Combined Training (Aerobic Plus Strength) Potentiates a Reduction in Body Fat but Demonstrates No Difference on the Lipid Profile in Postmenopausal Women When Compared With Aerobic Training With a Similar Training Load

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Abstract

Rossi, FE, Fortaleza, ACS, Neves, LM, Buonani, C, Picolo, MR, Diniz, TA, Kalva-Filho, CA, Papoti, M, Lira, FS, and Freitas Junior, IF. Combined training (aerobic plus strength) potentiates a reduction in body fat but demonstrates no difference on the lipid profile in postmenopausal women when compared with aerobic training with a similar training load. *J Strength Cond Res* 30(1): 226–234, 2016—The aim of this study was to verify the effects of aerobic and combined training on the body composition and lipid profile of obese postmenopausal women and to analyze which of these models is more effective after equalizing the training load. Sixty-five postmenopausal women (age = 61.0 ± 6.3 years) were divided into 3 groups: aerobic training (AT, $n = 15$), combined training (CT [strength + aerobic], $n = 32$), and control group (CG, $n = 18$). Their body composition upper body fat (TF), fat mass (FM), percentage of FM, and fat-free mass (FFM) were estimated by dual-energy x-ray absorptiometry. The lipid profile, total cholesterol, high-density lipoprotein (HDL) cholesterol, and low-density lipoprotein cholesterol were assessed. There was a statistically significant difference in the TF (AT = −4.4%, CT = −4.4%, and CG = 1.0%, $p = 0.001$) and FFM (AT = 1.7%, CT = 2.6%, and CG = −1.4%, $p = 0.0001$) between the experimental and the control groups. Regarding the percentage of body fat, there was a statistically significant difference only between the CT and CG groups (AT = −2.8%, CT = −3.9%, and CG = 0.31%; $p = 0.004$). When training loads were equalized, the aerobic and combined training decreased core fat and increased FFM, but only the combined training potentiated a reduction in percentage of body fat in obese postmenopausal women after the training program. High-density lipoprotein-c levels increased in the combined group, and the chol/HDL ratio (atherogenic index) decreased in the aerobic group; however, there were no significant differences between the intervention programs. Taken together, both the exercise training programs were effective for improving body composition and inducing an antiatherogenic status.

Key Words endurance training, fat mass, menopause, strength training

Introduction

Menopause is related to important changes in body composition, such as a decrease in lean body mass (24) and increased fat mass (FM), especially in the trunk region, favoring an overweight/obese frame (21). Changes in body composition, especially the redistribution of fat in different adipose tissue deposits, promote the establishment of chronic low-grade inflammation (25). This framework contributes to the devel-

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opment of morbidities such as type 2 diabetes mellitus, hypertension, dyslipidemia, metabolic syndrome (19), and cardiovascular diseases, such as atherosclerosis, which are the leading causes of death worldwide (27).

Across this framework, several strategies have been recommended in an attempt to reduce the deleterious effects of menopause. Physical exercise is often recommended for health promotion (5,22,36). Among the different types of exercises, aerobic exercise is strongly emphasized, primarily for reducing total body mass (22), total body fat (22), and improving the lipid profile (36). Strength training also appears to be beneficial as it helps reduce total body mass, core fat, and relative body fat (5), in addition to contributing to an increase in lean body mass (17), thus preventing the development of diseases such as osteoporosis (3) and sarcopenia (12), which are quite prevalent in this population.

In addition to these models, some studies have used a combination of these types of training in the same training session, described as combined or concurrent training (32). This type of exercise has induced significant reductions in the total and trunk body fat as well as increasing lean body mass (32). Therefore, combined exercise seems to reflect the adaptations of both isolated aerobic and strength training, thereby potentiating the benefits of training in postmenopausal women.

However, in a review, Leveritt et al. (20) stated the difficulties in comparing concurrent training with other training protocols, because of the differences in protocols, equipment models used, and the duration and intensity of the training. Moreover, previous studies ignored the internal training load values. This analysis can help to explain the results observed and in choosing the best training method to be applied. In this sense, monitoring the training load distinguishes whether the adaptations observed are truly related to different exercise modalities (e.g., aerobic or strength + aerobic) or whether they are simply differences in total work done in the experimental groups. Finally, the determination of the training load only by the volume (i.e., time or frequency of session) may interfere with the calculation of real physiological stress, mainly in high-intensity sessions or during resistance exercises (10).

The rating of perceived exertion method (RPE × time session) is a validated tool for monitoring exercise at various ages (10), mainly because of the significant correlations with heart rate (HR), blood lactate concentrations, and cortisol levels (2,10,13,28,31). Moreover, the RPE session is used to determine an index of training variability, which is related to banal illness and overtraining syndrome (9). Although few studies were found using RPE sessions for equalizing load (8,10), this parameter represents the global feeling of exertion experienced during training sessions, allowing for the monitoring of high-intensity exercises, such as resistance training in older women (8). Thus, we believe that RPE session is a good method for determining the internal training load during continuous or high-intensity efforts, given that it allows for comparisons between aerobic (continuous and submaximal) and combined training, which included resistance efforts (high-intensity and discontinuous exercise).

Thus, the objectives of this study were to assess the effects of isolated aerobic training and combined training (aerobic + strength) on the body composition and lipid profile of postmenopausal women and to analyze which of these models was the more effective in improving these variables, after equalizing the training loads. We hypothesized that, after the equalization of the training loads, the combined model would be more effective than the aerobic training performed in isolation in reducing total and core body fat, increasing muscle mass, and improving the lipid profile of postmenopausal women.

METHODS

Experimental Approach to the Problem

This controlled clinical trial study was performed from February to July 2013 at the Science and Technology Department of the Paulista State University (FCT/UNESP), Presidente Prudente campus, SP, Brazil. Evaluations were performed at baseline (M0) and after 16 weeks of training (M16) and involved the following: screening for inclusion in the study, anthropometric measurements, body composition, lipid profile measurements, and 3 nonconsecutive 24-hour dietary recalls conducted during 2 periods: 1 week before the beginning of the intervention and in the first week after the intervention.

The training groups: aerobic training (AT) and combined training (CT) performed 16 weeks of training (strength + aerobic) and the control group (CG) maintained 16 weeks of a sedentary lifestyle without participating in any regular physical exercise–essentially maintaining their habits.

Subjects

Subjects were invited through television and newspaper advertising to participate in the study. The participants contacted the researchers by phone, and an appointment was made to perform a more detailed interview. All measurements were taken at the University Laboratory. The inclusion criteria were: (a) being in menopause (having had no menstrual cycle for one or more years (23) and Follicle-stimulating hormone ≥ 30 $\mathrm{UI \cdot l^{-1}}$); (b) being overweight (body mass index > 25.0 $\mathrm{kg \cdot m^{-2}}$) according to WHO (35); (c) not presenting any physical limitations or health problems that could prevent the completion of the assessments and exercise interventions; (d) presenting a medical certificate to participate in the training; (e) not having participated in any systematic physical exercise for, at least, 6 months before the study; (f) not receiving treatment for hormone replacement; (g) signing the consent form. After being informed of the risks and benefits involved in the study, the participants signed an informed consent. The project was approved by the Ethics Research Group of the University (Protocol 64/2011).

Of a total of 113 women who participated in the first screening, only 104 met all the inclusion/exclusion criteria and agreed to participate in the study protocol. Participants were randomized into 3 study groups: CT ($n = 35$), AT ($n = 35$), and CG ($n = 34$). During the 16 weeks of training, 34 of the 104 women dropped out of the study (a dropout rate of 37.5%). The reasons for dropouts included personal/family problems, unspecified reasons, and the accumulation of 3 consecutive absences or 4 nonconsecutive absences during 1 month. The final sample was composed of 65 subjects: CT ($n = 32$), AT ($n = 15$), and CG ($n = 18$) (Figure 1).

Procedures

Laboratory tests were performed after a 4-hour overnight fast in a hydrated state. Height and total mass were measured with the subjects wearing light clothing. The anthropometric measures were conducted on the same morning as dual-energy x-ray absorptiometry (DXA). Body composition was assessed between 8:00 and 12:00, by the same evaluator.

Anthropometric Measurements, Body Composition, and Dietary Intake Assessment

Anthropometric measurements, body composition, and dietary intake were assessed before (M0) and after intervention (M16). Anthropometry was composed of body weight and height measurements. Height was measured on a fixed stadiometer of the Sanny brand, with an accuracy of 0.1 cm and a length of 2.20 m. Body weight was measured using an electronic scale (Filizola PL 50; Filizola Ltda., São Paulo, Brazil), with a precision of 0.1 kg.

Whole and core fat were estimated using a DXA scanner (version 4.7, Lunar DPX-NT; General Electric Healthcare, Buckinghamshire, UK). The subjects were positioned in a supine position and remained immobile throughout the examination. Fat mass, fat-free mass (FFM), and core fatness (TF) were assessed and expressed in absolute values by the DEXA software. The TF was estimated in the abdominal region and was defined as 20% of the length from a circumference line at the pelvis to a circumference line at the neck. All measurements were performed at the University Laboratory in a temperature-controlled room. Each morning, before the beginning of the measurements, the equipment was calibrated by the same researcher, according to the manufacturer's instructions.

Twenty-four-hour dietary recalls were conducted on 3 nonconsecutive days (1 weekend and 2 weekdays). The participants were oriented by a nutritionist as to how to complete the food records. Data were analyzed by the same nutritionist using the software NutWin (version 1.5; Programa de Apoio à Nutrição, Universidade Federal de São Paulo, Brazil, 2002).

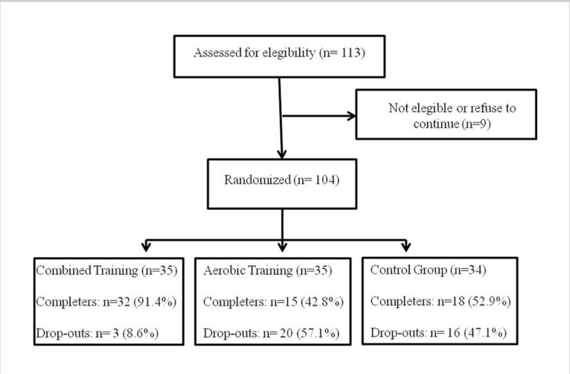

Figure 1. Trial profile of the 16 weeks of the study.

Blood Samples

After an overnight fast (12 hours), venous blood samples were collected to measure total fasting cholesterol (Chol), high-density lipoprotein cholesterol (HDL-c), and low-density lipoprotein cholesterol (LDL-c) using the colorimetric technique and dry chemicals, with equipment of the Johnson and Johnson brand (model Vitros 250). The Friedewald et al. (11) formula was used to calculate LDL-chol concentration. The atherogenic index was calculated by dividing the total cholesterol by the high-density lipoprotein (Chol/HDL-chol). The blood samples were taken at the baseline and after the program.

Aerobic Training Procedures

The determination of the intensity of the aerobic training was performed using the critical velocity protocol (16). The aerobic training group traveled 3 distances (400, 800, and 1,200 m) on a running track on separate, nonconsecutive, days. The participants were instructed to cover the distance in the shortest possible time, which was recorded using a digital stopwatch (model S810i; Polar Electro, Kempele, Finland). A linear regression was obtained from the relation between distance (in meters) and time (in seconds). The critical velocity was assumed by the angular coefficient of linear regression straight line between the distances and the respective times obtained in each repetition (16). Before the beginning of the training, the participants performed 2 weeks of familiarization. The training volume was equivalent to 52 $\text{min}\cdot\text{d}^{-1}$ at 100% of critical velocity. After 4 weeks, the procedures of critical velocity were repeated to determine and adjust the intensities of training. Participants were instructed to drink water and wear appropriate shoes and clothing during training. The RPE was determined at the end of each session (4).

Combined Training Procedures

Aerobic and strength training were performed for 57 minutes per day, with 27 minutes of strength training and 30 minutes of aerobic training, including 10 minutes of warm-up and stretching at the end of the training session. The exercises used in the program were 45° leg press, leg extension, leg curl, bench press, seated row, arm curl, triceps extension, side elevation with dumbbells, and abdominal exercises. The strength training program consisted of 4 progressive

TABLE 1. General characteristics of the sample at baseline and differences within intervention.*†

	CG ($n = 18$)		AT ($n = 15$)		CT ($n = 37$)		p between-group baseline
Variables	Pre	Post	Pre	Post	Pre	Post	p
Weight (kg)	65.4 ± 13.8	64.7 ± 14.2	66.8 ± 10.9	66.3 ± 11.0	64.6 ± 10.6	64.3 ± 10.7	0.829
BMI ($kg \cdot m^{-2}$)	30.5 ± 4.3	30.0 ± 4.3	28.4 ± 2.9	28.1 ± 2.9	28.3 ± 2.7	28.3 ± 2.8	0.219
FM (kg)	28.9 ± 9.2	28.6 ± 9.7	31.8 ± 11.3	28.6 ± 7.1‡	27.9 ± 7.2	26.6 ± 7.2‡	0.348
FM (%)	43.3 ± 6.6	43.2 ± 6.6	43.9 ± 5.5	42.7 ± 5.4‡	42.5 ± 5.0	40.9 ± 5.4‡	0.707
TF (kg)	15.2 ± 4.6	14.9 ± 4.9	15.7 ± 3.6	14.9 ± 3.5‡	14.8 ± 3.7	14.1 ± 3.8‡	0.761
TF (%)	46.0 ± 6.4	46.0 ± 6.5	46.8 ± 6.1	45.7 ± 5.4‡	46.4 ± 5.5	44.3 ± 5.8‡	0.930
FFM (kg)	34.3 ± 6.0	33.9 ± 5.5	34.7 ± 5.0	35.3 ± 5.1‡	34.4 ± 4.4	35.3 ± 4.7‡	0.968
Chol	195.8 ± 34.0	201.3 ± 34.9	202.5 ± 36.6	200.0 ± 37.2	203.6 ± 30.4	209.8 ± 34.8	0.714
LDL-c	117.4 ± 26.7	123.3 ± 24.7	124.5 ± 34.7	114.7 ± 29.9	122.5 ± 25.3	129.7 ± 27.6	0.745
HDL-c	49.1 ± 7.7	50.0 ± 8.4	57.9 ± 12.9	60.9 ± 13.0	51.9 ± 10.7	54.8 ± 12.0‡	0.063
Chol/HDL	4.0 ± 0.74	4.0 ± 0.7	3.6 ± 0.90	3.4 ± 0.8‡	4.0 ± 8.7	4.0 ± 0.9	0.257
Dietary ($kcal \cdot d^{-1}$)	1,615.3 ± 345.9	1,631.1 ± 220.5	1,427.6 ± 390.3	1,492.2 ± 364.7	1,641.9 ± 398.7	1,550.2 ± 431.2	0.227

*BMI = body mass index; CG = control group; AT = aerobic training; CT = combined training; TF = trunk fatness; FM = fat mass; FFM = fat-free mass; Chol ($mg \cdot dl^{-1}$) = total cholesterol; LDL-c ($mg \cdot dl^{-1}$) = low-density lipoprotein cholesterol; HDL-c ($mg \cdot dl^{-1}$) = high-density lipoprotein cholesterol; Chol/HDL ($mg \cdot dl^{-1}$) = atherogenic index; SD = standard deviation; Dietary = $kcal \cdot dl^{-1}$.

†Values are presented as mean ± *SD*.

‡Difference within groups (pre-post) with $p \leq 0.05$.

Table 2. Median, interquartile range, and 25th and 75th percentile of the load training week.*†

	AT ($n = 15$)	CT ($n = 37$)	p
Week 1–2	780.0 (52) (728.0; 780.0)	798.0 (60) (741.0; 801.0)	0.132
Week 3–4	780.0 (13) (767.0; 780.0)	798.0 (101) (741.0; 841.5)	0.156
Week 5–6	780.0 (0) (780.0; 780.0)	798.0 (101) (741.0; 841.5)	0.758
Week 7–8	780.0 (52) (728.0; 780.0)	798.0 (114) (741.0; 855.0)	0.361
Week 9–10	754.0 (52) (728.0; 780.0)	798.0 (114) (741.0; 855.0)	0.113
Week 11–12	780.0 (0) (780.0; 780.0)	795.0 (96) (741.0; 826.5)	0.572
Week 13–14	780.0 (0) (780.0; 780.0)	798.0 (101) (741.0; 841.5)	0.288
Week 15–16	780.0 (13) (767.0; 780.0)	798.0 (114) (741.0; 855.00)	0.684
Mean	776.8 (9.2)	797.6 (1.1)	0.317

*AT = aerobic training; CT = combined training.
†$p \le 0.05$.

phases (phase 1 [first to fourth week, 15 repetitions or ∼65% of maximum, 3 sets per exercise, 60–90 seconds between sets]; phase 2 [fifth to eighth week, 12 repetitions or ∼70% of maximum, 3 sets per exercise, 60–90 seconds between sets]; phase 3 [ninth to 12th week, 10 repetitions or ∼75% of maximum, 3–4 sets per exercise, 60–90 seconds between sets], and phase 4 [13th to 16th week, 8 repetitions or ∼80% of maximum, 3–4 sets per exercise, 60–90 seconds between sets]).

The intensity of the strength training was controlled through the zone of maximum repetitions (MR). The series were executed until momentary exhaustion, meaning that when the participants performed the training with repetitions varying from 12 to 15 MR, they were always encouraged to execute at least 12 and no more than 15 repetitions (33). In the case of the participants executing more than 15 repetitions, the load was increased to respect the training zone (33). The test of 1 MR was performed only for the *leg press* and *bench press*. The 1 MR test consisted of a warm-up, followed by the performance of 1 series of 10 repetitions of each exercise without overload. The load was increased gradually during the test until the participants were no longer able to perform the entire movement, and 3 attempts were considered to meet the corresponding 1 MR load (34). For recovery, an interval of 3–5 minutes between attempts was given (34).

The intensity of the aerobic stimuli was determined by the critical velocity, similar to the model used in the AT. The volume of aerobic exercise for AT was 30 $\text{min}\cdot\text{d}^{-1}$. Rating of perceived exertion was determined at the end of each session (4).

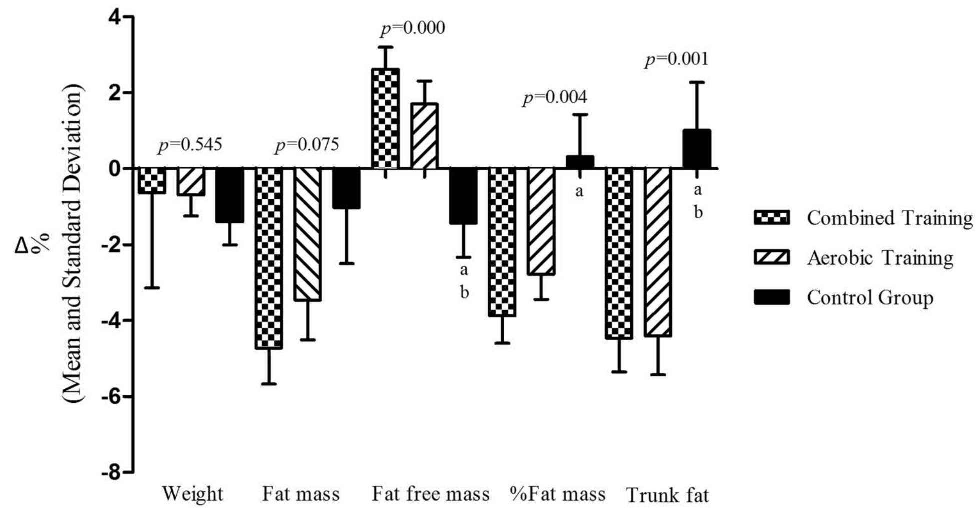

Figure 2. Relative variation after the 16 weeks of intervention. ^{a}Tukey's post hoc test with p value ≤0.05 compared with combined training; ^{b}Tukey's post hoc test with p value ≤0.05 compared with aerobic training.

Table 3. Characteristics of subjects before and after the exercise program on the lipid profile.*

	CG ($n = 18$)			AT ($n = 15$)			CT ($n = 37$)		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Chol ($mg\cdot dl^{-1}$)	195.8 ± 34.0	201.3 ± 34.9	5.5 ± 33.7 (−11.9; 22.8)	202.5 ± 36.6	200.0 ± 37.2	−2.5 ± 17.8 (−12.3; 7.4)	203.6 ± 30.4	209.8 ± 34.8	6.24 ± 30.8 (−4.0; 16.5)
HDL-c ($mg\cdot dl^{-1}$)	49.1 ± 7.7	50.0 ± 8.4	0.9 ± 5.8 (−2.0; 3.9)	57.9 ± 12.9	60.9 ± 13.0	3.0 ± 6.8 (−0.8; 6.8)	51.9 ± 10.7	54.8 ± 12.0†	2.9 ± 6.7 (0.6; 5.0)
LDL-c ($mg\cdot dl^{-1}$)	117.4 ± 26.7	123.3 ± 24.7	5.9 ± 24.8 (−6.8; 18.7)	124.5 ± 34.7	114.7 ± 29.9	−9.9 ± 19.8 (−20.8; 1.1)	122.5 ± 25.3	129.7 ± 27.6	7.1 ± 27.5 (−2.0; 16.3)
Chol/HDL	4.0 ± 0.7	4.0 ± 0.7	0.03 ± 0.6 (−0.28; 0.35)	3.6 ± 0.9	3.4 ± 0.8†	−0.24 ± 0.4 (−0.48; −0.0)	4.0 ± 0.9	4.0 ± 0.9	−0.07 ± 0.7 (−0.30; 0.15)

*CG = control group; AT = aerobic training; CT = combined training; Chol = total cholesterol; LDL-c = low-density lipoprotein cholesterol; HDL-c = high-density lipoprotein cholesterol; Chol/HDL = atherogenic index.

†Difference within groups (pre-post) with $p \leq 0.05$.

Session Rating of Perceived Exertion

A previous pilot study was performed to equalize the load of the training groups, which involved a session of combined exercise and another session of aerobic training. The time of sessions was modified to induce similar values of RPE between groups of different training methods. The pilot study indicated the necessity of 27 minutes of strength exercises and 30 minutes of aerobic exercise for the combined training group and 52 minutes of continuous exercise for aerobic group. The session RPE for each session was calculated by multiplying the duration of the session and the RPE expressed in arbitrary units (a.u.) (i.e., session RPE [a.u.] = duration [in minutes] × RPE [a.u.]), as proposed by Foster et al. (10). This model was chosen because it allows the assessment of internal training load in both continuous efforts (i.e., aerobic stimuli) and intense efforts of short duration (i.e., strength training) (8,10). The RPE was determined at the end of the aerobic and strength training. Thus, the session RPE for the CT was taken as the sum of the values observed for the strength training and the aerobic training (session RPE [a.u.] = [27 × RPE of strength^{-1}] + [30 × RPE of aerobic^{-1}]). The session RPE of the AT was equivalent to the product of the duration of the session (i.e., 52 minutes) and the final RPE. The weekly training load was assumed as the sum of session RPE observed in the 3 sessions.

Statistical Analyses

The Levene's test was used to analyze the data set homogeneity. Initially, to identify similarity of groups at baseline, the Analysis of covariance (ANCOVAs) were used. In the longitudinal analysis, dependent variables were treated as "mean differences" (postexercise value minus baseline value) and the one-way Analysis of variance (ANOVA) was used once more to compare the mean differences between the CG, AT, and CT groups. When a significant difference in group or interaction was observed, a Tukey's post hoc test was conducted. Pearson's rank correlation (rho) analyzed the relationship between the mean differences of TF, FM, and FFM and dietary intake. To compare the load between 2 training groups between the 2 training models, the Mann-Whitney test was used. All analyses were performed using the BioEstat (version 5.0) statistical software. The level of significance was set at 5%.

RESULTS

Table 1 presents the mean values of body weight, body composition, lipid profile, and dietary intake in the preintervention and postintervention period in the 3 groups studied. It can be seen that there were no statistical differences at the start of the study for any of the variables investigated. In relation to the age, there were no statistical differences between groups (CG = 62.6 ± 5.9, AT = 60.5 ± 7.3, and CT = 60.3 ± 6.1; $p = 0.447$).

The weekly TRIMP behavior between the 2 intervention groups was not significantly different over the 16 weeks

(Table 2). In addition, the mean TRIMP during the training period also presented no significant differences (Table 2).

Figure 2 presents the changes in the percentage values of the body composition variables after 16 weeks of training in the CT, AT, and CG groups, as well as the differences between them. It can be observed that both the AT and the CT groups presented statistically significant differences compared with the CG for reduction in trunk fat and increased lean body mass; however, only the CT group presented a statistically significant reduction in body fat percentage. There was no statistical difference between the intervention groups for any of the variables analyzed.

Table 3 presents the comparisons between the groups, before and after intervention, and the absolute changes in the lipid profile in the comparisons between the CT, AT, and CG groups after 16 weeks of training.

Statistically significant differences were only observed in the HDL-c for the CT group ($p = 0.013$) and the atherogenic index for the AT group ($p = 0.047$). Regarding the LDL-c, the largest reductions were in the AT ($p = 0.074$) group but with no statistically significant difference. When comparing the alterations between the groups, there were no significant differences in either the Chol ($p = 0.714$), LDL-c ($p = 0.745$), HDL-c ($p = 0.063$), or Chol/HDL-c ($p = 0.456$) after the training protocols.

Regarding dietary intake (expressed in kilocalories), after 16 weeks of training, no differences were observed between groups (Table 1). The mean differences in the TF (CG: rho $= -0.08$; $p = 0.761$, AT: rho $= -0.55$; $p = 0.05$, and CT: rho $= 0.009$; $p = 0.960$), FM (CG: rho $= -0.05$; $p = 0.830$, AT: rho $= 0.25$; $p = 0.396$, and CT: rho $= 0.08$; $p = 0.624$), and FFM (CG: rho $= 0.07$; $p = 0.775$, AT: rho $= -0.04$; $p = 0.885$, and CT: rho $= -0.27$; $p = 0.102$) were not significantly related to the mean differences in dietary intake (i.e., 16-week value minus baseline value).

DISCUSSION

The results of this study demonstrated changes in body composition after 16 weeks of aerobic training and combined training (aerobic plus strength), and both training programs induced an "antiatherogenic" profile. However, our data showed that combined training was more efficient in reducing body fat and increasing FFM. To our knowledge, this is the first study that has evaluated different training protocols applied at similar loads.

Aerobic training improves the maximal oxygen uptake and oxidative capacity and increases the activity of aerobic enzymes, intramuscular glycogen, mitochondrial, and capillary densities in the muscles but without leading to significant improvement in FFM (6). Strength training is effective in increasing FFM and, in turn, muscle strength (17). The biological mechanisms related to the effects of strength training are supported by the recruitment of satellite cells, improvement in motor unit activations, and increased high-energy phosphate availability (17). Responses to acute exercise suggest that higher-intensity exercise may be more effective than low-to-moderate-intensity exercise for inducing the secretion of lipolytic hormones, facilitating greater excess postexercise oxygen consumption and fat oxidation (26).

Corroborating the findings of this study, Sillanpaa et al. (32) compared the effects of aerobic and strength training, both alone and in combination, for 21 weeks, examining variables of body composition in women aged 39–64 years. The authors observed significant reductions in total and percentage body fat in both groups, accompanied by an increase in FFM in the strength and combined groups, but no statistical difference between the kinds of training. Thus, the results of this study demonstrate that these findings can be observed when these training modalities were applied at similar loads, decreasing the possible effects of different total work done by experimental groups.

Regarding the lipid profile, there were no changes in the HDL-c for the CT group or the atherogenic index for the AT group. When comparing both the training models, there were no statistically significant differences between the groups for any of the variables investigated. A reduction in HDL-c and increase in LDL-c increases the risk of developing cardiovascular diseases because the fractions of LDL cholesterol are more susceptible to oxidation and greater accumulation in the arterial wall (18) and the HDL-c fractions perform reverse cholesterol transport (29). Acute and chronic exercise increases the activity of lecithin-cholesterol acyltransferase (L-CAT), the enzyme responsible for transferring cholesterol ester to the HDL, which reduces the activity of the plasmatic cholesterol ester transfer protein (CETP), the enzyme responsible for transferring the ester of HDL to other lipoproteins (29). It is possible that decreased concentrations of LDL-c in the plasma might be attained through the exchange of cholesterol esters from tissues and lipoproteins to the HDL-c (29).

Seo et al. (30) verified the effects of 12 weeks of combined training on components of the metabolic syndrome in obese women with a mean age of 40 years and observed increases twice as large as those observed in this study in the concentrations of HDL-chol ($6.4\ \text{mg}\cdot\text{dl}^{-1}$). However, it should be noted that the average age differed from that of our study and the postmenopausal period in this study may have influenced these alterations. In a study by Ghahramanloo et al. (14), which verified the effects of concurrent training on the lipid profile and anthropometric variables of young healthy men, it was found that this type of training was more effective than aerobic or strength training in isolation in improving the lipid profile and body composition in this population. However, the same authors added that the adaptations induced by physical training on the lipid profile of women are more resistant to change when compared with men and that changes in HDL-c appear to be more influenced by the intensity of exercise than on the total training volume.

In the absence of a gold standard method for equalization of training loads in different modalities of exercise

(1,2,7,8,28), session RPE can be used mainly because of its validity for monitoring exercise at various ages (1,8–10,15). Moreover, this method presents significant correlations with HR, blood lactate concentrations, and cortisol levels at continuous efforts (2,8–10,13,15,31). Although no study was found using RPE session for equalizing load, this parameter represents the global feeling of exertion experienced during training session, allowing the monitoring of high-intensity exercises, like resistance training in older women (7,8). Thus, we believe that the RPE session is the best method for determining internal training load during continuous or high-intensity efforts, allowing the comparisons between aerobic (continuous and submaximal) and combined training, which included resistance efforts (high-intensity and discontinuous exercise).

This analysis can help to explain the results observed and in choosing the best training method to be applied. In this sense, the training load monitoring distinguishes whether the adaptations observed are really related to different exercise modalities (e.g., aerobic or strength + aerobic) or just by differences in total work done in the experimental groups. Moreover, the determination of training load just by the volume (i.e., time or frequency of session) may interfere with the calculation of real physiological stress, mainly in high-intensity sessions or during resistance exercises (8). Thus, this study demonstrates that when applied with a similar training load, the combined training can be used when changes in body composition are necessary and both training modalities (aerobic and combined) demonstrate similar results to the lipid profile.

Although this study was the first to compare the effects of combined aerobic and strength training with aerobic training in isolation on the variables of body composition and lipid profile, using a model of similar training loads, we suggest further studies that aim to compare the effects of these exercise protocols on other variables such as hemodynamics and functionality. In addition, there was a higher dropout in the aerobic training group that can be, at least in part, related to the monotonous characteristic of the training and the intensity of the anaerobic threshold.

Thus, we can conclude that when training loads are equivalent, both aerobic training and combined training (strength + aerobic) were effective in reducing upper body fat and increasing lean body mass, although only the combined training enhanced the reduction in the body fat percentage in obese postmenopausal women. With regard to the lipid profile, there was an increase in HDL-c in the combined group and a reduction in the atherogenic index in the aerobic group but without significant differences between the 2 training models.

PRACTICAL APPLICATIONS

Simultaneously performing strength and endurance training in the same workout potentiates a reduction in body fat but demonstrates no difference to aerobic training on the lipid profile after equalizing training load in obese postmenopausal women. Although studies have been conducted to find the most effective model of training in different populations, these studies made comparisons by standardizing only the total time of the training session, not performing appropriate load adjustments, and thus were unable to discern whether the changes in body composition were caused by the training stimulus or whether they were the consequence of the total quantity of work performed. In this regard, so that the actual adaptations to the training models can be better investigated, it is essential that the training load is the same for the experimental groups, thereby avoiding possible false-positive influences.

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