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Original Article

EFFECT OF CIRCUIT RESISTANCE TRAINING ON BLOOD BIOMARKERS OF CARDIOVASCULAR DISEASE RISK IN OLDER WOMEN

EFEITO DO TREINAMENTO DE RESISTÊNCIA EM CIRCUITO SOBRE BIOMARCADORES DE SANGUE DO RISCO DE DOENÇAS CARDIOVASCULARES EM MULHERES IDOSAS

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ABSTRACT

The purpose of this study was to analyze the effects of circuit resistance training (CRT) on blood biomarkers of cardiovascular disease risk in older women. Nineteen physically independent older women (≥ 60 years) were randomly assigned to one of the two groups: control (CG n = 9) and CRT (n = 10). The CRT performed a resistance exercise program for 12 weeks, with 10 exercises. Anthropometry, total cholesterol, triglycerides (TG), low density lipoprotein cholesterol (LDL-c), high density lipoprotein cholesterol (HDL-c), very low-density lipoprotein cholesterol (VLDL-c), glucose were measured. Main effect of time ($p < 0.05$) was observed for total cholesterol (-9.9%), LDL-c (-16.1%), VLDL-c (-15.9%) and HDL-c (+10.2%) in the CRT. The composite Z-score was reduced for the CRT group but not for CG. It was concluded that CRT can be effective for enhancing some blood biomarkers of CVD risk. In addition, the decrease in composite Z-score suggests that CRT can reduce cardiovascular disease risk in older women.

Palavras-chave: Aging. Physical Exercise. Health. Strength Training.

RESUMO

O objetivo deste estudo foi analisar os efeitos do treinamento de resistência em circuitos (TRC) nos biomarcadores sanguíneos de risco de doença cardiovascular em mulheres idosas. Dezenove mulheres idosas fisicamente independentes (≥ 60 anos) foram aleatoriamente designadas para um dos dois grupos: controle (GC n = 9) e TRC (n = 10). A TRC realizou um programa de exercícios resistidos por 12 semanas, com 10 exercícios. Antropometria, colesterol total, triglicérides (TG), colesterol de lipoproteína de baixa densidade (LDL-c), colesterol de lipoproteína de alta densidade (HDL-c), colesterol de lipoproteína de densidade muito baixa (VLDL-c) e glicose foram medidos. O efeito principal do tempo (p <0,05) foi observado para colesterol total (-9,9%), LDL-c (-16,1%), VLDL-c (-15,9%) e HDL-c (+ 10,2%) na TRC. O escore Z composto foi reduzido para o grupo TRC, mas não para o GC. Concluiu-se que a TRC pode ser eficaz para melhorar alguns biomarcadores sanguíneos do risco de DCV. Além disso, a diminuição do escore Z composto sugere que a TRC pode reduzir o risco de doença cardiovascular em mulheres idosas.

Keywords: Envelhecimento. Exercício Físico. Saúde. Treinamente de força.

Introduction

The aging process is characterized by changes in lipid and glucose metabolism, which are associated with various cardiovascular diseases (CVD). These negative changes affect a large part of the older population and can be considered one of the main causes of CVD and mortality in the world[1,2]. Circuit resistance training (CRT) have been suggested as an intervention to attenuate these age-related dysfunctions and promote health and wellness for older populations[3–5].

Several metabolic variables are related to the risk of CVD, such as blood glucose, total cholesterol, triglycerides, and lipoproteins (low-density lipoprotein, high-density lipoprotein and very low-density lipoprotein). Several studies have shown the positive effects of exercise training programs to improve these metabolic variables in older women[6–10]. Both aerobic and resistance training have been shown to improve these health-related parameters in older populations[4,11].

However, different types of training promotes different adaptations in different body systems[12-15]. Circuit resistance training (CRT) can be a good strategy for exercise prescription in older adults, since it may provide aerobic and anaerobic characteristics in a single training sessions, thus being more efficient for improving health status and decreasing the chance of developing of CVD[16–18]. In addition, CRT can be more time-efficient, reducing the session time which may favor adherence to the exercise program[19,20].

Recent investigations have shown significant effects of CRT on physical function, muscle strength, body composition in older population[16,21–24], but none of these studies analyzed the impact of CRT on blood biomarkers. Thus, the purpose this investigation was analyze the effect of CRT on blood biomarkers. Our hypothesis was that CRT would be effective to improve these variables and thus lowering the risk of CVD.

Methods

Research project approved by the ethics committee of the Metropolitan Faculty of Maringá under number 3,302,400 / 2017. This investigation was conducted according to the Declaration of Helsinki and approved by the local University Ethics Committee.

Participants

This investigation was carried out over a period of 14 weeks, with 12 weeks dedicated to the exercise program and 2 weeks for measurements. The blood collection was performed in weeks 1 and 14 for pre-and post-training, respectively. A supervised CRT exercise program was performed between weeks 2–13. The CG did not perform any type of physical exercise during this period. The blood collection measurements were obtained during the morning hours (between 7:00 and 9:00 am). The schedule of participant evaluations was similar at pre- and post-training, thereby helping to ensure consistency and strengthen internal validity. The post-training measurements were performed at least 72 h after the final exercise session to avoid any acute effects of the last training session.

Subjects

Forty older women (≥ 60 years old) volunteered to participate in this study. All participants completed a health history and met the following inclusion criteria: 60 years old or older, physically independent, free from cardiac or orthopedic dysfunction, not receiving hormonal replacement therapy, and not performing any physical exercise more than once a week in the six months preceding the investigation. After individual interviews, 16 volunteers were excluded as potential candidates because they did not meet inclusion criteria. The remaining 24 older women were randomly divided into two groups using a random numbers program (random.org): a group that performed exercise training (CRT, n=12) and a control group (CG, n=12) that did not perform any type of physical exercise. A total of 19 participants completed the experiment (CRT, n=10, CG, n=9) and were included in the analyses. Reasons for withdrawal were reported as lack of time and personal reasons. After being provided with a detailed description of investigation procedures, written informed consent was obtained from all participants.

Anthropometry

Body mass was measured to the nearest 0.1 kg using a calibrated electronic scale (Balmak, Laboratory Equipment Labstore, Curitiba, PR, Brazil), and height was measured to the nearest 0.1 cm with a stadiometer attached on the scale. Subjects wore light clothes and no shoes during measurement. Body mass index was calculated as body mass in kilograms divided by the square of height in meters.

Biochemical analysis

Subjects rested in a seated position for a minimum of 5 min prior to sampling. Venous blood samples were collected into one tube between a 12 h fast and after a minimum of 72 h following any exercise. Five milliliters were withdrawn from a prominent superficial vein in the antecubital space using a clean venous puncture with minimal stasis and placed in a tube containing a dipotassiumethylenediaminetetra-acetic acid (EDTA) as an anticoagulant and preservative. All samples were centrifuged at 3000 rpm for 15 min, and plasma or serum aliquots were stored at −80 °C until assayed. Inter- and intra-assays coefficients of variation were <10% as determined in human plasma. Measurements of serum levels of glucose, total cholesterol (TC), high-density lipoprotein (HDL-c), and triglycerides (TG) were determined by standard methods in a specialized hospital laboratory. The low-density lipoprotein (LDL-c) was calculated using the Friedewald, Levy, and Fredrickson equation[25]: LDL-c=TC−(HDL-c+TG/5). The analyses were carried out using a biochemical auto-analyzer system (Dimension RxL Max - Siemens Dade Behring) according to established methods in the literature consistent with the manufacturer's protocol.

Composite Z-score

The Z-score of the percentage changes (from pre- to post-training) of the raw data for each parameter was calculated. Moreover, a composite Z-score derived from the average of the components was calculated as following formula: (-1 x HDL-c Z-score) + (LDL-c Z-score) + (VLDL-c Z-score) + (TC Z-score) + (TG Z-score) + (GLU Z-score)/6.

Circuit resistance training

The training sessions were performed in circuit format (circuit training). Each session consisted of three phases: warm-up (5 min), exercise training (30 min) and cool-down (5 min). The exercise session was composed by 10 exercises: unipodal balance (30s), squats (12 rep), bench presses (12 rep), seated rows (12 rep), triceps push-downs (thera-band/12 rep), preacher curls (free weights/12 rep), shoulder adductions (free weights/12 rep), (20s/), medicine ball throw2 into the floor (12 rep), static run (30s), and abdominal isometric contraction (20s). The subjects underwent the circuit three times per session. The goal of the training session was to strength and power muscular, cardiorespiratory fitness, and balance[4]. The intensity was prescribed based on rating of perceived exertion (RPE). The intensity training was maintained between moderate to high. The interval rest between exercise was minimal, and 60-90 s between each lap. Each participant was personally supervised by physical education professionals to ensure consistent and safe performance.

Statistical analysis

For the comparisons of baseline between the groups (CG and CRT), Student's independent t-test was used. Two-way analysis of covariance (ANCOVA) for repeated measures was applied for comparisons between groups, with pre-training scores used as covariates[26–28]. When an F-ratio was significant, Bonferroni's post hoc test was employed to identify mean differences. The effect size (ES) was calculated to verify the magnitude of the differences by Cohen's d, where an ES of 0.20–0.49 was considered as small, 0.50–0.79 as moderate and ≥ 0.80 as large[29]. To verify the differences among groups on the percentage changes and composite Z-scores, a one-way ANOVA was applied; when the F-ratio was significant, a Bonferroni post hoc test was employed to identify the mean differences.

Significance was set at p < 0.05. Data were analyzed using Statistica software version 10.0 (Statsoft Inc., Tulsa).

Results

The anthropometric characteristics of the subjects at pre-training are presented in Table 1. There were no significant differences between groups for any variable (p > 0.05).

Table 1. General characteristics of the participants at pre-training

	CG (n= 9)	CRT (n= 10)	*P*
Age (years)	68.1 ± 6.3	69.6 ± 6.2	0.61
Body mass (kg)	68.9 ± 8.8	64.9 ± 11.0	0.39
Height (m)	1.56 ± 0.4	1.52 ± 0.8	0.26
Body mass index (kg/m2)	28.6 ± 4.7	28.0 ± 5.2	0.79

Not:. CG: control group. CRT: circuit resistance training group. Data are presented as mean and standard deviation
Source: Authors

The values at pre- and post-training according to groups for blood biomarkers of CVD risk, are presented in Table 2. The significant time effect was observed for TC, HDL-c, LDL-c, VLDL-c, TG ($p < 0.05$), where the presented significant changes after 12 weeks of training. For GLU, no significant changes were observed in any groups (p > 0.05).

Table 2. Participants' scores at baseline (pre) and post the 12-week intervention

		CG (n= 9)	CRT (n= 10)	Ancova Effects	*P*
Total cholesterol	Pre-training	197.44 ± 38.00	212.70 ± 39.35		
	Post-training	200.78 ± 35.13	191.70 ± 24.29*	Interaction	0.07
	Δ%	1.7%	-9.9%		
	ES	0.09	0.66		
HDL-c	Pre-training	54.11 ± 15.93	49.90 ± 8.39		
	Post-training	57.44 ± 14.93	55.00 ± 8.10*	Interaction	0.94
	Δ%	6.2%	10.2%		
	ES	0.22	0.62		
LDL-c	Pre-training	125.29 ± 38.54	140.48 ± 38.35		
	Post-training	121.69 ± 33.78	117.92 ± 28.03*	Interaction	0.23
	Δ%	-2.9%	-16.1%		
	ES	0.10	0.68		
VLDL-c	Pre-training	18.04 ± 7.38	22.24 ± 13.82		
	Post-training	21.62 ± 7.91*	18.70 ± 6.41*	Interaction	0.17
	Δ%	19.8	-15.9%		
	ES	0.47	0.35		
Triglycerides	Pre-training	90.22 ± 36.92	111.20 ± 69.11		
	Post-training	108.11 ± 39.56*	93.50 ± 32.03*	Interaction	0.13
	Δ%	19.8	-15.9%		
	ES	0.47	0.35		
Glucose	Pre-training	81.88 ± 16.28	86.0 ± 14.23		
	Post-training	86.11± 10.94	84.30 ± 14.99	Interaction	0.35
	Δ%	5.2%	-2.0%		
	ES	0.31	0.12		

Note: CG: control group. CRT: circuit resistance training group. * p < 0.05 vs pre-training. TC: total cholesterol. TG: triglycerides. LDL-c: low density lipoprotein cholesterol. HDL-c: high density lipoprotein cholesterol. VLDL-c: very low-density lipoprotein cholesterol. Δ%: percentage change, ES: Effect size. Data are presented as mean and standart deviation
Source: Authors

The composite Z-score of the percentage changes from pre- to post-intervention for blood biomarkers of CVD risk of both groups are showed in Figure 1. Although no significant statistics changes were observed, a tendency of change was identified in exercise group ($p > 0.06$). The composite Z-score: CRT = -0.48 ± 1.12; CG = 0.53 ± 1.32.

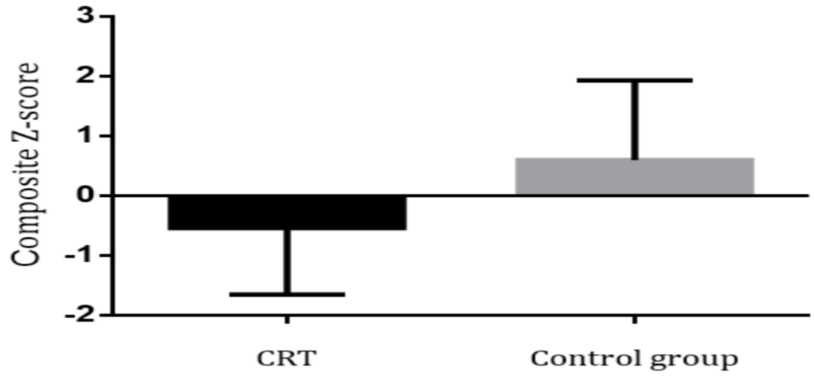

Figure 1. Composite Z-score of the percentage changes from pre- to post-intervention for blood biomarkers of cardiovascular disease risk of both groups
Note: CRT: circuit resistance training group
Source: Authors

Discussion

The main and novel finding observed in our study was that CRT program was effective to improve blood biomarkers related to CVD risk, confirming our hypothesis. Previous studies have found improvements on lipid profile in older women[14,30–32]. However, the experimental design, duration of intervention, volume and/or intensity and type of training/exercise can hamper the comparison between studies, since adaptations induced by exercise are dependent on manipulation of the variables training[12,13,33].

The overall changes induced by CRT in blood biomarkers were expressed by the composite Z-score. This approach may be an important tool to estimate the effect of training on blood biomarkers related to CVD risk, because it considers the overall response of an exercise training program, allowing the ability to draw inferences of the intervention as whole as opposed to isolated outcomes. This investigation showed that the CRT program tended to improve the composite Z-score, thus showing that training can be a good tool for health in older adults.

To our knowledge, this is the first investigation that analyzed the effectiveness of CRT on blood biomarkers in older women. Because of this unique approach, it limits comparison with other studies. Other studies have analyzed other variables like muscle strength and body composition[22,23,34,35]. Bocalini et al.[34] showed reduction in overweight and obese older women after 12-week of CRT. In addition, Balachandran et al. (2014) showed improvement of 20% on physical function, lCRT press (+41%) and chest press peak power (+24%) after 15 weeks of CRT.

Although we did not find studies that analyzed the effects of CRT on blood biomarkers in older women, other studies showed effectiveness of resistance training on these variables[10,30,31,32,36]. Tomeleri et al.[31] analyzed the effect of resistance training on blood biomarkers in older women and found reduction of LDL-c, glucose, IL-6, TNF-α, C-reactive protein and increase in HDL-c after 12-week of intervention. In other study, Ribeiro et al.[30] found reduction in glucose, total cholesterol, triglycerides and LDL-c and increase in HDL-c, corroborating with Tomeleri et al. study[31]. Thus, these results showed that physical training is effective to improve blood biomarkers, but, the better prescription still not is clear.

Our study showed that CRT was effective to reduce TC, LDL-c, VLDL-c, TG and to increase HDL-c, which supports the benefits of CRT in older women. Previous studies have shown the effectiveness of the resistance training on these variables[30–32], however, these studies did not employ a CRT program, which hampers the comparison with ours. A possible mechanism related to the findings of our results is the increased ability of skeletal muscle to use fat as energy source[37,38]. Regarding GLU, no changes were observed post-training, which was a surprise, because previous works of our laboratory found significant reductions on GLU after training[30–32]. A plausible reason for the results of the present study is related to the participants' low glucose level.

The results found here can help the exercise prescription in older adults and promote improvement in health status. In addition, the performing an exercise program in group usually favors the social life among older adults[39,40]. The CRT can provide the adherence to training due to a shorter time to execute the exercise session, and it is also considered a more dynamic intervention[3].

This study has some limitations. The results reported here are specific to untrained older women and cannot be extrapolated to other populations. In addition, the small sample size also is a limitation. We were also not able to monitor physical activity levels and dietary intake outside the study environment, which have confounded the results; however, all participants were instructed to maintain their normal level of physical activity and dietary intake. However, study's strengths were the follow-up of the subjects by trained professionals, analyzed variables are important to health. In addition, further studies should be performed with a larger sample size, and other health-related variables should be analyzed. Thus, future studies must replicate this study exploring the its limitations.

The results of the present study provide important information for professionals working in the practice. The results suggest that RT performed in circuit is efficient to improve blood variables such as glucose and lipid profile. This can help professionals in prescribing training for this population.

Conclusion

Twelve (12) weeks of CRT were effective to reduce TC, LDL-c, VLDL-c, TG, and to increase HDL-c in older women. In addition, CRT decreased composite Z-score, thus reducing CVD risk in older women.

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