Original Article

ISSN 0103-1716

Effects of concurrent training on morphological and functional parameters and blood pressure in hypertensive women

Efeitos do treinamento concorrente sobre parâmetros morfofuncionais e pressão arterial de mulheres hipertensas

AGUIAR REM, LA SCALA TEIXEIRA CV, PAULINO H, PAULI JR, MEDEIROS A, CERRONE LA, FERREIRA SA, GOMES RJ. Effects of concurrent training on morphological and functional parameters and blood pressure in hypertensive women. **R. bras. Ci. e Mov** 2017;25(3):53-60.

Renata Emilia M. Aguiar[1]
Cauê V. La Scala Teixeira[1]
Heverton Paulino[1]
José Rodrigo Pauli[2]
Alessandra Medeiros[1]
Letícia Andrade Cerrone[1]
Sionaldo E. Ferreira[3]
Ricardo José Gomes[1]

[1]Universidade Federal de São Paulo
[2]Universidade de Campinas
[3]Universidade Federal do Triângulo Mineiro

ABSTRACT: Aerobic and resistance exercise have been prescript to prevention and non pharmacological treatment of hypertension. However, there is a lack of studies investigating the effects of concurrent training in hypertensive women. Thus, the aim of this study was to investigate the effects of concurrent training program on rest blood pressure, biochemical variables (blood glucose and total cholesterol), anthropometric (body mass index and waist circumference) and functional fitness in hypertensive women. Eighteen hypertensive postmenopausal and untrained women (59±12 years old) started in the intervention, but only ten subjects finished. The voluntaries were enrolled in concurrent training, 60 min/day, 3 times a week, during 6 months. Systolic and diastolic blood pressure, blood glucose, total cholesterol, body mass index, waist circumference and functional fitness (AAPHERD) were measured pre and post experimental period. Data were analyzed using the Student's t test with significance level set at 5% ($P \leq 0.05$) and Cohen's Effect Size (ES). The results showed significant improvement in systolic and diastolic blood pressure at rest. The other variables did not show significantly changes, but the ES was medium and large for several variables (body mass index, blood glucose, total cholesterol, agility, coordination, aerobic fitness, strength endurance and general functional fitness index). In conclusion, this study confirms that 6 month of concurrent training program improved systolic and diastolic blood pressure in hypertensive women. In addition, the protocol suggests an improvement in anthropometric, biochemical and functional variables related to health.

Key Words: Hypertension; Exercise; Resistance training; Aerobic exercise.

RESUMO: O treinamento aeróbio e resistido têm sido prescritos para prevenção e tratamento não farmacológico da hipertensão arterial. No entanto, há escassez de trabalhos investigando os efeitos do treinamento concorrente em mulheres hipertensas. Assim, o objetivo desse trabalho foi investigar os efeitos de um programa de treinamento concorrente sobre pressão arterial de repouso, variáveis bioquímicas (glicose sanguínea e colesterol total), antropométricas (índice de massa corporal e perímetro de cintura) e aptidão funcional em mulheres hipertensas. Dezoito mulheres menopausadas, hipertensas e destreinadas iniciaram o programa, mas somente 10 terminaram. As voluntárias foram submetidas a programa de treinamento concorrente, com frequência de 3 vezes por semana (60 minutos/sessão) e duração de 6 meses. Pressão arterial sistólica e diastólica de repouso, glicemia de jejum, colesterol total, índice de massa corporal, perímetro de cintura e aptidão funcional (AAPHERD) foram mensurados nos períodos pré e pós intervenção. Após confirmação da normalidade, os dados foram analisados usando o test *t* para amostras em pares, adotando nível de significância de 5% ($P \leq 0,05$), além do cálculo do tamanho do efeito de Cohen (ES). Os resultados permitiram observar melhora significativa na pressão sistólica e diastólica de repouso. As outras variáveis não se alteraram significativamente, mas o ES foi médio a grande em diversas variáveis analisadas (índice de massa corporal, glicemia, colesterol total, agilidade, coordenação, aptidão aeróbia, resistência de força e índice geral de aptidão funcional). Em conclusão, esse estudo confirma que um programa de treinamento concorrente de 6 meses diminui os níveis de pressão arterial sistólica e diastólica de repouso em mulheres hipertensas. Além disso, o protocolo sugere melhora em variáveis antropométricas, bioquímicas e funcionais relacionadas à saúde.

Palavras-chave: Hipertensão; Exercício físico; Treinamento resistido; Exercício aeróbio.

Contato: Cauê Vazquez La Scala Teixeira - contato@caueteixeira.com.br

Recebido: 27/09/2016
Aceito: 23/07/2017

Introduction

Hypertension is a cardiovascular disease that affects more people in the world[1], accounting for 40% of deaths from stroke and 25% of those occurred from coronary artery disease[2]. Hypertensive subjects often have other medical conditions that contribute to increased cardiovascular risk, such as obesity, elevated blood glucose and total cholesterol[3].

Primary strategies for prevention, treatment and control of disease include regular physical exercise[4,5]. Aerobic exercise is primarily recommended, but resistance training has been presented as a complementary form of training in guidelines of the major health entities related to physical exercise and high blood pressure[4,6,7]. The combination of aerobic and resistance exercises in the same training program is usually called by concurrent training[8]. The aim of combining these different protocols is take advantages of different benefits offered by each. For hypertensive subjects, aerobic exercises improve cardiovascular function and contribute to the reduction of blood pressure levels at rest[9]. Resistance training has a strong influence on the functional capacity of individuals, given the direct relationship between muscle strength and daily activities performance[10]. Despite the recommendations lead to the combined practice of aerobic and resistance exercises, there is a lack of longitudinal studies involving concurrent training in hypertensive subjects, especially, in women.

Thus, the aim of this study was to verify the effects of 6 month of concurrent training program on morphological and functional, biochemical and hemodynamic parameters in hypertensive women. Our initial hypothesis was to observe improvement in all analyzed parameters, with emphasis on hemodynamic, biochemical and functional variables.

Materials and methods

Subjects

Eighteen hypertensive postmenopausal women (59±12 years old), previously not engaged in physical exercise program, were recruited. The inclusion criteria were control of hypertension through medication, medical authorization for physical training, controlled blood pressure below 140/90 mmHg at the beginning of the experiment, and lack of orthopedic injuries order. Exclusion criteria included cardiopulmonary disease, neurological dysfunction, liver disorders, auto immune diseases, renal disorders and change in medication or dosage during the intervention period. The training attendance less of 75% was used as exclusion criteria, thus, only ten volunteers completed the study. Participants were asked to refrain from other forms of physical therapy during the study.

All subjects signed the informed consent term and the project was approved by the Ethics Committee in Research of the Federal University of São Paulo under No. 1024/11.

Tests

Functional capacity

The functional capacity was measured by AAHPERD battery tests, involving flexibility (FLEX), motor coordination (COOR), balance (BAL) and dynamic agility (AGIL), upper-body muscle endurance (RES) and aerobic endurance (AER)[11], used in studies with elderly[12] and postmenopausal adult women[13]. The individual analysis of each variable allows the calculation of the general functional fitness index (GFFI).

The individual values in the tests were classified as absolute value and transformed into percentile values[14]. Although percentile values have been proposed for the elderly, a recent study found that the application of the AAHPERD battery is feasible for postmenopausal women[13]. The sum of percentiles was used to calculate the GFFI. The percentiles were classified according to functional classification reference.

Antropometric measurement

The body mass was measured by using of digital anthropometric balance (Tanita® 150 KGUM080), accurate to 100 g. The height was measured using an estadiometer (ES Standard Sanny® 2030), with 0.1 cm. From these anthropometric measurements it was calculated the body mass index (BMI). The waist circumference (WC) was measured with a flexible and inextensible tape (Sanny®), with accuracy of 0.1 cm, and the measurement was performed two fingers above the umbilicus.

Blood pressure

Hemodynamic analysis contemplated the measurements of systolic (SBP) and diastolic blood pressure (DBP), measured pre and post-experimental period. Blood pressure was measured after 15 minutes at rest, using stethoscope (Littmann® classic li S.) and aneroid sphygmomanometer, conventional pressure devices with closure BIC velcro for adult, properly calibrated. The subject sat in a chair with your back supported. The device is always placed on the bare arm supported at the level of the precordium, two to three centimeters of elbow flexure, neither loose nor tight, with the manometer on the longitudinal axis of the brachial artery. All analyzes were performed by the same evaluator.

Biochemical variables

Capillary blood samples were collected in the morning after overnight fasting (12 hours), by puncturing the fingertip. Blood glucose and total cholesterol were measured. The analyzes were made using portable equipment with specific strips, following the manufacturer's recommendations (Accutrend Plus, Roche).

Concurrent training protocol

The concurrent training was performed three times a week, with sessions of moderate intensity during 6 months. Each session had the duration by 60 minutes: 10 minutes for heating; 45 minutes to the main activities; 5 minutes for stretching and back to calm.

The main part includes 20 to 30 minutes of aerobic exercises (oriented walks, play activities and adapted games) of moderate intensity, and 15 to 20 minutes of neuromotor exercises, involving integrated resistance exercises focusing on the development of different physical capacities in a synergistic way. The characteristics of the integrated resistance exercises and the associated physical capacity are mentioned below:

- Contemplation of major muscle groups: strength and muscle endurance
- Multi-segmented and multiplanar movements: coordination and agility
- Full range of motion: flexibility
- High speed of movement: power

The intensity of aerobic and resistance exercises was determined by rated perceived exertion (RPE)[15]. The scale remained visible to the subjects during training sessions and workload was adjusted from the perception of individual effort, and the intensity remained between 12 and 16 (6-20 scale), which is considered somewhat hard and hard.

Initially, resistance exercises were performed with the body weight in order to learn the correct execution technique, postural correction and breathing (passive). After an adaptation period (three weeks), dumbbells were used adapted from recycled material (plastic bottles containing water and sand), elastic bands and manual resistance (exercises in pairs). For resistance exercises, three sets of fifteen to twenty repetitions per exercise or three sets of one minute execution were performed, with the same RPE zone used in aerobic exercises. When the RPE was below the target zone, the load was increased by 10%. Varied exercises were applied to the major muscle groups of the upper-, lower-limbs and trunk.

The first week was used to familiarization with the training protocol and the RPE scale.

Statistics analysis

The descriptive analysis was showed by mean and standard deviation. For inferential analysis, it was used the Student's t test for paired sample, after the confirmation of the normality of date by Shapiro-Wilk test. The significance level adopted was 5% ($P \leq 0.05$). To verify the magnitude of responses, it was calculated the Cohen's Effect Size (ES). The software used were Assistat Version 7.6 beta 2011.

Results

Systolic (SBP) and diastolic blood pressure (DBP) significantly decreased after intervention (Figure 1). The ES was large for both variables (1,04 and 1,35 for SBP and DBP, respectively).

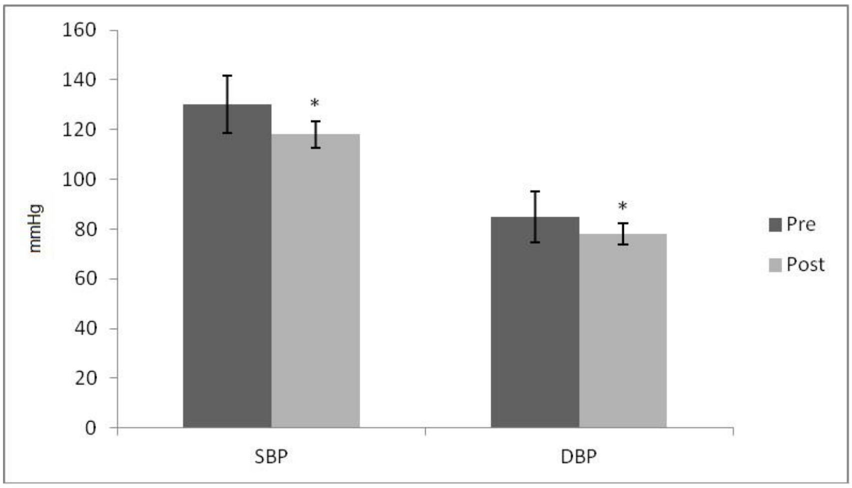

Figure 1. Systolic (SBP) and diastolic blood pressure (DBP) values at pre and post experimental period.
Legenda: *$P \leq 0.05$ vs. Pre

The table 1 shows the results of anthropometric and functional variables. It was not found significant differences between pre and post-experimental period for any variable. But the ES was medium for BMI, coordination, aerobic fitness and GFFI, and large for agility.

Table 1. Anthropometric and functional variables at pre and post-experimental period.

Variables	Pre	Post	*D*	ES
BMI (kg/m^2)	29.4 ± 5.4	27.5 ± 4.8	0.35	Medium
Waist circunference (cm)	90.3 ± 12.1	89.5 ± 11.6	0.07	Small
Agility (s)	25.6 ± 2.9	23.1 ± 2.9	0.86	Large
Coordination (s)	12.3 ± 1.7	11.5 ± 3.3	0.47	Medium
Flexibility (cm)	54.5 ± 9.3	55 ± 6.5	0,05	Small
Aerobic fitness (s)	513.4 ± 39.3	500.4 ± 37.5	0,33	Medium
Strength endurance (reps)	28.8 ± 2.8	27.5 ± 2.4	-0,46	Medium
GFFI (percentile)	256.3 ± 53.2	291 ± 73.7	0,65	Medium

Legenda: BMI: body mass index; GFFI: general functional fitness index; ES: effect size.

Blood glucose and total cholesterol did not showed significant changes, but the ES was medium for both variables (table 2). Although blood glucose and total cholesterol levels were not considered as initial inclusion and exclusion criteria, more than half of the volunteers presented altered basal levels for both variables.

Table 2. Biochemical variables at pre and post-intervention.

Variables	Pre	Post	*d*	ES
Blood glucose (mg/dl)	110.0 ± 20,9	103.2 ± 16,68	0.33	Medium
Aerobic fitness (s)	201.7 ± 68.2	179.8 ± 28,3	0,32	Medium

Legenda: *the sample includes 7 subjects; ES: effect size.

Discussion

Considering the recent training recommendations for hypertensive individuals, which include aerobic and resistance exercises, and the limited number of studies investigating the effects of concurrent training in this population, especially, in women, the aim of this study was to evaluate the effects of 6 months of concurrent training program on health parameters of controlled hypertensive women. Our initial hypothesis was that the intervention would provide positive effects on all variables. This hypothesis was partially confirmed.

The most important result of the intervention was a large and significant decrease in systolic and diastolic blood pressure at rest, considering that is the main cardiovascular risk variable analyzed in the study. Previous studies have also observed a decrease in systolic and diastolic blood pressure at rest in response to concurrent training programs lasting 16 and 24 weeks, respectively, but there is lack of investigations involving hypertensive women[16–18].

It has been amply demonstrated that exercise training causes significant autonomic and hemodynamic changes that affect the cardiovascular system contributing to blood pressure control. One of the possible mechanisms to explain the decrease in blood pressure after a physical training period is a decrease in peripheral vascular resistance, which is related to the decrease in sympathetic nerve activity[19,20]. This decrease is very important, because the sympathetic nervous activity and the subsequent release of noradrenaline lead to tachycardic and vasoconstrictor responses[18,21].

Thus, a possible decrease in sympathetic tone might be associated with blood pressure decreased at rest. Conlon[22] demonstrated that sympathetic over activity observed in hypertensive patients was normalized in these patients after 4 months physical training program, stating that the decrease in activation of the sympathetic nervous system in hypertensive patients seem to determine lower blood pressure levels at rest. Regarding concurrent training, Bonganha[23] also noted improvement in cardiac autonomic modulation at rest after 24 weeks of intervention in obese subjects, reflecting a decrease of 7.1% in diastolic blood pressure.

Our results also revealed that the training protocol did not significantly change blood glucose and total cholesterol. Although it was not significant difference, the ES was medium for both variables, which represents an important clinical outcome. For blood glucose, the values approximate the normality condition (< 100 mg/dl) and for total cholesterol, the values move away from the cutoff point (< 200 mg/dl). Sillanpää *et al*.[24] also found no significant difference in these variables after 21 weeks of concurrent training in middle-aged and elderly individuals.

The coexistence of cardiovascular risk factors increases the risk of metabolic syndrome, morbidity and death in hypertensive subjects[3]. Thus, current recommendations suggest that levels of glycemia, total cholesterol and other metabolic variables are evaluated and controlled in hypertensive subjects[3]. The effects observed in our study, although not significant, led to blood glucose and cholesterol levels close to normality, which highlights the clinical relevance of the intervention.

The intervention did not significantly change the anthropometric variables. For BMI, although the results did not show significant difference, the ES was medium, contributing to distance the sample mean of the cutoff point for obesity (pre: 29.4 kg/m², post: 27.5 kg/m²). The BMI has a strong association with the development of cardiovascular disease, morbidity and mortality and even small reductions in BMI may represent large increases in life expectancy[25].

Another anthropometric parameter evaluated was waist circumference. According several authors[26,27], increased adipose tissue in the abdominal region is considered a risk factor for several chronic diseases, representing different risk when compared to other forms of body fat distribution. On the other hand, previous studies have observed decrease of this variable in middle-aged and older women after 21 weeks of concurrent training[24]. However, our intervention produced moderate effect in reducing BMI, but not altered waist circumference. Recent researches has shown that intra-abdominal fat is more sensitive to high-intensity exercise[28,29], which may explain no changes in waist circumference at present, due to the moderate intensity during the intervention.

Finally, physical fitness parameters from AAHPERD battery tests have also been measured. These parameters were evaluated by the absolute values obtained in each test, enabling to calculate the GFFI, based on corresponding percentiles found in each test[30]. According Gonçalves *et al*.[30], the GFFI is an important tool to detect the functional fitness level of the participant individually and in relation to the group, and also what the functional fitness component need more attention in the exercise program.

Regarding to absolute values found in the tests, although it was not observed significant improvement in any variable, the ES was large for agility and medium for coordination, aerobic fitness and GFFI. Considering the importance of skills as agility, coordination and aerobic fitness for functional ability to perform everyday tasks, our results are important for the sample. However, strength endurance and flexibility did not respond to training. Regarding the strength endurance, we believe that the results are due to test specificity, because the battery uses only test based on the biceps contraction and this exercise was not used in the training protocol. Regarding flexibility, probably the lack of specific training of this component has influenced the results.

In a recent research conducted by our group[12], which adopted similar intervention protocol, but in diabetic women, the results showed significant improvement in coordination, strength endurance and GFFI. The other variables showed no difference, underscoring the idea that different subjects respond differently to similar training programs, which reinforces the need to identify the individual responsiveness to training and the adequacy of the program, as suggested by some studies[31,32].

The results of this study confirm that a concurrent training program is directly associated with the SBP and DBP control, corroborating the literature. The other parameters evaluated, although not present statistically significant differences, showed ES among medium and large for most variables. The limitations of the study were the small number of volunteers who completed the intervention (n=10) and the lack of a control group, but as the sample included only controlled hypertensive women and the other variables (drugs, diet, etc.) were not modified during intervention, we believe that results were related to training program. We also emphasize the need for researches that applies concurrent training in different protocols (strength and aerobic exercises in different periods or on different days) in order to verify if the training effects are different.

Conclusion

In conclusion, 6 month of concurrent training program improved SBP and DBP in hypertensive women. In addition, the protocol suggests an improvement in anthropometric, biochemical and functional variables related to health.

References

1. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet. 2005; 365(9455): 217-23.

2. Arntz RM, Van Den Broek SMA, Van Uden IWM, Ghafoorian M, Platel B, Rutten-Jacobs LCA, *et al*. Accelerated development of cerebral small vessel disease in young stroke patients. Neurology. 2016; 87(7): 1-8.

3. Malachias MVB, Souza WKSB, Plavnik FL, Rodrigues CIS, Brandão AA, Neves MFT, *et al*. 7ª Diretriz brasileira de hipertensão arterial. Arq Bras Cardiol. 2016; 107(3Supl.3):1-83.

4. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. Exercise and Hypertension. Med Sci Sport Exerc. 2004; 36(5): 533-53.

5. Dasgupta K, Quinn RR, Zarnke KB, Rabi DM, Ravani P, Daskalopoulou SS, *et al*. The 2014 Canadian Hypertension Education Program recommendations for blood pressure measurement, diagnosis, assessment of risk, prevention, and treatment of hypertension. Can J Cardiol. 2014; 30(5): 485-501.

6. Pescatello LS, MacDonald HV, Lamberti L, Johnson BT. Exercise for Hypertension: A Prescription Update Integrating Existing Recommendations with Emerging Research. Curr Hypertens Rep. 2015; 17(11): 87.

7. Pollock ML, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, *et al*. Resistance exercise in individuals with and without cardiovascular disease benefits, rationale, safety, and prescription an advisory from the committee on exercise, rehabilitation, and prevention, council on clinical cardiology, American Heart Association. Circulation. 2000; 101(7): 828-33.

8. Kang J, Ratamess N. Which Comes First? Resistance Before Aerobic Exercise or Vice Versa? ACSMs Health Fit J. 2014; 18(1): 9-14.

9. Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. J Am Heart Assoc. 2013; 2(1): 1-9.

10. Kraemer WJ, Adams K, Cafarelli E, Dudley GA, Dooly C, Feigenbaum MS, *et al*. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sport Exerc. 2002; 41(3): 687-708.

11. Clark BA. Tests for fitness in older adults: AAHPERD Fitness Task Force. J Phys Educ Recreat Danc. 1989; 60(3): 66-71.

12. Paulino H, Aguiar REM, Teixeira CVLS, Santos GM, Ferreira SE, Pauli JR, *et al*. Efeitos do treinamento concorrente sobre aspectos bioquímicos, antropométricos, funcionais e hemodinâmicos de mulheres diabéticas do tipo 2. RBM rev bras med. 2015; 72(3): 65-9.

13. Neves LM, Fortaleza AC, Rossi FE, Diniz TA, Picolo MR, Buonani C, *et al*. Assessment of functional fitness through the set of AAHPERD tests in women after menopause: Is there a decline between the fifth and sixth decades of life? Rev Bras Ginecol Obstet. 2015; 37(6): 278-82.

14. Benedetti TRB, Mazo GZ, Gobbi S, Amorim M, Gobbi LTB, Ferreira L, *et al*. Normative values of functional fitness in 70-to-79 year-old women. Brazilian J Kinanthropometry Hum Perform. 2007; 9(1): 28-36.

15. Borg G. Borg’s perceived exertion and pain scales. Champaign, Hum Kinet. 1998; 13-6.

16. Eklund D, Hakkinen A, Laukkanen JA, Balandzic M, Nyman K, Hakkinen K. Fitness, body composition and blood lipids following 3 concurrent strength and endurance training modes. Appl Physiol Nutr Metab. 2016; 41(7): 767-74.

17. Lamberti LM, MacDonald HV, Johnson BT, Farinatti P, Livingston J, Zaleski AL, *et al*. Is Concurrent training efficacious antihypertensive therapy? A meta-analysis. Med Sci Sports Exerc. 2016; 44(3): 88-122.

18. Duschek S, Worsching J, Reyes Del Paso GA. Autonomic cardiovascular regulation and cortical tone. Clin Physiol Funct Imaging. 2014; 35(5): 383-92.

19. McDonnell BJ, Maki-Petaja KM, Munnery M, Wilkinson IB, Cockcroft JR, McEniery CM. Habitual exercise and blood pressure: age dependency and underlying mechanisms. Am J Hypertens. 2013; 26(3): 334-41.

20. Rahmouni K, Correia MLG, Haynes WG, Mark AL. Obesity-associated hypertension: new insights into mechanisms. Hypertension. 2005; 45(1): 9-14.

21. Herrera NA, Jesus I, Shinohara AL, Dionisio TJ, Santos CF, Amaral SL. Exercise training attenuates dexamethasone-induced hypertension by improving autonomic balance to the heart, sympathetic vascular modulation and skeletal muscle microcirculation. J Hypertens. 2016; 34(7): 1235-448.

22. Conlon JA, Newton RU, Tufano JJ, Banyard HG, Hopper AJ, Ridge AJ, *et al*. Periodization Strategies in Older Adults: Impact on Physical Function and Health. Med Sci Sports Exerc. 2016; 48(7): 1227-430.

23. Bonganha V. Respostas cardiovasculares e autonômicas após treinamento concorrente em obesos de meia-idade. 2014.

24. Sillanpää E, Laaksonen DE, Häkkinen A, Karavirta L, Jensen B, Kraemer WJ, *et al*. Body composition, fitness, and metabolic health during strength and endurance training and their combination in middle-aged and older women. Eur J Appl Physiol. 2009; 106(2): 285-96.

25. Collaboration PS. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet. 2009; 373(9669): 1083-96.

26. Despres JP. Treatment of obesity: need to focus on high risk abdominally obese patients. Bmj. 2001; 322(7288): 716-20.

27. Catoira NP, Tapajoz F, Allegri RF, Lajfer J, Rodriguez Camara MJ, Iturry ML, *et al*. Obesity, metabolic profile, and inhibition failure: Young women under scrutiny. Physiol Behav. 2016; 157: 87-93.

28. Irving BA, Davis CK, Brock DW, Weltman JY, Swift D, Barrett EJ, *et al*. Effect of exercise training intensity on abdominal visceral fat and body composition. Med Sci Sports Exerc. 2008; 40(11): 1863-72.

29. Boutcher SH. High-intensity intermittent exercise and fat loss. J Obes. 2011; 2011(1): 868-305.

30. Goncalves LHT, Silva AH, Mazo GZ, Benedetti TRB, Santos SMA, Marques S, *et al*. Institutionalized elderly: functional capacity and physical fitness. Cad Saude Publica. 2010; 36(9): 1738-46.

31. Hautala AJ, Kiviniemi AM, Makikallio TH, Kinnunen H, Nissila S, Huikuri HV, *et al*. Individual differences in the responses to endurance and resistance training. Eur J Appl Physiol. 2006; 96(5): 535-42.

32. Barwell ND, Malkova D, Leggate M, Gill JMR. Individual responsiveness to exercise-induced fat loss is associated with change in resting substrate utilization. Metabolism. 2009; 58(9): 1320-8.