Response of the Resting Metabolic Rate after 16 Weeks of Resistance Training in Postmenopausal Women

EXERCISE AND SPORTS SCIENCES

ORIGINAL ARTICLE

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ABSTRACT

Introduction: The physical changes from menopause such as decrease in lean mass (LM), growth and redistribution of body fat and decrease in resting energy expenditure, contribute to the increase in body size and subsequent increase in total body mass. Accordingly, the recognized benefits of resistance training (RT) are not only linked to increased strength and muscle hypertrophy, but also to body composition and consequently to the resting metabolic rate (RMR). Objective: To evaluate the RMR response after 16 weeks of RT in postmenopausal women. Methods: 28 female volunteers subdivided into two groups participated in the study: training (TG n = 17) and control (CG n = 11). The RT program was conducted in three weekly sessions, on alternate days and lasted approximately 60 min/session during 16 weeks. Load intensity was determined by means of target area of maximum repetitions, with weekly load readjustment. The oxygen consumption ($\dot{V}O_2$) and carbon dioxide production ($\dot{V}CO_2$), using open circuit indirect calorimetry was used to calculate the RMR according to Weir equation (1949). Statistical analysis: statistical package Bioestat, version 5.0, with a significance level of $p < 0.05$ was used. Results: There was significant increase of the LM values and muscle strength in TG only. No significant differences were found for the RMR values after intervention for both groups. Conclusion: The RT program of 16 weeks was effective in promoting changes in body composition and muscle strength in postmenopausal women; nevertheless, there was not change in RMR after intervention.

Keywords: menopause, body composition, energy expenditure, strength training.

INTRODUCTION

Aging process inevitably occurs to men and women. However, for women the effects become more remarkable with the occurrence of menopause[1].

The body alterations derived from menopause such as decrease of lean mass (LM), increase and redistribution of body fat and decrease of resting energy expenditure, contribute to the increase in the body dimensions and subsequent increase of total body mass (TBM)[2,3].

Increase in TBM, besides increasing risk of obesity, is associated with higher incidence of cardiovascular diseases, dyslipidemias and other comorbidities, especially when associated to physical inactivity[4].

It has been observed among the strategies to reduce or revert the effects of the aging physiological processes the practice of regular physical exercises[5]. Considering this strategy, the recognized benefits of resistance training (RT) are not only connected to the increase of muscle strength and hypertrophy[6], but also to the body composition[7,8] and, consequently, in the resting metabolic rate (RMR)[9].

Therefore, the proposal of the present study was to assess the RMR response after 16 weeks of RT in postmenopausal women.

METHODS

Sample

28 female volunteers subdvided in two groups participated in this research: training group (TG; n = 17) and control group (CG; n = 11). The volunteers were clinically healthy and were in post-menopause (minimum absence of 12 months of menstruation), did not make use of any kind of hormone replacement therapy and were not physically active.

All volunteers after having been told about the study aims and procedures which they would be submitted to, signed the Free and Clarified Consent Form.

The study was approved by the Ethics in Research Committee of the State University of Campinas, according to the norms of the Resolution 196/96 of the National Health Board on research involving humans under the protocol # 248/2004, with addition in 2007.

Procedures

Anthropometry was evaluated with measurements of the TBM, stature and waist circumference (WC).

Body composition was obtained by the skinfolds thickness measurement technique, with a calibrated adipometer (LANGE).

Anthropometry and body composition were assessed according to procedures described by Heyward and Stolarczyk[10].

Body density was obtained by the generalized formula proposed by Jackson and Pollock[11] and transformed in fat percentage (%F) through the Siri's formula[12] and the fat mass (FM) and the LM values were estimated[13].

The modification of the components of body composition may influence the RMR values; therefore, the total RMR was calculated relative by the total body mass (TBM) and the lean mass (LM). Correlations between the body composition components and the RMR were performed at the initial and final moments of the study for justifying the correlation between these variables.

One repetition maximum test (1-RM)

The muscle strength indicators were determined by the one repetition maximum test (1-RM) in three exercises: bench press, leg press and biceps curl[14]. A familiarization protocol was applied to the training protocol in the phase prior to the 1-RM evaluation protocols with the purpose to not underestimate the results obtained[15]. Muscle strength was assessed in this study, although these values have not been used in the training prescription to show its efficiency.

Evaluation of the resting metabolic rate

The RMR was determined through the oxygen consumption ($\dot{V}O_2$) and carbon dioxide production ($\dot{V}CO_2$), using indirect calorimetry of open circuit by the gas analysis system (Ultima CPX, MedGraphics,USA) and calculated in daily values (kcal/day) by the Weir equation [16]: RMR = $[(3.941 * \dot{V}O_2) + (1.106 * \dot{V}CO_2)] * 1.440$, where: $\dot{V}O_2$ = mean consumed value (liters/minute) and $\dot{V}CO_2$ = mean expired value (liters/minute). The test was performed in the Laboratory of Exercise Physiology (FISEX) of the Physical Education College of Unicamp, in laboratory conditions and after a fasting period of 12 hours. For this test, the volunteers used a facial mask connected to the gas analyzer, remaining in silence, at supine position, avoiding movement and sleeping during 30 min, so that breath after breath could be obtained. The gas analyzer was calibrated before each test. In order to have the RMR calculated, the 10 initial min were discarded for stabilization of the physiological variables in the resting position.

Training program

The RT was divided in two phases: first phase (P1) and second phase (P2). The phases were different in intensity, order and exercise prescription, as detailed: in E1, the exercises prescription was alternated by segments, with three sets of 10 repetitions maximum (RM) with one-minute pause between them; and E2 was prescribed in a localized manner by articulation with three sets of eight RM and one-minute and 30 s interval between sets. This prescription followed the recommendations of the studies presented by the ACSM[17].

The load intensity was determined through the target zone of the RM and not in percentage values of 1-RM[18], with weekly load readjustment.

The proposed exercises in the E1 and E2 were: 1) extensor table; 2) flexor table; 3) free horizontal bench press; 4) front pulley; 5) elbow flexion; 6) elbow extension; 7) leg press; 8) lateral fly; 9) abdominals and 10) calves. For the abdominal exercises and calves three sets 15 repetitions were prescribed during the entire experimental period.

The RT was performed in three weekly sessions, in alternated days and with approximate duration of 60 min/session, during 16 weeks. The volunteers were supervised by physical education teachers during the entire experimental period, so that each teacher could follow a maximum of three volunteers at the same time.

Statistical treatment

Data normality was verified by the Shapiro-Wilk test. In order to have the RT effects in both groups at the initial and final moments (IM = initial moment and FM = final moment) on the RMR and the body composition the two-way ANOVA was used, variables which presented normal distribution.

In order to analyze the muscular strength results the Kruskal-Wallis test was used, due to the lack of data normality.

Pearson correlation was used to assess the correlation between the RMR and body composition and age variables.

All analyses used the statistical package Bioestat, version 5.0, with significance level of $p < 0.05$.

RESULTS

No significant difference was found in the body composition, age, stature and WC components when the TG and CG were compared. However, during the study, significant increase ($p \leq 0.05$) for the LM values in the TG and significant decrease ($p \leq 0.05$) of the LM values in the CG was observed (Table 1).

Indicators of muscular strength presented significant increase ($p < 0.05$) of the values in the three assessed exercises after the intervention only for the TG. No significant difference was found for the CG, nor in the comparison between groups (Table 2).

The absolute and relative RMR values to the body composition did not show significant alterations ($p < 0.05$) between IM and FM for both groups.

Concerning the absolute RMR, there was increase of 6.1% for the TG and decrease of about 2.5% for the CG in the same period. In the RMR concerning the LM, there was approximate increase of 2% for the TG and decrease of 4.5% for the same variable in the CG during the evaluated period. The RMR concerning the TBM suffered increase of 5% in the TG and decrease of 1.3% for the CG (Table 3).

Positive and significant correlation was found between RMR and the WC, TBM and LM values in the TG between the IM and FM and negative significant between the RMR and age in the IM of the TG. No significant corelation was found in the CG (Table 4).

Table 1. Mean and standard deviation, age, stature, waist circumference and body composition components values between groups (TG and CG) in the moments (IM and FM) of the study.

Variables	TG			CG		
	IM	FM	p	IM	FM	p
Age (yeras)	54.7±3.9	---		52.7 ± 7.2	---	
Stature (m)	1.56±0.05	---		1.60 ± 0.03	---	
WC (cm)	79.3 ± 8.5	80.3 ± 7.6	0.351	80.3 ± 6.8	81.4 ± 6.1	0.383
TBM (kg)	63.5 ± 7.6	64.1 ± 7.6	0.23	69.1 ± 10.1	68.8 ± 10.0	0.976
BMI (kg/m²)	25.7 ± 2.6	26.0 ± 2.4	0.651	26.8 ± 3.3	26.7 ± 3.4	0.983
LM (kg)	41.1 ± 4.1	42.5 ± 3.7	0.0002*	44.9 ± 5.0	43.4 ± 6.0	0.004*

* Significant difference ($p < 0.05$) between IM and FM

Table 2. Mean, standard deviation and percentage variation values (Δ%) of the absolute resting metabolic rate concerning the body composition between groups (TG and CG) in the moments (IM and FM) of the study.

Variables	TG				CG			
	IM	FM	p	Δ%	IM	FM	p	Δ%
RMR (kcal/day)	989.9 ± 117.2	1.062.4 ± 146.2	0.45	6.1	1111.6 ± 138.2	1.083.7 ± 221.5	0.94	-2.5
RMR/LM (kcal/kg/day)	23.2 ± 2.6	25.1 ± 2.5	0.94	5.0	24.8 ± 3.2	23.7 ± 5.7	0.80	-1.4
RMR/TBM (kcal/kg/day)	15. 9 ± 1.9	16.8 ± 1.9	0.58	2.0	16.3 ± 2.7	16.1 ± 4.2	0.99	-4.5

* Significant difference ($p < 0.05$) between IM and FM.

Table 3. Mean and standard deviation values of the muscle strength indicators between groups (TG and CG) in the moments (IM and FM) of the study.

Variables	TG			CG		
	IM	FM	p	IM	FM	p
Bench press (kg)	36.6 ± 7.5	45.0 ± 7.3	0.0001*	38.3 ± 5.8	37.6 ± 6.3	0.934
Leg press (kg)	124.4 ± 13.6	170.1 ± 35.8	0.0001*	140.0 ± 23.4	151.0 ± 22.8	0.522
Biceps curl (kg)	23.2 ± 3.9	27.1 ± 6.7	0.0001*	23.0 ± 3.3	22.5 ± 3.2	0.842

Table 4. Correlation coefficient and determination coefficient among resting metabolic rate, body composition components, waist circumference and age.

Variables	Moments	TG			CG		
		r	r^2 (%)	p	r	r^2 (%)	p
RMR x age	IM	0.550#	31.36	0.022	-0.114	1.29	0.312
	FM	-0.351	12.32	0.167	0.02	0.04	0.935
RMR x WC	IM	0.536*	28.40	0.027	0.035	0.12	0.919
	FM	0.549*	30.10	0.022	-0.235	5.52	0.488
RMR x TBM	IM	0.560*	31.36	0.019	0.336	11.28	0.312
	FM	0.594*	35.28	0.012	-0.151	2.28	0.659
RMR x LM	IM	0.570*	32.49	0.017	0.420	17.64	0.198
	FM	0.657*	43.16	0.004	-0.118	1.39	0.729

* Significant positive correlation; # significant negative correlation.

DISCUSSION

RMR has been topic of many studies[9,19-22] where RT importance was evidenced since it stimulates the increase of LM as strategy for increase of resting energetic cost and hence increase the RMR values.

The present study was conducted in a trial to investigate the RT influence (with hypertrophic characteristic), on the RMR in postmenopausal women during 16 weeks of intervention.

Reduction in the RMR occurs with age increase and due to alterations in the body composition caused by menopause[23]. From 20 years old, women present decrease of RMR of about 2% per decade, and decrease of LM has been reported as the body composition component of highest influence on this decrease[24].

After intervention with RT, significant increase of LM was found in the TG, showing that the training proposed was efficient in promoting alterations in body composition. These results corroborate other studies[7-9] confirming the efficiency of the RT for this aim.

According to Hunter *et al.*[5], loss of LM is of only 5 to 10% in ages between 20 and 50 years, but later, the additional loss is of 30-40% between 50 and 80 years.

The RT prescription by target zone of repetition maximum was efficient in increasing the values of the muscular strength indicators statistically significant after intervention in the group which participated in the training. Such results have also been found in the research by Silva *et al.*[6], who used prescription by repetition target zone in elderly women.

Concerning both the RMR absolute and relative values evaluated in this study, significant increase has not been found for none of the studied groups. These studies confront the results published by Trevisan and Burini[9], who showed significant increase in the RMR of postmenopausal women at the same intervention period.

Although there is similarity with the study by Trevisan and Burini[9] concerning the studied gender, type of exercise and time of intervention involved, the age amplitude of the studied sample (elderly women) was higher than in the sample of this study (midlife women), and can cause disparity in the found results since elderly women present more fragile physical conditions concerning midlife women.

The research by Lemmer *et al.*[26] showed gender effect in the RMR response after intervention with RT, whose results showed significant increase in RMR only in elderly men, even when the values were relativized by the LM.

The correlations evaluated in this study showed that the RMR estimation shows relation with the body composition components (TBM and LM),regardless of the training level.

The WC has been very much used as an indirect indicator of abdominal obesity. The significant correlation found between RMR and WC, in both moments in the TG, indicates that abdominal fat may influence on the RMR prediction, corroborating hence the studies by Luhrmann *et al.*[20].

However, the correlations between RMR and WC are not well-elucidated yet[20,27], and the results in this study are just indication of this behavior.

Dionne *et al.*[28] after six months of RT in young and elderly women, did not find significant alterations in the TBM, RMR and only a tendency of increase of LM.

The increase in LM in this study was not sufficient to promote increase of RMR after intervention, which leads us to a limitation and can point that the time of intervention would be insufficient to promote such adaptation.

Previous publishing[28,29] have shown reverse relation of RMR with age. However, in this study negative significant correlation between RMR and age was only found in the IM in the TG, making us infer that for the studied sample, age was not a deter mining factor for decrease of RMR.

The menopause process by itself can significantly contribute to the decrease of RMR due to decrease in the production of female hormones[23].

Disparity of the RT effects for increase of RMR in post-menopausal women shows the need for further research.

CONCLUSION

The postmenopausal women did not present significant increase after 16 weeks of RT. On the other hand, there was significant increase of muscular strength and LM, corroborating that RT is efficient in attenuating some alterations that the women at this age range suffer due to the deleterious effects of aging and menopause, promoting benefic adaptations to health.

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