The effect of weekly low frequency exercise on body composition and blood pressure of elderly women

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Summary

Introduction: Regular physical activity can provide several benefits for human health, including improvements in cardiovascular, muscular and endocrine systems as well as in body composition. The aim of this pilot study was to analyze the effect of low frequency exercise (once *vs.* twice per week) on the body composition and blood pressure of elderly women who participated in a public exercise program.
Methods: Fifty-five sedentary elderly women, aged between 60 and 80 years, were evaluated by weight, stature, anthropometric measures (waist, abdomen, and hip) and systolic and diastolic blood pressure. The participants were divided into two groups: G1 performed exercise once a week and G2 performed exercise twice a week. Over six months the participants performed a combined program of aerobic exercise (walking and gymnastic aerobics) and strength exercise (using elastic bands, balls and bats). All exercise sessions lasted 60 minutes.
Results: The results showed body composition improvements for both groups in waist (G1: p= 0.002; G2: p= <0.001) and abdomen (G1: p= 0.014; G2: p= 0.001) measurements, percentage body fat (G1: p= 0.010; G2: p= 0.007) and waist–hip ratio (G1: p= 0.037; G2: p= <0.001) as well as in systolic (G1: p= <0.001; G2: p= <0.001) and diastolic blood pressure (G1: p= 0.001; G2: p= 0.014), except in fat free mass which was found only in G1 (p= 0.001). However, there were no significant differences between the groups in any variables.
Conclusion: It was concluded that this exercise, independent of the frequency (once or twice a week), resulted in improvements in body composition variables and blood pressure; however, no differences were found in the percentage of variation between both groups.

Key words:
Blood pressure.
Body composition.
Elderly women.
Weekly frequency.

El efecto de baja frecuencia semanal del ejercicio sobre la composición corporal y la presión arterial de las mujeres ancianas

Resumen

Introducción: La actividad física regular puede proporcionar varios beneficios para la salud humana, incluyendo mejoras en el sistema cardiovascular, muscular y endocrino, y en la composición corporal. El objetivo de este estudio piloto fue analizar el efecto de la frecuencia semanal del ejercicio (una vez vs. dos veces) sobre la composición corporal y la presión arterial de las mujeres ancianas que participaron en un programa público del ejercicio.
Métodos: Se evaluaron 55 mujeres ancianas sedentarias, con edades comprendidas entre 60 y 80 años, por la masa corporal, estatura, medidas antropométricas (de la cintura, el abdomen y cadera) y la presión arterial sistólica y diastólica. Las participantes fueron divididas de acuerdo con sus posibilidades en dos grupos: G1 (realizada una vez a la semana de ejercicio) y G2 (realizado dos veces a la semana de ejercicio) y durante 6 meses las participantes realizaron un entrenamiento combinado compuesto de ejercicio aeróbico (caminar y gimnasia) y ejercicio de fuerza usando bandas elásticas, pelotas y canes de un programa de ejercicios. Todas las sesiones de ejercicio tuvieran una duración de 60 minutos.
Resultados: Los resultados mostraron que ambos grupos tuvieron mejoras en la composición corporal de la cintura (G1: p = 0,002; G2: p = <0,001), el abdomen (G1: p = 0,014; G2: p = 0,001), porcentaje de grasa corporal (G1: p = 0,010; G2: p = 0,007) y la relación cintura cadera (G1: p = 0,037; G2: p = <0,001) la presión arterial sistólica (G1: p = <0,001; G2: p = <0,001) y en la sangre diastólica presión (G1: p = 0,001; G2: p = 0,014), excepto en la masa libre de grasa que se encuentra sólo en el grupo uno (p= 0,001). Sin embargo, no hubo diferencia significativa entre los grupos en todas las variables.
Conclusión: Se concluye que independientemente de la frecuencia de ejercicio (una o dos veces a la semana), se observaron mejoras en las variables de composición corporal y la presión arterial. Y, sin embargo, no encontramos diferencias en la variación porcentual entre ambos grupos.

Palabras clave:
Tensión arterial.
Composición corporal.
Mujeres ancianas.
Frecuencia semanal.

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Introduction

The aging process can lead to impairment in women's health, particularly when they are sedentary. A decrease in cardiorespiratory capacity can be observed, increasing risk factors associated with coronary heart disease[1,2], increased fat mass and weight[3,4], decreased strength and muscle mass[5,6], decreased bone mineral density[7], decreased dynamic stability[8,9] and decreased functional capacity[10,11]. Thus, the sum of all these cited factors leads to a worsening of the quality of life[12,13].

The number of sedentary people in the world is high, mainly among the elderly[14]. This condition, associated with a diet rich in carbohydrates and saturated fats, leads to increased fat mass, weight and body mass index, causing several health problems[15,16]. Normally, this population takes medication for several diseases, such as diabetes, hypertension, high cholesterol and other pathologies; however the inclusion of exercise in daily routines could modify this situation.

There is some evidence that exercise and lifestyle change (moderation of alcohol consumption, dietary changes, weight reduction, smoking cessation) is a sufficient nonpharmacological way to reduce the risk of morbidity, mainly in hypertensive subjects, even at an advanced age[17]. Exercise can produce significant hemodynamic changes and increase muscle blood flow, nitric oxide production and alpha 1 and 2 adrenergic receptor density in skeletal muscles[18]. Mota *et al*.[19] found a significant decrease in the blood pressure of elderly sedentary women who took part in a resistance training protocol three times per week over 16 weeks. In relation to the other variable, Aragão *et al*.[7] found significant differences in the total body fat, muscle mass and lean mass of elderly women who performed a multicomponent exercise training program three times per week for 12 months. These improvements in blood pressure and body composition may decrease the risk of morbidity.

To enable an increase in muscle strength and cardiorespiratory capacity in adults, ACSM[20] guidelines recommend 30 minutes or more of physical activity, preferably every day of the week or, if that frequency is not possible, at least 20 minutes of vigorous intensity exercise three times per week. However, with this population it is difficult to carry out physical activity programs with a frequency of three times per week or more, because of the lack of adherence. Studies have shown low adherence when an exercise program greatly increases in volume or intensity[21,22].

It is known that exercise of an appropriate volume can cause changes to body composition and some haemodynamic variables; however can this also be observed with weekly training of a low frequency?

Thus, this pilot study aimed to analyze the effect of weekly exercise frequency (once vs. twice) on the body composition and blood pressure of elderly women who participated in a public exercise program for six months.

Material and method

Study design

This was an experimental pilot study involving six months of intervention within the public program "Live Well". This program was introduced in the state of Rio Grande do Sul (southern region of Brazil).

Participants

Before the start of the program, different advertising methods (visits within the community, newspapers, internet, posters, radio, etc.) were used to invite the elderly to participate. The inclusion criteria were as follows: elderly sedentary women; aged 60–80; not suffering from chronic diseases or musculoskeletal disorders; no uncontrolled hypertension (systolic arterial pressure >200 mmHg and diastolic arterial pressure >105 mmHg); no use of β-blockers or antiarrhythmic medication; and no positive responses to the seven questions of the Physical Activity Readiness Questionnaire (PAR-Q) which relate to their health status. However, as some participants were over 69 years old, they were advised to check with their doctor, even if they had negative responses. If the participants answered "yes" to any of the questions, they were excluded from the program[23,24].

One hundred and fourteen participants enrolled in the program; however due to the exclusion criteria (uncontrolled hypertension and diabetes = 17; positive responses to questions of the PAR-Q = 5), 22 of the women could not participate in the program and were advised to seek medical attention. After screening, all of the 92 selected participants were informed by telephone about their random allocation in one of the two exercise protocol groups (once or twice a week). The first group (G1) was composed of 41 participants who performed one session of exercise per week. The second group (G2) was composed of 51 participants who performed two sessions per week. They agreed to maintain their baseline level of physical activity for the duration of the study.

Before starting the exercise program, some participants were already taking diuretics, statins and insulin sensitizers; all medicaments were unchanged until the end of the program. The research design was developed according to the Declaration of Helsinki. All volunteers signed a form consenting to participate in the study.

All participants completed a three day food intake questionnaire before intervention. These three days included two nonconsecutive weekdays and one weekend and were overseen by a nutritionist. They were instructed to maintain their usual diet for the duration of the program[25].

After participant recruitment and admission, data were collected in the initial stage of the program and six months after. Only 55 of the 92 volunteers who began the program finished the six months of training because of health problems or low frequency (attending less than 80% of the total classes). Therefore, only the data of these 55 participants were used for analysis, comprising 25 subjects in G1 (once a week) and 30 subjects in G2 (twice a week); the average age and education level (years of schooling) in the two groups were 67.32 ± 6.27, 8.14 ± 1.0 and 65.57 ± 5.21, 9.96 ± 2.85 for G1 and G2, respectively.

Data collection

In the first two weeks all participants were evaluated. On arrival, they remained seated in a quiet room for 30 minutes, to assess blood pressure. Blood pressure was evaluated with an ambulatory blood pressure device (Micromed, model ABPM-04, Porto Alegre, Brazil) placed on the subjects' non-dominant arm. The cuff was completely wrapped, covering at least two thirds of the upper arm. The participants

were instructed to avoid caffeine on the day of their visit and not to perform physical activities for at least 24 hours prior to the evaluation[26]. This procedure was in accordance with the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC7)[27].

After blood pressure evaluation, the participants were moved to another room for anthropometric measurements (body mass, height and circumference of waist, abdomen and hip) to be taken. Body mass was measured in kilograms (kg) using a Plena scale (model MEA-07420) with an accuracy of 100 g and a range of 150 kg. Using the Frankfurt plane as a reference, height was measured in centimeters (cm) using a stadiometer (Sanny Medical) with a precision of millimeters (mm). From these measurements were obtained body mass index values (weight/height^2). Waist, abdomen and hip circumferences were determined using a flexible steel tape (Cescorf) graduated in (mm). Waist circumference was taken at the mid-point between the lower costal (12th rib) border and the iliac crest. Abdominal circumference was measured on the umbilicus, and hip circumference was taken at the level of the greatest posterior protuberance of the buttocks, which usually corresponds anteriorly to about the level of the symphysis pubis.

Anthropometric measures (circumferences) were used to estimate fat percentage (% fat) because this allows for less technical error from evaluators than assessment by skinfolds[28] and because elderly people have morphological changes such as body fat distribution, elasticity and thickness of the skin[29,30]. All measurements were performed twice by an experienced evaluator trained by the International Society of Advancement of Kinanthropometry (ISAK)[31]. These same procedures and protocols were used in the initial and final evaluations.

Exercise program

The exercise program was performed over six months according to the weekly frequencies assigned to the two groups. In the initial three weeks of training, participants were familiarized with and adapted to the multicomponent exercise training program (combined aerobic and resistance exercise training) and also to the OMNI Res scale. For the duration of the training program there was incremental progress in the duration of the training sessions, beginning with 20–30 minutes initially and 60 minutes at the end of the program. All the sessions had the same structure: (i) warming-up 5–10 minutes, (ii) main part 40–45 minutes, involving walking different routes, exercises for lower (squats, lunges, calf rises) and upper limbs (shoulder abductions, biceps curls, triceps and abdominal extension), using elastic bands, balls and bats and (iii) return to calm, with stretching and/or relaxation activities. The main characteristics of the load and structure of the training program and the progression of the exercises during the six months are presented in Table 1. To equalize the exercise intensity for each participant, the Resistance Exercise Scale (OMNI Res)[32] was used for the active muscles. All activities were supervised by two trained instructors and all sessions, for both groups, were conducted by the same instructors.

Statistical analysis

The data distribution was verified by the Kolmogorov-Smirnov test with reference to the Gaussian curve. Average and standard deviation were used to characterize the sample. Student's t-test for paired samples was used to compare the two points of evaluation for each variable, and Student's t-test for independent samples was used to compare the percentage of all variables between groups. All analyses were performed using SPSS (Statistical Package for Social Sciences) version 21.0. The significance level was set at 5% (p <0.05).

Results

Table 2 shows all body composition measurements, as well as blood pressure values for the two groups. Significant differences within G1 were found in waist and abdominal measurements, percentage body fat, fat free mass, waist–hip ratio and systolic and diastolic blood pressure, wherein these same variables were also significantly different within G2, except for fat free mass which was found only in G1. In Table 2, it can be observed that no significant differences between the groups were found for any of the variables; this was also the case when the percentage variations of each variable for both groups were compared (Table 3).

Discussion

It is well known that several changes in body composition, including the reduction of fat free mass and the increase of fat mass occur within the aging process, particularly in sedentary people. The purpose of this

Table 1. Exercise training program.

Variables	1º Mesocicle		2º Mesocicle		3º Mesocicle	
Week	1-4	5-8	9-12	13-16	17-20	21-25
Aim	Familiarization of Scale OMNI Res	Muscular endurance	Muscular Hypertrophy	Maximal strength	Power	Loss weight
Type	Aerobic and resistance exercise, flexibility					
Mode	Walking, weight training, recreational games					
Duration	20-30 minutes	30-50 minutes	40-50 minutes	50-60 minutes	60 minutes	60 minutes
Intensity (Scale OMNI Res)	2-Easy 4-Somewhat easy	4-Somewhat easy/ 6-Somewhat hard	4-Somewhat easy/ 6-Somewhat hard	6-Somewhat hard/ 8-hard	6-Somewhat hard/ 8-hard	8-9 Hard
Frequency	1 or 2 days/week (non-consecutive)					

Table 2. General anthropometric characteristics of the participants in the once week exercise (G1) and twice week exercise (G2). Data are given as mean ± standard deviation.

Variables	Once a week (n=25)			Twice a week (n=30)		
	Before	After	*P* value	Before	After	*P* value
Body weight (kg)	73.40 ± 10.33	73.72 ± 10.65	0.473	68.10 ± 9.59	67.33 ± 9.20	0.227
Body mass index (kg/m^2)	29.36 ± 4.11	29.54 ± 4.32	0.333	26.60 ± 4.08	26.49 ± 4.33	0.693
Fat mass (%)	44.23 ± 4.48	43.43 ± 4.81*	0.010	39.96 ± 5.68	39.06 ± 6.13*	0.007
Fat mass (kg)	32.80 ± 7.38	32.37 ± 7.58	0.245	27.58 ± 7.27	26.67 ± 6.97*	0.040
Fat-free mass (kg)	40.60 ± 3.94	41.35 ± 4.28*	0.001	40.52 ± 4.26	40.67 ± 4.38	0.630
Circumference abdomen (cm)	97.16 ± 8.98	95.48 ± 8.59*	0.014	91.06 ± 8.29	89.13 ± 8.68*	0.001
Circumference waist (cm)	93.40 ± 8.77	91.24 ± 8.82*	0.002	87.03 ± 8.58	84.73 ± 8.91*	<0.001
Circumference hip (cm)	105.80 ± 7.96	104.92 ± 7.92	0.080	100.60 ± 7.46	100.13 ± 7.44	0.363
Waist-hip ratio (cm)	0.884 ± 0.073	0.870 ± 0.072*	0.037	0.865 ± 0.058	0.845 ± 0.059*	<0.001
Blood pressure systolic (mmHg)	132.80 ± 10.90	128.40 ± 11.87*	<0.001	129.00 ± 12.06	124.33 ± 12.50*	<0.001
Blood pressure diastolic (mmHg)	85.00 ± 6.45	82.00 ± 7.77*	0.001	80.00 ± 6.43	77.66 ± 8.06*	0.014

Significant difference from before to after intervention: * (p <0.05).

Table 3. Comparation of percentage variation (Δ) of variables in study between groups.

Variables (%)	Group 1 n (25) Mean ± SD	Group 2 n (30) Mean ± SD	*P* value
Body weigth (kg)	0,42 ± 3.00	-0,99 ± 4.87	0.195
Body mass index	0,58 ± 3.15	-0,41 ± 4.89	0.390
% fat	-1,85 ± 3.48	-2,40 ± 4.52	0.622
Fat mass	-1,37 ± 5.88	-3,26 ± 8.06	0.335
Fat free mass	1,80 ± 2.21	0,40 ± 4.02	0.110
Circumference abdomen	-1,66 ± 3.27	-2,15 ± 3.10	0.574
Circumference waist	-2,28 ± 3.48	-2,65 ± 3.53	0.697
Circumference rip	-0,81 ± 2.27	-0,44 ± 2.71	0.586
Waist-rip ratio	-1,46 ± 3.50	-2,21 ± 3.14	0.409
Blood pressure systolic	-3,32 ± 3.86	-3,55 ± 5.00	0.851
Blodd pressure diastolic	-3,57 ± 5.00	-2,93 ± 6.12	0.676

study was to determine body composition changes in sedentary elderly people who performed a multicomponent exercise training program once or twice a week for six months. The primary findings of the study show that a periodic exercise program, even performed with low weekly frequency, can provide significant improvements in waist and abdominal measurements, percentage body fat, fat free mass, waist–hip ratio and systolic and diastolic blood pressure; however there were no significant differences for these variables between groups. These differences may have occurred due to different volumes and intensities within the exercise periodization, as well as due to alterations in training goals and aims (muscular endurance, hypertrophy, maximum strength or power).

When the effects of the two weekly frequencies (once or twice a week) on body composition were compared, a significant change in variables of waist and abdomen measurements, percentage body fat and waist–hip ratio were observed in both, except fat free mass which was observed only in G1. Our results corroborate partially with Izquierdo *et al.*[21] who also reported that once per week combined strength and aerobic exercise can induce a similar increase in fat free mass of elderly people, when compared with training alone (twice per week strength or endurance exercise). However, the aims of the two studies were different because the present study compares once and twice weekly combined training, while Izquierdo *et al.*[21] compared combined training with strength or endurance per se. In addition, Sillanpää *et al.*[33] found improvements in body composition of elderly men who performed low frequency (twice a week) combined training. These studies show that low weekly frequency (once or twice per week) training can provide improvements in body composition and allow for an easier adherence to exercise, since it involves less time each week[21].

On the other hand Mynarski *et al*.[34] analyzed the effect of different physical exercise programs (strength training, functional and gymnastic) on anthropometric measures and the functional autonomy of elderly people at risk of fracture in the southern region of Brazil. The participants performed 35 training sessions with a duration of 60 minutes per session, twice a week. The study showed that these sessions, independent of training type, were not sufficient to provide significant changes in body mass index and body composition. One fact that may explain the absence of change in anthropometric measures in this study is the lack of load in strength training.

We did not find statistical differences when the percentage variation of all variables was compared between the two frequency groups (once or twice per week). These results are in accordance with the results of Fisher *et al*.[35] study which evaluated 63 women between 60 and 77 years of age who participated in 16 weeks of combined aerobic and strength training. The elderly women were divided into three physical training groups: the first performed strength and aerobic training once per week, the second performed two sessions per week and the third performed three sessions per week. Anthropometric and body composition results showed that body fat percentage, body fat, fat free mass and body mass index were not significantly different between groups.

A study developed by Nakamura *et al*.[36] evaluated elderly women using a different training methodology (exclusively aerobic) and more training groups (three groups plus a control group); significant differences were not found between the three exercise groups. In others words, elderly women that exercised once, twice or three times per week did not have significantly different changes in body composition.

Relative to blood pressure, there was a significant decrease in the level of systolic and diastolic blood pressure in both groups after six months of intervention. These results were also found in a study by Liu *et al*.[37] that evaluated 17 sedentary 45–60-year-old subjects during an eight week exercise program. However, the methods used differ from the present study, because this study used aerobic and strength exercises with a once or twice per week frequency, while Liu *et al*.[37] used exclusively aerobic exercises, with a frequency of four times per week. The significant decrease in blood pressure may be associated with central and peripheral adaptations for improving oxygen consumption (VO_2), although these variables were not evaluated.

Limitations of this study are the lack of control group, the impossibility of monitoring and controlling the other daily activities of the study sample and of not monitoring biochemical variables such as cholesterol, triglycerides and glucose.

Conclusion

It can be concluded that even low weekly frequency (once or twice per week) exercise over a sustained period of time can substantially modify or maintain the body composition of elderly women, as well as decreasing their systolic and diastolic blood pressure.

These results can also provide important information for this population, showing that it is not necessary to engage in high weekly frequency exercise to have satisfactory outcomes.

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Bibliography

1. Blair SN, Kampert JB, Kohl HW, Barlow CE, Macera CA, Paffenbarger RS, Gibbons LW. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *Jama.* 1996;276:205-10.
2. Rantanen T. Muscle strength, disability and mortality. *Scand J Med Scie Sports.* 2003;13:3-8.
3. Van Pelt R, Evans E, Schechtman K, Ehsani A, Kohrt W. Contributions of total and regional fat mass to risk for cardiovascular disease in older women. *Amer J Physiol Endocr Metabol.* 2002;282:E1023-E8.
4. Kraemer WJ, Nindl BC, Ratamess NA, Gotshalk LA, Volek JS, Fleck SJ, Newton RU, Hakkinen K. Changes in muscle hypertrophy in women with periodized resistance training. *Med Scie Sports Exerc.* 2004;36:697-708.
5. Wilhelm EN, Rech A, Minozzo F, Radaelli R, Botton CE, Pinto RS. Relationship between quadriceps femoris echo intensity, muscle power, and functional capacity of older men. *Age.* 2014;36:1113-22.
6. Sirola J, Rikkonen T. Muscle performance after the menopause. *Brit Menop Soc J.* 2005;11:45-50.
7. Aragão F, Abrantes C, Gabriel R, Sousa M, Castelo-Branco C, Moreira M. Effects of a 12-month multi-component exercise program on the body composition of postmenopausal women. *Climacteric.* 2014;17:155-63.
8. Bento PCB, Pereira G, Ugrinowitsch C, Rodacki ALF. Peak torque and rate of torque development in elderly with and without fall history. *Clin Biomech.* 2010;25:450-4.
9. Rogers ME, Fernandez JE, Bohlken RM. Training to reduce postural sway and increase functional reach in the elderly. *J Occup Rehabil.* 2001;11:291-8.
10. Suzuki T, Bean JF, Fielding RA. Muscle power of the ankle flexors predicts functional performance in community-dwelling older women. *J Amer Ger Soc.* 2001;49:1161-7.
11. Kobayashi H, Koyama Y, Enoka R, Suzuki S. A unique form of light-load training improves steadiness and performance on some functional tasks in older adults. *Scand J Med Scie Sports.* 2014;24:98-110.
12. Chodzko-Zajko WJ. Exercise and physical activity for older adults. *Kinesiol Rev.* 2014; 3:101-6.
13. Katula JA, Sipe M, Rejeski WJ, Focht BC. Strength training in older adults: an empowering intervention. *Med Scie Sports Exerc.* 2006;38:106-11.
14. Organization WH. World health statistics 2010: World Health Organization; 2010.p.59.
15. Clark BC, Manini TM. What is dynapenia? *Nutr.* 2012;28:495-503.
16. Bann D, Hire D, Manini T, Cooper R, Botoseneanu A, McDermott MM, Pahor M, Glynn NW, Fielding R, King AC. Light intensity physical activity and sedentary behavior in relation to body mass index and grip strength in older adults: Cross-sectional findings from the lifestyle interventions and independence for elders (LIFE) study. *PloS One.* 2015;e0116058:1-13.
17. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, Macera CA, Castaneda-Sceppa C. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation.* 2007;116:1094-105.
18. Stamler JS, Meissner G. Physiology of nitric oxide in skeletal muscle. *Physiol Rev.* 2001;81:209-37.
19. Mota MR, Oliveira RJ, Terra DF, Pardono E, Dutra MT, de Almeida JA, Silva FM. Acute and chronic effects of resistance exercise on blood pressure in elderly women and the possible influence of ACE I/D polymorphism. *Inter J Gen Med.* 2013;6:6.581-7.
20. ACSM (American College of Sports Medicine). *Guidelines for exercise testing and prescription.* Lippincott Williams & Wilkins; 2013.p.162.
21. Izquierdo M, Ibanez J, Hakkinen K, Kraemer WJ, Larrion JL, Gorostiaga EM. Once weekly combined resistance and cardiovascular training in healthy older men. *Med Scie Sports Exerc.* 2004;36:435-43.
22. Singh MAF. Exercise comes of age rationale and recommendations for a geriatric exercise prescription. *J Gerontol Ser A: Biol Scie Med Scie.* 2002;57:M262-M82.
23. Chisholm D, Collis M, Kulak L, Davenport W, Gruber N, Stewart G. *PAR-Q Validation Report: The evaluation of a self-administered pre-exercise screening questionnaire for adults.* Victoria: Canada: BC Ministry of Health and Health and Welfare; 1978.
24. Shephard RJ, Thomas S, Weiler I. The Canadian home fitness test. *Sports Med.* 1991;11:358-66.

25. Lopes C, Aro A, Azevedo A, Ramos E, Barros H. Intake and adipose tissue composition of fatty acids and risk of myocardial infarction in a male Portuguese community sample. *J Amer Diet Assoc.* 2007;107:276-86.
26. Neves EB. Prevalence of overweight and obesity among members of the Brazilian army: association with arterial hypertension. *Ciê Saúde Col.* 2008;13:1661-8.
27. Chobanian A. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Heart, Lung, and Blood Institute; National High Blood Pressure Education Program Coordinating Committee: Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertens.* 2003;42:1206-52.
28. Tran ZV, Weltman A. Predicting body composition of men from girth measurements. *Hum Biol.* 1988;167-75.
29. Heyward V. ASEP methods recommendation: body composition assessment. *J Exerc Physiol.* 2001;4:1-12.
30. Dey DK, Bosaeus I. Comparison of bioelectrical impedance prediction equations for fat-free mass in a population-based sample of 75 y olds: the NORA study. *Nutr.* 2003;19:858-64.
31. Marfell-Jones MJ, Stewart A, de Ridder J. International standards for anthropometric assessment; 2012. p. 25-32.
32. Colado JC, Triplett NT. Effects of a short-term resistance program using elastic bands versus weight machines for sedentary middle-aged women. *J Strength Cond Res.* 2008;22:1441-8.
33. Sillanpää E, Häkkinen A, Nyman K, Mattila M, Cheng S, Karavirta L, Laaksonen DE, Huuhka N, Kraemer WJ, Häkkinen K. Body composition and fitness during strength and/or endurance training in older men. *Med Scie Sports Exerc.* 2008;40:950-8.
34. Mynarski J, dos Santos L, Verffel A, de Mello D, Berticell M, Olkoski MM. Efeitos de diferentes programas de exercícios físicos sobre a composição corporal e a autonomia funcional de idosas com risco de fratura. *Rev Ed Fis/UEM.* 2014;25:609-18.
35. Fisher G, McCarthy JP, Zuckerman PA, Bryan DR, Bickel CS, Hunter GR. Frequency of combined resistance and aerobic training in older women. *J Strength Cond Res.* 2013;27:1868-76.
36. Nakamura Y, Tanaka K, Yabushita N, Sakai T, Shigematsu R. Effects of exercise frequency on functional fitness in older adult women. *Arch Gerontol Geriatr.* 2007;44:163-73.
37. Liu S, Goodman J, Nolan R, Lacombe S, Thomas SG. Blood pressure responses to acute and chronic exercise are related in prehypertension. *Med Scie Sports Exerc.* 2012;44:1644-52.