention. Were found that both resting and 6MWT pulse rate values were significantly ($p \leq 0.05$) higher in study subjects (group 1) as compared to study subjects (group 2). Mean maximum 6MWT values (covered distance) were significantly ($p \leq 0.05$) higher in subjects (group 2), as compared to subjects (group 1). Mean blood pressure measurements qualified as the normal range (less 140/90 mmHg) in both groups. There were significantly ($p \leq 0.05$) lower blood pressure values in study subjects (group 2). **Outcomes:** These findings demonstrated that particular physical activity intervention including a regular practice of combined (aerobic+strength) physical exercise should be recommended for middle-aged women with AH and overweight or obesity. Beneficial effects of this particular PA on BMI, resting pulse rate and blood pressure value reductions in study subjects is acknowledged.
Key words: Hypertension; women; physical activity (PA); blood pressure; 6 minute walk test (6MWT); IPAQ; combined (aerobic+strength) training.

Introduction

The World Health Organization estimates that 54% of strokes and 47% of cases of ischemic heart disease are the direct consequence of high blood pressure, which thus takes its place among the main risk factors for cardiovascular morbidity and mortality (Lawes, Hoorn, & Rodgers, 2008). According to the current European guidelines, AH is diagnosed when repeated measurements in a doctor's office yield values of 140/90 mmHg or higher (Jordan, Kurschat, & Reuter, 2018). Obviously, AH accounts for a significant number of diseases and mortality in the modern world (Campbell, Lackland, Niebilsky, et al., 2014). Today, hypertension affects up to 40% of people around the world and is a precursor to strokes, myocardial infarction and other heart diseases (Rêgo, Cabral, Costa, et al., 2019). It should be noted that hypertension has a negative impact not only on the physical condition, but also on the psychological health of individuals (Tikhonova, Demina, Klimatckaia,

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et al., 2018; Jackson, Pathirana, & Gardiner, 2016). Exposure to chronic stress is known to be a factor of the significant risk of the onset and development of hypertension (Spruill, 2010). By the way, depression and hypertension are closely related problems of public health. Depression is a significant risk factor for patients' mortality with AH (Song, Zhang, Zhang, et al., 2018). The need to develop techniques reducing stress and depression of people suffering from hypertension is an important task for the doctors and health professionals. Treatment of hypertension includes pharmacological and nonpharmacological interventions. Among the nonpharmacological interventions emphasizes the practice of regular physical exercise (Braz, Carneiro, Oliveira-Ferreira, et al., 2012). There is evidence of the benefits of regular PA for reducing the level of depression and improving the patients' functional status (Ortiz-Ortiz, Gomez-Miranda, Chacon-Araya, et al., 2019). Besides, consideration may be given using particular PA interventions reducing the patients with hypertension. It's known, that the long-term regular PA is a critical factor for preventing the decline in cognitive function and improving the body composition, physical function, blood pressure in hypertensive elderly women (Min-Ki, Seul-Hee, Je-Kwang, et al., 2019). Beneficial effects of long-term aerobic training on the physical status of middle-aged women were investigated (Romanchuk, & Dolgier, 2017).

Investigators state that the high prevalence of physical inactivity among adult women population has a strong association with hypertension (Rouf, Rasool, Salim Khan, et al., 2018). There is a need for focusing on the development of strategies that encourage the adoption of regular PA as a way to control and prevent of AH. Regular PA is considered a coadjutant factor in the control of AH, helping to control this societal burden (Brás, Esteves, Rodrigues, et al., 2020). Investigators state that the lack of regular PA contributes to the development of this disease. By the way, low levels of PA and a sedentary lifestyle are recognized by the experts as significant risk factors for cardiovascular diseases (Nagovitsyn, Osipov, Kudryavtsev, et al., 2020; Nystoriak, & Bhatnagar, 2018). Clearly, regular PA helps lowering blood pressure and reducing the risk of various heart diseases (Hegde, & Solomon, 2015; Murphy, Nevill, Murtagh, et al., 2007).

No secret that aerobic exercise results in small reductions in resting systolic and diastolic blood pressure among adult women. Investigators state that aerobic interval training is an effective method to lower blood pressure and improve other cardiovascular risk factors (Molmen-Hansen, Stolen, Tjonna, et al., 2012). However, a need exists for additional, well-designed studies on this topic, especially among hypertensive adult women (Kelley, 1999). *Cornelissen, & Smart,* argue that the most effective training effects decreasing blood pressure will be training with dynamic and isometric resistance of sufficient intensity (Cornelissen, & Smart, 2013). *Sharman, et al.,* recommend the use of daily training classes of medium intensity with the use of strength training with weights at least 2 times a week (Sharman, La Gerche, & Coombes, 2015). The positive effects of regularly performed physical training, especially aerobic and resistance exercises, for physically inactive women are seen in the scientific knowledge (Turğut, Bağir, Sarikaya, et al., 2019). It's known that dynamic resistance exercises, if done properly, contribute to lowering both systolic and diastolic blood pressures in patients (Ghadieh, & Saab, 2015). *Procopets, et al.,* state that regular fitness cardio training during six months to increasing functional status of middle-aged women with AH (Procopets, Osipov, Kudryavtsev, et al., 2020). Health professionals recommended to use regular aerobic training for AH prevention (Pippi, Bini, Reginato, et al., 2021), because moderate intensity aerobic exercise has been proven to prevent hypertension (Ghadieh, & Saab, 2015). Well known, that aerobic training is effective physical training aimed at improving cardio-respiratory fitness of individuals (Aksović, Bjelica, Joksimović, et al., 2020). *Shim, et al.,* indicate that aerobic exercise can be transformed into various forms, so it can be applied to a large number of individuals through group exercise (Shim, Choi, & Shin, 2019). *Li, & Siegrist,* emphasize that the level of PA should be sufficiently higher and combined with PA of the patients' professional activity (Li, & Siegrist, 2012). At the same time, the scientific dates presents knowledge about the significant risk of the occurrence of cardiovascular diseases among the women suffering from hypertension and enjoying a high level of PA (Allesøe, Søgaard, Aadahl, et al., 2016). Medical professionals state that adverse effects were observed after treadmill intervention in patients with hypertension (Chan, Chin, Kennedy, et al., 2013).

The available evidence strongly supports a role for regular PA in the prevention of AH. The optimal prescription for the prevention of hypertension, however, still remains elusive. *Riegel, et al.,* indicate that a simple PA recommendation has low association with blood pressure control in people, who have hypertension (Riegel, Martins, Schmidt, et al., 2019). *Pippi, et al.,* show that structured physical exercise program individualized for type, frequency and intensity in order to effectively counteract AH, may not be replicable in a simple ambulatory if devoid of specific instrument, machines, and a team of highly qualified personnel (Pippi, et al., 2021). It is known that knowledge about the effect of PA on hypertension and heart disease is somewhat limited. The most of the studies of this area have been performed on small samples of the white middle-aged men (Hegde, & Solomon, 2015; Moraes, Bacurau, Simões, et al., 2012). The further research is needed for a more complete understanding of the benefits of PA for people of different sex and age suffering from AH. Also, more conclusive evidence regarding the appropriate mode (aerobic, resistance, or combined), intensity (HIT, CME, or combined), and duration (accumulated bouts or continuous bouts) of PA for hypertensive individuals is still needed (Diaz, & Shimbo, 2013), as the chronic effects of aerobic and resistance training on blood pressure

in hypertensive women are related to acute blood pressure responses after a single bout of aerobic or resistance exercise (Moreira, Cutato, Terra, et al., 2016).

This study aimed to investigate the impact of the different healthful physical activity interventions in physically inactive middle-aged women, who have hypertension. The authors hypothesized that the presented intervention of conducting healthful PA training with these individuals will contribute to increase of subjects' functional status (resting pulse rate and blood pressure value reductions).

Material & methods

Participants

The middle-aged (from forty to fifty years old) women (n=234), participated in study. AH was diagnosed among all individuals (blood pressure is 140/90 mmHg or higher). Moreover, all women had a sedentary lifestyle and had not been engaged in a regular PA. The inclusion criteria of the subjects in main study were follows: those women, who are can walk independently for more than 60 minutes, have no side effects (such as dizziness or obesity), living in independent daily living activities and no significant differences with regard to age, height, weight, BMI, measurements of pulse rate and blood pressure, functional testing indicators (6MWT). A total of 57 subjects were recruited to this study. The mean age of study subjects was 44.61±4.26 years old. All study subjects were fully informed of the research protocol and provided signed informed consent. The study was approved by the local ethics expert committees: committee of the Institute of Physical Culture, Sports and Tourism (Siberian Federal University), committee of the Voino-Yasenetsky Krasnoyarsk State Medical University and committee of the Tomsk Research Institute of Cardiology. Full study data were collected between May and September, 2019.

The study design

Health and medical professionals recommended that all subjects should have their blood pressure reduced to less than 140/90 mmHg or less. The main non-pharmacological measures against high blood pressure are balanced diet (reduction of salt in the diet, avoidance of excessive alcohol consumption) and healthy lifestyle (smoking cessation, physical exercise and weight loss). All individuals (n=57) were randomly assigned to two groups: group 1 (n=29) and group 2 (n=28). Mean height of study subjects: group 1 – 168.34±7.13 cm; group 2 – 167.85±6.52 cm. Mean body weight of study subjects: group 1 – 72.16±5.27 kg; group 2 – 71.69±5.44 kg. A total of 16 weeks of healthful PA intervention was conducted three times a week for 50-60 minutes per session. Both groups performed the same preparatory exercises (adequate warm-up and stretching) for the first 10 minutes in each session. Both groups performed the same strength exercises for the 15 minutes in each session. Strength exercises were selected taking into the recommendations for resistance training in stage 1 hypertensive individuals (Moraes, et al., 2012). Strength exercises were performed at 45-60% of 1-RM in three sets of 10-12 repetitions with 1.5 min pauses between the sets. Maximal strength was assessed for distinct muscle groups, using the one-repetition-maximum technique (1-RM, that is, the weight that can be lifted no more than once) and pinloaded weight-stack resistance equipment (VictoryFit, VF-T66, China). Before the 1-RM test, all study subjects underwent three familiarization sessions (two sets, 10-12 repetitions of each exercise with the minimum weight allowed by the machines). Following a adequate warm-up, resistance exercises were used during the 1-RM test, which consisted of: leg press, leg curl, shoulder press, biceps curl and triceps extension, squat with an overhead press. All study subjects were instructed in correct-lifting and hand-gripping techniques. All exercises were fully explained and previously demonstrated by the experienced gym instructors, and all study subjects were asked to try them during a few minutes before starting the first session of the PA.

The healthful aerobic training was composed of three weekly sessions of walking exercises: jogging/walking (group 1) and walking uphill: treadmill (VictoryFit, VF-660, China) walking/jogging in incline feature of treadmill – 1-3% (group 2), and monitored for a period of 16 uninterrupted weeks. Aerobic exercises were selected taking into the recommendations for aerobic and combined (aerobic+strength) exercises in normontensive women (Pippi, et al., 2021; Osipov, Ratmanskaya, Nagovitsyn, et al., 2020) and patients with hypertension (Carvalho, Marins, Lade, et al., 2019; Anunciação, Farinatti, Goessler, et al., 2016). The training sessions were performed with a progressive duration of 20-30 minutes and 120-155 bpm intensity of HR. During the training sessions, the HR target was monitored by a Polar H9 heart rate monitor (Finland) every 3 minutes. The main information in healthful PA intervention outlined in Table 1.

Table 1. The highlights in PA intervention program (May – September, 2019).

Healthful PA intervention program	
Group 1 (n=29)	**Group 2 (n=28)**
Stage I: Weeks 1-4 (50 min)	
Adequate warm-up and stretching – 10 min.	
Marching in place while swinging arms, Arm circles and shoulder shrugs, hip circles, hip rotations, hip extensions, leg swings, squats and lunges – 5 min. Stretching in neck, shoulders, back, glutes, hips, hamstrings, calves – 5 min.	
Aerobic training – 20 min.	

Walking exercise: jogging/walking on an outdoor track reaching 120-135 bpm of pulse rate and 2-minute cool-down.	Walking uphill: treadmill walking/jogging reaching 125-135 bpm of pulse rate (incline feature of treadmill – 1-2%) and 2-minute cool-down.
Strength training – 15 min.	
All subjects did 3 sets of 10-12 reps at 45-50% of their 1 RM of the following exercises: shoulder press, biceps curl, triceps extension, leg press, leg curl, squat with an overhead press. Rest between sets was 1.5 min.	
Stretching – 5 min.	
Stretching in neck, shoulders, back, glutes, hips, hamstrings, calves.	
Stage II: Weeks 5-8 (55 min)	
Adequate warm-up and stretching – 10 min.	
Marching in place while swinging arms, Arm circles and shoulder shrugs, hip circles, hip rotations, hip extensions, leg swings, squats and lunges – 5 min. Stretching in neck, shoulders, back, glutes, , hips, hamstrings, calves – 5 min.	
Aerobic training – 25 min.	
Walking exercise: jogging/walking on an outdoor track reaching 125-140 bpm of pulse rate and 2-minute cool-down.	Walking uphill: treadmill walking/jogging reaching 135-145 bpm of pulse rate (incline feature of treadmill – 1.5-2.5%) and 2-minute cool-down.
Strength training – 15 min.	
All subjects did 3 sets of 10-12 reps at 50-55% of their 1 RM of the following exercises: shoulder press, biceps curl, triceps extension, leg press, leg curl, squat with an overhead press. Rest between sets was 1.5 min.	
Stretching – 5 min.	
Stretching in neck, shoulders, back, glutes, hips, hamstrings, calves.	
Stage III: Weeks 9-16 (60 min)	
Adequate warm-up and stretching – 10 min.	
Marching in place while swinging arms, Arm circles and shoulder shrugs, hip circles, hip rotations, hip extensions, leg swings, squats and lunges – 5 min. Stretching in neck, shoulders, back, glutes, hips, hamstrings, calves – 5 min.	
Aerobic training – 30 min.	
Walking exercise: jogging/walking on an outdoor track reaching 135-150 bpm of pulse rate and 2-minute cool-down.	Walking uphill: treadmill walking/jogging reaching 135-155 bpm of pulse rate (incline feature of treadmill – 2-3%) and 2-minute cool-down.
Strength training – 15 min.	
All subjects did 3 sets of 10-12 reps at 55-60% of their 1 RM of the following exercises: shoulder press, biceps curl, triceps extension, leg press, leg curl, squat with an overhead press. Rest between sets was 1.5 min.	
Stretching – 5 min.	
Stretching in neck, shoulders, back, glutes, hips, hamstrings, calves.	

The research tools

The robust and simply tools: BMI, IPAQ (modified version of the long form), measurement of the pulse, measurement of the blood pressure, six-minute walk test (6MWT), were in this study.

Body mass index (BMI) is an estimate of how moderate a person's body weight is based on their height and weight (a person's weight in kilograms divided by the square of their height in meters) (Sperrin, Marshall, Higgins, et al., 2016). Each subject's weight was measured using a electronic scale ("HEALTH" 150-VDA, Moscow, Russian Federation). Three consecutive measurement procedures were performed. The mean weight value was taken. Each participant's height was measured using a mechanical stadiometer (TVEC-RP, Russian Federation). The measurements were recorded. Doctors and health professionals consider a healthy BMI for women to be 18.5–24.9. A BMI of 25.0–29.9 may indicate overweight. A BMI of 30 or above may indicate obesity (Jakicic, Powell, Campbell, et al., 2019). All study subjects completed the measurement of BMI twice (at the beginning and at the end of the study). The outcomes were recorded.

The international physical activity questionnaire (IPAQ) was developed to obtain internationally comparable data on health-related PA of adults (18–65 years). Two versions of the IPAQ that could be administered by interview or self-completed were developed. The short form (SF) was designed for population surveillance of PA; while the long form (LF) was designed to be appropriate for use in research that requires detailed information on different PA domains, including PA at work, household, during leisure and transportation and time spent in sedentary activities (Oyeyemi, Bello, Philemon, et al., 2014). The modified version of the IPAQ (LF) was involved in this research. Next outcomes: domestic PA, occupational PA, leisure-time PA (intensive PA: fitness, walking and sitting time) were measured on two occasions, four months apart. All study subjects were to self-complete a written survey (modified version of the IPAQ) twice: May and September, 2019. To the reliability of the measures, all study subjects self-completed survey twice additionally (with an interval of 1 week after primary and secondary survey) (Osipov, Nagovitsyn, Vaganova, et al., 2021). The outcomes were recorded. The overall IPAQ findings are presented in the spent total time of PA (minutes), because most study subjects had difficulty counting results at the MET (metabolic equivalent of task).

Measuring the pulse provides precise information on the regularity of heart beat and an indication of the strength of heart contraction (pulse volume or amplitude). Each subject was assessed for there regularity of

resting heart beat in this study. It is known that some automated blood pressure recording devices also measure pulse rate (Yousefipoor, & Nafisi, 2015). But these devices rarely take dysrhythmias into account and do not assess pulse amplitude. For this reason, we didn't use these devices for measuring the resting pulse rate in subjects. The measurement of the pulse at the radial point (inside the wrist), as this is the most common point at which to measure the pulse of medical patients, was used in this research. Each subject had a passive rest in sitting (at least 20 minutes). Measuring the pulse for full minute with help gently press of the first and second fingers on the inside of the subject's wrist was using (Pickering, 2013). All pulse beat rates were recorded.

Accurate measurement of blood pressure is regarded among the most important of all medical tests. The conventional threshold at which medical experts might consider giving medication to lower pressure is 140/90 mmHg. All subjects had a passive rest in sitting (at least 20 minutes). Then, a broad cuff is placed over the upper arm of each subject and inflated until the main artery in the arm is completely occluded and blood flow is stopped. The cuff is then slowly deflated until blood flow returns into the lower arm. A series of signals then be measured that represent the systolic and diastolic blood pressure (Ogedegbe, & Pickering, 2010). These were measured by using automate device Omron M3 Expert – HEM 7132-ALRU (Japan). All blood pressure measurements were recorded.

The six-minute walk test (6MWT) has been used as a performance-based measure of functional exercise capacity in different populations, including middle-age and older adults. This test measures the distance an individual is able to walk over a total of six minutes on a hard, flat surface. The main goal is for the individual to walk as far as possible in six minutes. The each subject is allowed to self-pace and rest as needed as they traverse back and forth along a marked walkway (30 meter corridor with cones placed at the beginning and end of the 30 meter boundary to indicate turns). The primary outcome is the distance covered in meters over 6 minutes (Enright, 2003). The standard mean 6MWD ranging from 400 to 700 m, and the mean pulse rate values by the walk ranging from 100 to 130 bpm. (Chetta, Zanini, Pisi, et al., 2006). All study subjects completed the 6MWT twice (in pre- and post- intervention). The outcomes were recorded.

Statistical analysis

The overall findings of this study were analyzed using the IBM SPSS Statistics for Windows 20.0 (Armonk, NY: IBM Corp.). All values were expressed as means and standard deviations (SD). The differences between the study subject's group were determined using the Mann-Whitney U-test. A p value of ≤ 0.05 was considered statistically significant for this study.

Results

There were no significant differences among the groups with regard to age, height, body weight, BMI, IPAQ values, measurements of pulse rate and blood pressure, 6MWT values in pre-intervention (May, 2019). Resting pulse rate values qualified as the normal range (70-90 bpm) for subjects in both groups. There were excess of permissible values of blood pressure of all subjects has been revealed (blood pressure is higher 140/90 mmHg). The BMI values qualified as the overweight range for subjects in both groups. The 6MWT values (covered distance) qualified as the substandard (low) range for study subjects in both groups. There were significant excess of the recommended values of pulse rate (100-130 bpm) in 6MWT in both groups. All study subjects demonstrated about 142 bpm, when performed load in 6MWT. All study subjects reported they weren't following the recommendation for PA to their physicians (moderate to vigorous (fitness) PA for 150 minutes per week or more). The general information in pre-intervention period outlined in Table 2.

Table 2. The overall findings of study subjects in pre-intervention (May, 2019).

Tests	Group 1 (n=29)	Group 2 (n=28)	p≤
Height (cm)	168.34±7.13	167.85±6.52	0.38974
Body Weight (kg)	72.16±5.27	71.69±5.44	0.43644
BMI	25.47±0.05	25.44±0.07	0.16109
Pulse rate (bpm)	85.01±5.76	85.17±5.89	0.40905
IPAQ (minutes per week)			
Domestic PA	313.07±26.68	311.04±28.64	0.38974
Occupational PA	430.74±46.60	439.31±44.18	0.22363
Fitness PA	105.10±14.26	104.89±16.19	0.43251
Sitting time	2060.24±276.94	2043.07±274.32	0.42465
Blood Pressure (BP)			
Systolic BP	145.16±3.29	144.63±4.32	0.50926
Diastolic BP	94.53±2.95	95.31±2.34	0.05705
The six-minute walk test (6MWT)			
Covered distance (m)	381.25±15.79	379.58±11.74	0.30503
Pulse rate (bpm)	142.68±3.83	142.91±4.21	0.42074

Legend: * - (reliability of differences) - p≤0.05.

No significant differences were observed among the groups with regard to height and IPAQ values in post-intervention (September, 2019). All study subjects reported they were following the recommendation for PA improvement to their physicians, and performed moderate to vigorous (fitness) PA for 150 minutes per week or more in intervention period. There were significant ($p \leq 0.05$) differences among the groups with regard to body weight, BMI, measurements of pulse rate and blood pressure, 6MWT values in post-intervention. Mean maximum body weight and BMI values were significantly lower in study subjects (group 2), as compared to study subjects (group 1). Mean BMI values qualified as the normal range for individuals in both groups. Resting pulse rate values qualified as the normal range for study subjects in both groups. In this period, were found that both resting and 6MWT pulse rate values were significantly ($p \leq 0.05$) higher in subjects (group 1) as compared to subjects (group 2). The 6MWT values (covered distance) qualified as standard (normal) range for study subjects in both groups. Mean maximum 6MWT values (covered distance) were significantly ($p \leq 0.05$) higher in individuals (group 2), as compared to subjects (group 1). Mean blood pressure measurements qualified as the normal range (less 140/90 mmHg) in both groups. However, there were significantly lower blood pressure values in study subjects (group 2). The general information in post-intervention period outlined in Table 3.

Table 3. The overall findings of study subjects in post-intervention (September, 2019).

Tests	Group 1 (n=29)	Group 2 (n=28)	p≤
Height (cm)	168.32±7.11	167.84±6.49	0.38971
Weight (kg)	69.87±4.83	68.26±4.27	0.04846*
BMI	24.66±0.07	24.23±0.05	0.00010*
Pulse rate (bpm)	81.34±4.74	78.92±4.81	0.01321*
IPAQ			
Domestic PA	317.51±30.76	323.96±26.51	0.13350
Occupational PA	437.92±35.56	443.24±33.30	0.23271
Fitness PA	246.45±25.92	253.74±29.43	0.13136
Sitting time	1734.57±234.73	1752.79±237.31	0.36317
Blood Pressure (BP)			
Systolic BP	136.61±4.57	132.37±5.94	0.00008*
Diastolic BP	87.51±3.06	84.15±4.59	0.00019*
The six-minute walk test (6MWT)			
Covered distance (m)	468.87±22.29	501.15±21.34	0.00001*
Pulse rate (bpm)	134.71±5.49	129.77±5.04	0.00016*

Legend: * - (reliability of differences) - $p \leq 0.05$.

Discussion

Physician and health knowledge show that regular physical exercise is a significant factor in reducing the risk of heart disease and hypertension in individuals (Diaz, & Shimbo, 2013). It is known, that individuals with a sufficient PA level have lower blood pressure, than those who don't have any PA (Moraes-Silva, Mostarda, Silva-Filho, et al., 2017). However, the health professionals claim that specific PA doses reducing the risk of heart disease are not fully determined (Nystoriak, & Bhatnagar, 2018). Excessive PA levels can have a negative effect on the health of the cardiovascular system of the untrained individuals. Also, individuals suffering from any diseases, such as hypertension, are also at risk with high PA (Allesøe, et al., 2016). At the same time, we haven't found robust and accurate knowledge about the maximum permissible PA value for healthful physical training in people suffering from hypertension in the scientific literature. We're thinking that the further, more detailed studies will be needed for a more complete understanding of the benefits of PA for different population suffering from AH, to especially assess the behavior of BP and HR recovery and HR variability after exercise training, that *Braz, et al.,* point out (Braz, et al., 2012).

There is evidence of high intensity interval (Costa, Hay, Kehler, et al., 2018), dynamic (Ciolac, 2012) and aerobic training (Huang, Shi, Gibson, et al., 2013) in the practice of reducing systolic and diastolic blood pressure in the literature. It is known that a clinically meaningful blood pressure reduction arbitrarily defined as an absolute systolic blood pressure and diastolic blood pressure reduction of 3 mmHg or more (Collaboration BPLTT, 2003). *Bonsu, & Terblanche,* state that six HIIT sessions is sufficient to affect clinically significant post-exercise hypotension responses in overweight/obese women; however, the training effects are lost within two weeks of detraining (Bonsu, & Terblanche, 2016). *Hess et al.,* reported that after 6 weeks of isometric exercise, reductions in systolic blood pressure were of 5-7 mmHg (Hess, Carlson, Inder, et al., 2016). *Cornelissen, & Smart,* recorded a significant decrease in blood pressure among the individuals with AH (a decrease in systolic blood pressure readings of an average 8 mmHg and diastolic blood pressure readings of an average 5 mmHg) during the implementation of endurance training lasting more than 4 weeks (Cornelissen, & Smart, 2013). *Molmen-Hansen, et al.,* state that a decrease in systolic blood pressure of 12 mmHg and diastolic blood pressure at 8 mmHg among the women with hypertension, who used intensive aerobic interval training during 12 weeks (Molmen-Hansen, et al., 2012). In our study, a decrease of blood pressure was found in both

subjects' groups in post-intervention. Study subjects (group 2), demonstrated a mean decrease of systolic blood pressure of 12 mmHg and mean decrease of diastolic blood pressure of 11 mmHg. Study subjects (group 1), demonstrated a mean decrease of systolic blood pressure of 8 mmHg and mean decrease of diastolic blood pressure of 7 mmHg. We can explain the more significant results of lowering blood pressure in subjects (group 2) by the advantage of particular healthful PA intervention.

In scientific literature presents some limited knowledge about more significant benefits of combined aerobic and strength training in preventing the development of hypertension compared with using only aerobic or strength training (Diaz, & Shimbo, 2013). *Corrick, et al.,* found the advantage of using combined 16-week workouts in reducing blood pressure of the women (Corrick, Hunter, Fisher, et al., 2013). However, these studies were conducted among elderly patients over 55 years old. A significant proportion of these patients did not suffer from AH. We can declare the benefits of combined (aerobic + strength) workouts for a period of 16 weeks in practice of lowering blood pressure and increase of functional status in middle-aged women with hypertension. *Sharman, et al.,* recommend that the patients with hypertension perform aerobic exercise of an average intensity at least 30 minutes daily. It is also recommended performing additional exercises with weights at least 2-3 times a week (Sharman, et al., 2015). We found a significant decrease in blood pressure in middle-aged women with AH, who performing three combined (aerobic+strength) workouts per week about 50-60 minutes each.

It should be noted there is the polarity of scientists' opinion in determining the effectiveness of aerobic step load in decreasing blood pressure and preventing hypertension. *Shim, et al.,* investigate that aerobic exercise (for 50 minutes, twice a week, total of 8 weeks), which is composed of rhythmic functional movement, helped improve functional movement and quality of life for the elderly women (Shim, et al., 2019). Russian investigators founded of the meaningful efficiency of step aerobic load in an increase in physical fitness profile in middle-aged women (Surnin, & Usachev, 2020). *Soroush, et al.,* argue about the significant effectiveness of aerobic step load in reducing blood pressure (Soroush, Der Ananian, Ainsworth, et al., 2013). To instance, healthy but sedentary individuals, who take up a programme of regular brisk walking improves several known risk factors for cardiovascular disease, including body weight, BMI and resting blood pressure (Murphy, et al., 2007). *Igarashi et al.,* state that performing a large daily volume of a step load (10000 steps) will not lead to a significant decrease in blood pressure in healthy adults. These scientists recommend increasing the volume of the daily step load (Igarashi, Akazawa, & Maeda, 2018). We are combined aerobic training: walking/jogging and walking hill with strength exercises with weights in each healthful physical training session, in our study. Can be said that this combination has been quite effective in reducing blood pressure in middle-aged women with AH. At the same time, total amount of the aerobic step load did not increase significantly in study subjects during the study.

Investigators state that regular PA reduces risk of cardiovascular diseases, including AH (Rouf, et al., 2018). However, the IPAQ relationships with blood pressure (BP) and flow in healthy individuals have not been fully studied. It's known, that walking (moderate and total PA) correlated negatively with systolic blood pressure and diastolic blood pressure in healthy individuals. Besides that total PA successfully correlated with standard load (6MWD) (Alomari, Keewan, Qhatan, et al., 2011). Riegel, et al., did not find any association of PA (estimated by the IPAQ interview) with blood pressure control. We found that overall increase in total and moderate PA (walking/jogging) has a significant effect on lowering systolic and diastolic blood pressure in physically inactive middle-aged women with AH. We can confirm the positive impact of total PA on the results of standard load (6MWD) in study subjects. These findings indicate that the PA (estimated by the IPAQ interview) association with the circulatory measures demonstrates PA importance for controlling blood pressure in healthy individuals and people, who have hypertension.

The overall findings of this study should be interpreted in the light of some important limitations. One limitation of this study is the use of small sampling of study subjects. The intervention none included studying the impact of the different food habits, diet adherence and psychological status of subjects. Also, data collection based on one population reduces the external validity of our findings (we acknowledge that our findings are partially explained by our subjects' profile). The study finding may have limited generalizability to other samples of middle-aged women with AH, that have different characteristics from this sample (higher or lower values of height, bodyweight, BMI, blood pressure and other).

Conclusions

These findings demonstrated that particular PA intervention including a regular practice of combined (aerobic + strength) physical exercise should be recommended for middle-aged women with AH and overweight or obesity. Beneficial effects of this particular PA on BMI, resting pulse rate and blood pressure value reductions in study subjects can be seen in after intervention period. Future, more detailed studies will be needed to better understand the beneficial effects of combined (aerobic+strength) physical exercise on blood pressure in individuals affected by hypertension.

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Conflicts of interest

The authors declare that there is no any conflict of interest.

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