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Original Research

Effect of Different Training Programs at Self-Selected Intensity on Body Composition, Perceptual Responses and Fitness Outcomes in Obese Women

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ABSTRACT

International Journal of Exercise Science 15(4): 373-385, 2022. Obesity induces several disorders, such as android obesity, insulin resistance, and coronary/peripheral artery disease, and obese individuals commonly have low adherence to training programs. Exercise at self-selected intensity is a feasible strategy to avoid dropouts of training routines. We aimed to assess the effects of different training programs at self-selected intensity on body composition, ratings of perceived exertion (RPE), feelings of pleasure and displeasure (FPD) and fitness outcomes (maximum oxygen uptake (VO2max) and maximum dynamic strength (1RM)) in obese women. Forty obese women (n = 40; Body Mass Index: 33.2 ± 1.1 kg.m^{-2}) were randomly allocated to combined training (CT = 10), aerobic training (AT = 10), resistance training (RT = 10) and control group (CG = 10). The frequency that CT, AT and RT performed the training sessions was 3 times per week during 8 weeks. Body composition (DXA), VO2max and 1RM were assessed at baseline and after intervention. All participants were on a restricted dietary intake aiming to ingest 2.650 kcal per day. Post hoc comparisons revealed that CT promotes a larger decrease in body fat percentage (p = 0.001), body fat mass (p = 0.004) than other groups. CT and AT elicited higher VO2max increases (p = 0.014) than RT and CG, and 1RM values were higher in CT and RT (p = 0.001) than AT and CG at post-intervention. All training groups presented low RPE and high FPD over the training sessions, but only the CT was effective to reduce body fat percentage and body fat mass in obese women. In addition, CT was effective to increase simultaneously maximum oxygen uptake and maximum dynamic strength in obese women.

KEY WORDS: Obesity; rating of perceived exertion; combined training; resistance training; maximum oxygen uptake

INTRODUCTION

Exercise is a promising strategy against obesity due to its positive impact on anthropometric, metabolic and cardiovascular fitness parameters (1, 36, 39). The inclusion of aerobic and resistance exercises in a single session, known as combined training, has also shown positive results in obese subjects (7). The evidence for this training type indicates improvements on health outcomes (7). Despite these positive results, obese subjects present high dropout rates in different physical exercise programs (26). Previous studies have aimed to explain this phenomenon, with one potential reason being the reduced self-efficacy and the lower motivational state observed in this population (19). However, the main reason might be linked to the negative experience during physical exercise, which is directly related to the intensity recommended by exercise guidelines (14, 21). According to the ACSM (28), beginners must practice aerobic exercise between 60-85% $\dot{V}O_{2max}$ and resistance training between 60%-70% 1RM. Although these intensities provide health-related benefits, they also promote higher ratings of perceived exertion (RPE), a subjective scale developed to indicate intensity of effort during exercise, which contributes to decreased feelings of pleasure (30). Feelings of displeasure, associated with lower motivational levels and reduced self-efficacy, might contribute to the lower adherence and higher dropout rates from training programs (13).

Exercising at a self-selected intensity, which takes into account individual preferences when prescribing exercise, may be a valid method when trying to avoid low adherence to exercise (26, 30). Dishman (16) showed that lower RPE and higher feelings of pleasure during exercise at self-selected intensity decreases dropout rates in comparison to exercise prescribed at higher intensities. In fact, the feeling of pleasure experienced when exercising might influence the adherence to exercise programs (18, 19). Thus, this method is considered an important strategy to create a positive motivational state in obese subjects during exercise (26, 34). However, previous studies have investigated treadmill walking/running for 20 to 30 minutes at self-selected intensity and identified that the chosen workload was ~38% $\dot{V}O_{2max}$, below what is proposed for health benefits (9, 17). Likewise, similar findings from resistance training corresponding to loads of 40% 1RM for 3 sets of 10 repetitions was found (2, 20), which was not consistent with the recommended guidelines (22). One would assume that these intensities would not be enough to promote significant exercise-induced adaptations. On the other hand, due to the extremely low physical fitness, obese people could be more sensitive to lower intensities than those recommended by general public health guidelines. Thus, our hypothesis was that exercising at a self-selected intensity using various modalities would promote favorable changes to body composition, while maintaining low levels of perceived exertion and inducing pleasure while exercising. Additionally, we believe that these changes will be more prominent in the first two months due low physical fitness (obesity), a period in which there is also the highest dropout rate.

According to current theory, this period is crucial to verify the perceptual and affective responses. Thus, observation of favorable changes in body composition in addition to low RPE and high feelings of pleasure could significantly increase adherence to training programs. Another hypothesis is that the combined training at self-selected intensity may indirectly promote a high-energy expenditure due to increased training duration. This fact is still unknown, which made us propose different volumes of training considering the routines commonly applied to this population, increasing the external validity of the study. Understanding the impact of different training programs on body composition, RPE and feelings of pleasure and displeasure (FPD) is essential for effectively prescribing exercise for both health, fitness and exercise adherence in obese subjects. Thus, our purpose was to compare the effect of different training programs at self-selected intensity on body composition, RPE and FPD responses in obese women.

METHODS

Participants
Forty obese women (Body Mass Index (BMI): 33.2 ± 1.1 kg.m^{-2}) took part in this study and were randomly allocated into one of four groups: combined training (CT = 10); aerobic training (AT = 10), resistance training (RT = 10) and control group (CG = 10) (Table 1). Participants were recruited from the Weight Watchers Assistencial Group, a multidisciplinary group that aids obese subjects, and were following a restricted caloric diet prescribed by this organization. Participants' daily food intake was based on a diet for class I obesity, totalizing 2650 kcal per day. Daily foods were selected by the participant using a method by points (one point equals 3.6 kcal) provided by the Weight Watchers Assistencial Group. During each week there was a meeting (Thursday) with all participants at the Watchers Assistencial Group, in which they reported what they had ingested. The following inclusion criteria were adopted: (a) pre-menopausal state; (b) negative responses to all items of the Physical Activity Readiness Questionnaire (PAR-Q); (c) no tobacco usage; and (d) class I obesity (BMI 30 kg.m^{-2} to 34 kg.m^{-2}). Exclusion criteria were: (a) joint, neurological, cardiovascular or respiratory limitations that could influence training routine; (b) use of pharmacological drugs or hormonal replacement; (c) self-reported change in habits related to exercise in the six months preceding the study; (d) medical contraindication for high-intensity exercise in the 12 months preceding the study; (e) previous diagnosis of polycystic ovary; and (f) pregnancy. Sample size calculation was conducted with G* Power 3.1 software using parameters for the *F* family test (ANOVA) and was based on a power level of .8, an alpha criterion of .05, and an effect size of .28 (6, 37). A priori power analysis indicated a sample size of 10 participants for each group. All participation was voluntary, and each participant completed an informed consent form prior to the investigation. Importantly, no dropouts were observed during the entire intervention in the different groups. The present study was approved by the local Ethics Committee (CAAE: 39396914.8.0000.0102) and were in accordance with Declaration of Helsinki. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (27).

Protocol
The present research was a randomized controlled trial with within- and between-groups repeated measures. Initially, participants had an anthropometric assessment and their body composition assessed by STRATOS dual X-ray absorptiometry (DXA - Lunar, DPX model - Lunar Radiation Corporation, Madison, Wisconsin, USA). Participants went to a familiarization session with the protocol that would be performed during the intervention. All the experimental groups completed 8 training weeks, while the CG did not perform any kind of exercise during the same period. After the intervention period, participants repeated the same procedures of the pre-intervention, except for the familiarization session. During the familiarization session, each participant performed 10 reps with a low load for the bench press, leg extension, front lat

pulldown, barbell curl and leg curl for the resistance exercise training. During this session participants were also informed on how to rate their perceived exertion (OMNI-RES scale) and their FPD. Finally, all participants were instructed to perform the 1RM, VO2max and DXA tests in a fed state for pre and post intervention periods.

Body Composition: The anthropometric assessment consisted of calculating BMI for each subject using their height and body mass. The body mass measurement was performed on a scale (Toledo®, model 2096, São Paulo, Brazil) with an accuracy of 0.1 kg. Height, in centimeters, was measure in a stadiometer (Sanny® - Standard, São Bernardo do Campo, Brazil), fixed to the wall staggered at .1 cm, BMI was calculated by the ratio of body mass and height squared (BMI = $kg.m^{-2}$). DXA was used to assess total body composition. The participants were all placed with hands in a pronated flat position within the scan range, and the leg position was standardized and secured with straps to reduce bone overlap in lower limbs. The participants removed metal objects or jewelry from their body and wore the same minimal clothing (underwear) for each scan. The doses of radiation emitted during the examination varied between 1 and 3 mRem, posing no health risks (4). The test–retest reliability for the DXA unit for determining percent body fat is CV of 25.9% (20.1–37.1) with an ICC of 0.54 (0.22–0.76) for DXA.

Maximal Incremental Test: All participants went through a graded treadmill (Master Super ATL, Inbramed, Brazil) exercise test to volitional fatigue to determine $\dot{V}O_2max$ and $\dot{V}O_{2peak}$ according to the Bruce protocol (8). Expired air was collected and analyzed by a portable system (K4b2, COSMED, Rome, Italy) to determine the rates of $\dot{V}O_2$ and associated cardiorespiratory and metabolic variables. $\dot{V}O_2max$ was defined as the highest oxygen uptake value in the last 30 seconds of the test and $\dot{V}O_{2peak}$ the highest value was considered at the end of the test (14).

Maximum Dynamic Strength (1RM): 1RM testing began with a specific joint warm-up composed of 3 sets of 10 repetitions, with low-loads. 1RM testing was conducted only for the bench press and leg extension exercises. These exercises were chosen to quantify the 1RM because they are multi- and single-joint exercises, respectively. Since the subjects are untrained, these exercises allow a more precise determination on the biomechanical aspects related to exercise technique. In addition, they make it possible to perform a safe test where the researcher can also offer better technical support in the eventual task failure. Participants were instructed to lift the weight only one time. After the movement was completed, the load was increased, and another attempt was made after 3-5 minutes of rest interval. The last load used with the appropriate exercise technique was recorded as the 1RM value. After 48 hours, the loads were retested in order to obtain reliability, the greatest load between tests was used for analysis (5). The 1RM demonstrated reproducibility according to the ICC values (CI 95%), which were bench press ~ 0.98 and leg press ~0.97.

Self-selected loads: Aerobic training load was characterized as the velocity each participant choose to walk or run at a comfortable pace on a treadmill for 30 min. Instructions to the participant regarding intensity preference were adapted from Dishman (15), and read as follows: ‘‘select a walking or running intensity that you prefer. This should be an intensity that you would choose for a 30 min workout if you were attempting to get a good workout. The intensity should be high enough so that you would get a good workout, but not so high that exercising daily or every other day would be objectionable. It should be an intensity that feels appropriate to you.'' Regarding the resistance training sessions, participants had up to 3 attempts in order to select the appropriate load for the completion of 3 sets of 10 repetitions. Instructions to the participant regarding the preferred load were in accordance with Ratamess et al. (32), and read as follows: ''How much weight would you select for this exercise if you were completing 3 sets of 10 reps in your workout?''.

Perceptual responses: Rating of perceived exertion (RPE) was assessed with the OMNI-RES scale for the RT, and the OMNI-Walk/run scale for the AT. The procedures for the assessment of the RPE scales followed the instructions of Robertson & Noble (33). RPE was recorded at five-minute intervals on the treadmill and after each set during the resistance training exercises. The researcher asked, ''how much exertion are you feeling right now?''.

Affective valence (feelings of pleasure and displeasure) to exercise was measured using the feeling scale (FS) developed by Hardy & Rejeski (23). The FS is an 11-point single-item bipolar scale ranging from – 5 ("very bad") to + 5 ("very good"), with verbal descriptors, positioned at all odd integers and the zero point ("neutral"). Positive numbers represent pleasant sensations (i.e., positive affect), and negative numbers represent unpleasant sensations (i.e., negative affect). FPD were recorded at five-minute intervals on the treadmill and after each set during the resistance training exercises. The researcher asked: "how are you feeling right now?".

Training Sessions: Each experimental group (AT, RT and CT) performed 24 training sessions (8 weeks), 3 times per week (Monday, Wednesday and Friday). This intervention period was determined due to the participants' physical status (obesity), in which more prominent alterations occur in the first two months. In addition, according to the literature, this period is crucial to verify the perceptual and affective responses, as this is where the highest dropout rate occurs (12, 29, 35, 38). The AT performed 35 minutes of walking or running comprised of a 5 minute warm-up at a low speed (~1 $m.s^{-1}$), followed by 30 minutes at a self-selected intensity. The RT session comprised of a 5 minute general warm-up (treadmill walking at ~1 $m.s^{-1}$) followed by a specific warm-up of 2 sets with a low load for each exercise (bench press, leg press, front lat pulldown, leg curl and barbell curl). Following the warm-up, participants performed 3 sets of 10 repetitions at a self-selected load with 1-minute rest interval between sets in the exercise order aforementioned. The participants were instructed to perform the movements at a constant tempo (2:2 seconds) for both concentric and eccentric phases. Total duration of the training session was ~45 minutes. The CT session began with a 20-minute walk/run on the treadmill plus five resistance exercises aforementioned, both at self-selected intensities, performing 3 sets of 10 repetitions with 1 minute of rest interval between sets and 2 minutes between exercises, totaling ~60 minutes of training. After four weeks of training, the training type order was reversed, beginning with the resistance exercises followed by treadmill walking or running. This procedure was adopted in order to minimize any effect of the execution order on the results. RPE and FPD were recorded at 5-minute intervals during walking/running on the treadmill and immediately during each rest interval between sets during the RT session. In the CT sessions, RPE and FPD were recorded following the same procedures adopted during the AT and the RT sessions. The participants were told that during each session the selected load could be maintained, increased or decreased according to their preference. In order to avoid any intra-individual circadian variations (10), the participants trained at the same time across the intervention period (between 7- and 12AM, and between 13- and 18PM). All training sessions were supervised by certified personal trainers.

Statistical Analysis

All statistics were performed on SPSS 20.0 (Chicago, IL). Significance was set at $p < 0.05$ for all analyses. Descriptive statistics were conducted for all measures. All results are reported as mean ± SD. The distribution of the data was tested with the Shapiro–Wilk test, and results indicated a normal distribution. An intraclass correlation (ICC) was employed to test the homogeneity between the participants. A repeated measures ANOVA was used to compare the means of the dependent variables (FPD and RPE) throughout the moments, followed by a Bonferroni multiple comparison test to identify the possible differences. The assumption of sphericity was checked with the Mauchly test, and if violated, Greenhouse-Geisser correction would be employed. A mixed-model repeated measures within and between group analysis (group 4 x 2 time) followed by Bonferroni multiple comparisons were conducted to check for differences between the groups regarding body composition (BMI, fat percentage, lean body mass, fat body mass), VO2max and 1RM. For the effect size the omega squared (ω^2) was adopted because the samples of the groups were the same, being the most adequate calculation for the statistical model used (family *F*). Squared omega (ω^2) is classified as 0.01 small – 0.06 medium – 0.14 large (24, 25).

RESULTS

Participants' characteristics are presented in Table 1. The one-way ANOVA did not show significant differences between-groups for variables [age ($F_{(3,39)}$= 1.45; p = 0.24), body mass ($F_{(3,39)}$= 0.04; p = 0.98), height ($F_{(3,39)}$= 0.002; p = 1.00), BMI ($F_{(3,39)}$ = 0.54; p = 0.65), body fat percentage ($F_{(3,39)}$ = 2.02; p = 0.12), lean body mass ($F_{(3,39)}$ = 3.04; p = 0.41) and body fat mass ($F_{(3,39)}$ = 0.33; p= 0.79)].

Table 1. Anthropometric characteristics of participants.

	CT	AT	RT	CG	*ICC*
Age (years)	31.2 ± 7.5	35.1 ± 2.1	32.1 ± 6.3	30.3 ± 8.5	0.96
Height (cm)	165.1 ± 7.6	160.2 ± 5.9	162.1 ± 3.8	160.1 ± 4.5	0.96
Body mass (kg)	87.1 ± 8.3	87.4 ± 5.8	88.0 ± 7.2	88.0 ± 3.4	0.97
BMI ($kg.m^{-2}$)	33.2 ± 1.1	33.4 ± 1.4	33.0 ± 2.1	32.0 ± 2.2	0.98
Fat percentage (%)	50.2 ± 3.2	49.7 ± 2.1	51.1 ± 3.4	48.8 ± 5.9	0.98
Lean mass (kg)	40.5 ± 6.1	41.2 ± 4.1	42.1 ± 4.6	43.9 ± 4.9	0.96
Fat mass (kg)	40.7 ± 9.8	41.3 ± 4.9	40.6 ± 7.2	41.2 ± 5.1	0.98

Data are presented as mean ± standard deviation. Abbreviations: AT = aerobic training; BMI = body mass index; CG = control group; CT = combined training; ICC = intraclass correlation coefficient; RT = resistance training.

Repeated measures ANOVA did not show a significant time x group interaction for BMI ($F_{(3,39)}$ = 0.33; p = 0.80) and lean body mass (kg) ($F_{(3,39)}$ = 3.24; p = 0.33), however, body fat percentage

($F_{(3,39)} = 9.18$; $p = 0.001$) and body fat mass ($F_{(3,39)} = 14.6$; $p = 0.001$) were significant. The statistics showed a decrease ($F_{(3,39)} = 26.4$; $p = 0.001$; $\omega^2 = 0.01$) between pre- and post-test (49.4 ± 2.5 > 48.3 ± 1.2) in body fat percentage for the CT. CT presented a significant decrease in body fat percentage (48.3 ± 1.2) in the post-intervention compared to the post-intervention for the AT, RT and CG. BMI ($F_{(3,39)} = 3.00$; $p = 0.92$; $\omega^2 = 0.004$) and lean body mass ($F_{(3,39)} = 2.07$; $p = 0.15$; $\omega^2 = 0.005$) were not significantly different for any condition. There was a significant decrease in body fat mass ($F_{(3,39)} = 9.18$; $p = 0.004$; $\omega^2 = 0.02$) in the CT between pre- and post-intervention and between groups at post-intervention.

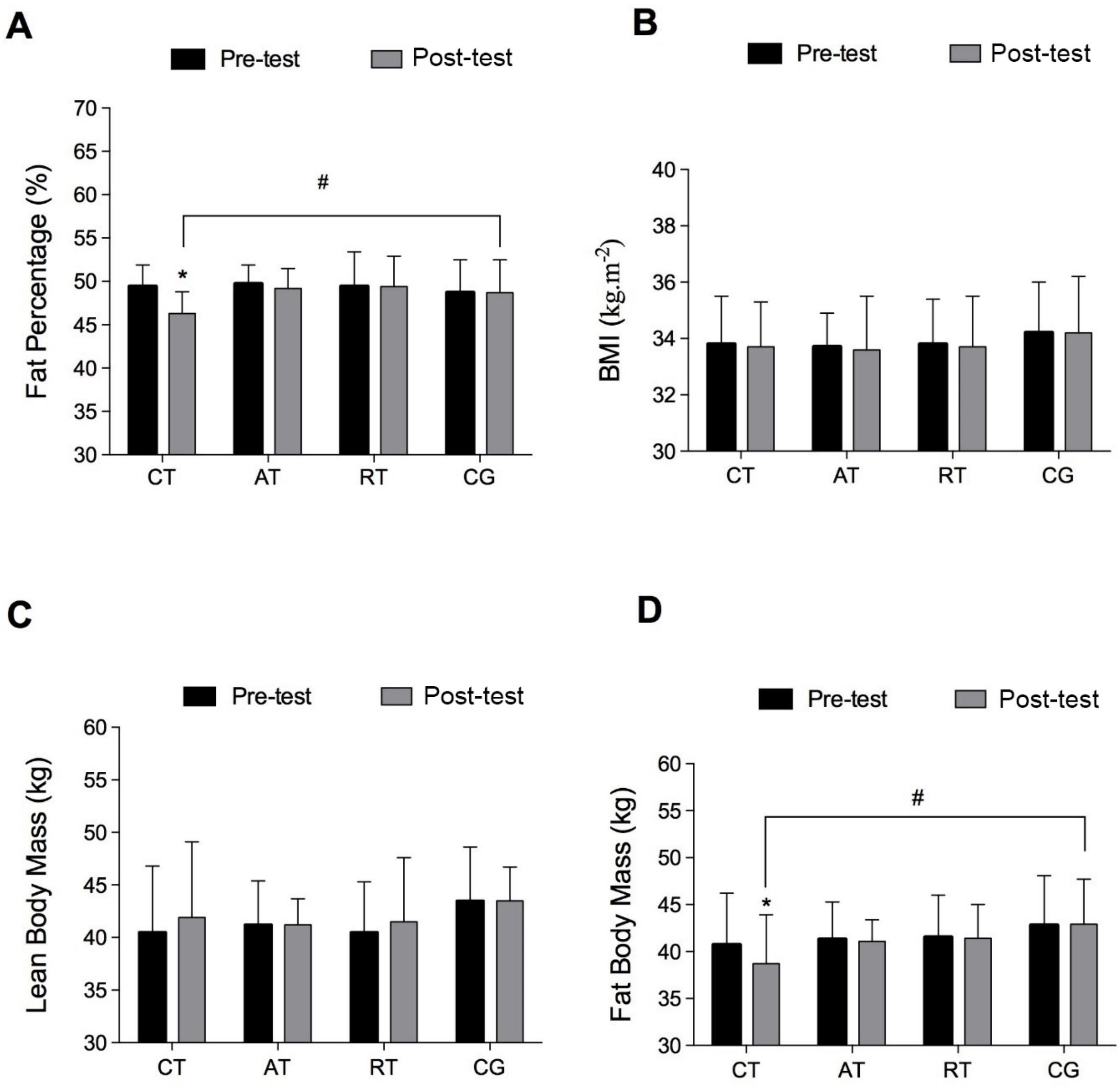

Figure 1. Fat percentage, body mass index, lean body mass and fat mass after 24 training sessions.
* Statistical difference $p < 0.05$ between pre- and post-test within groups. # Statistical difference $p < 0.05$ between pre- and post-test between groups. Abbreviations: BMI = body mass index; AT = aerobic training; CG = control group; CT = combined training; RT = resistance training.

Analysis did not show a significant time x group interaction for RPE ($F_{(2,29)} = 1.33$; $p = 0.30$) and FPD ($F_{(3,39)} = 0.97$; $p = 0.55$). The statistics showed a significant lower RPE ($p = 0.01$) and FPD ($p = 0.004$) in the AT compared to the RT only after the third week of training.

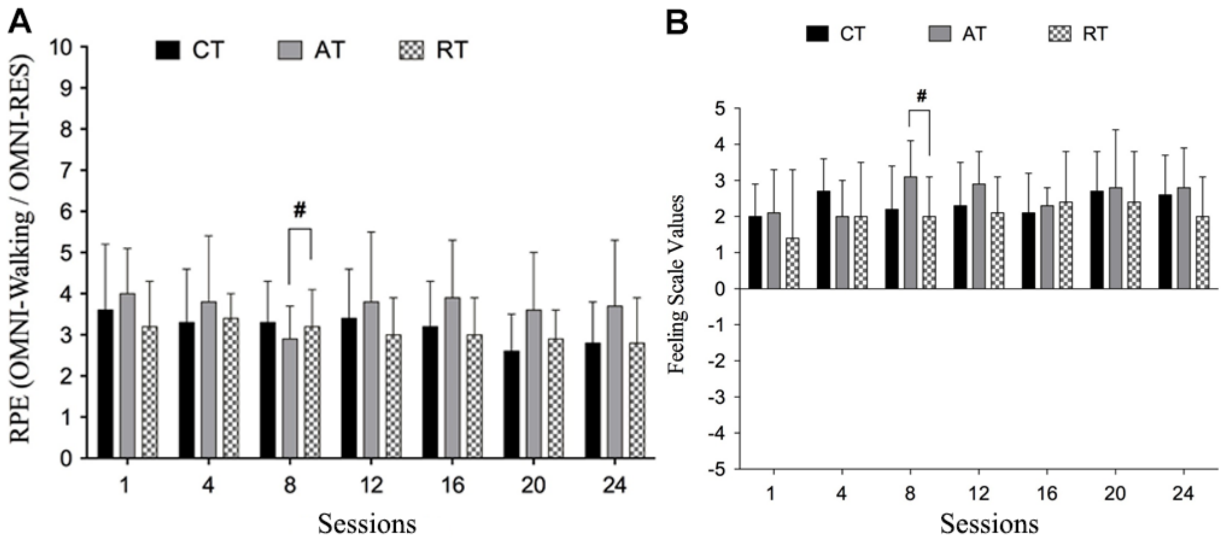

Figure 2. Ratings of perceived exertion (A) and feelings of pleasure and displeasure (B) within- and between-groups over 24 training sessions.
Statistical difference $p < 0.05$ between-groups. Abbreviations: AT = aerobic training; CT = combined training; RT = resistance training.

Analysis did not show a significant time x group interaction for VO_2max ($F_{(3,39)} = 2.97$; $p = 0.06$). ANOVA demonstrated a significant increase between the pre and post-test ($F_{(3,39)} = 757.8$; $p = 0.014$) for CT and AT. No significant difference was observed ($F_{(3,39)} = 7.54$; $p > 0.05$) between CT and AT, however, both demonstrated a significant increase in the post-test compared to RT and CG. The 1RM did not show significant interaction ($F_{(3,39)} = 2.54$; $p = 0.17$) for both upper- and lower-limbs between time x group factors. RM demonstrated a significant difference ($F_{(3,39)} = 24.6$; $p = 0 < 001$) between the pre- and post-test on upper and lower limbs for CT and RT. No significant difference between ($F_{(3,39)} = 7.54$; $p > 0.05$) CT and RT, however, both demonstrated a significant increase in the post-test in relation to AT and CG. In the CT for the bench press and the leg extension, the loads were self-selected at ~33% and ~35% of 1RM, respectively, and the walk remained below the ventilatory threshold (~45% of VO_{max}; ~47% of VO_{peak}).

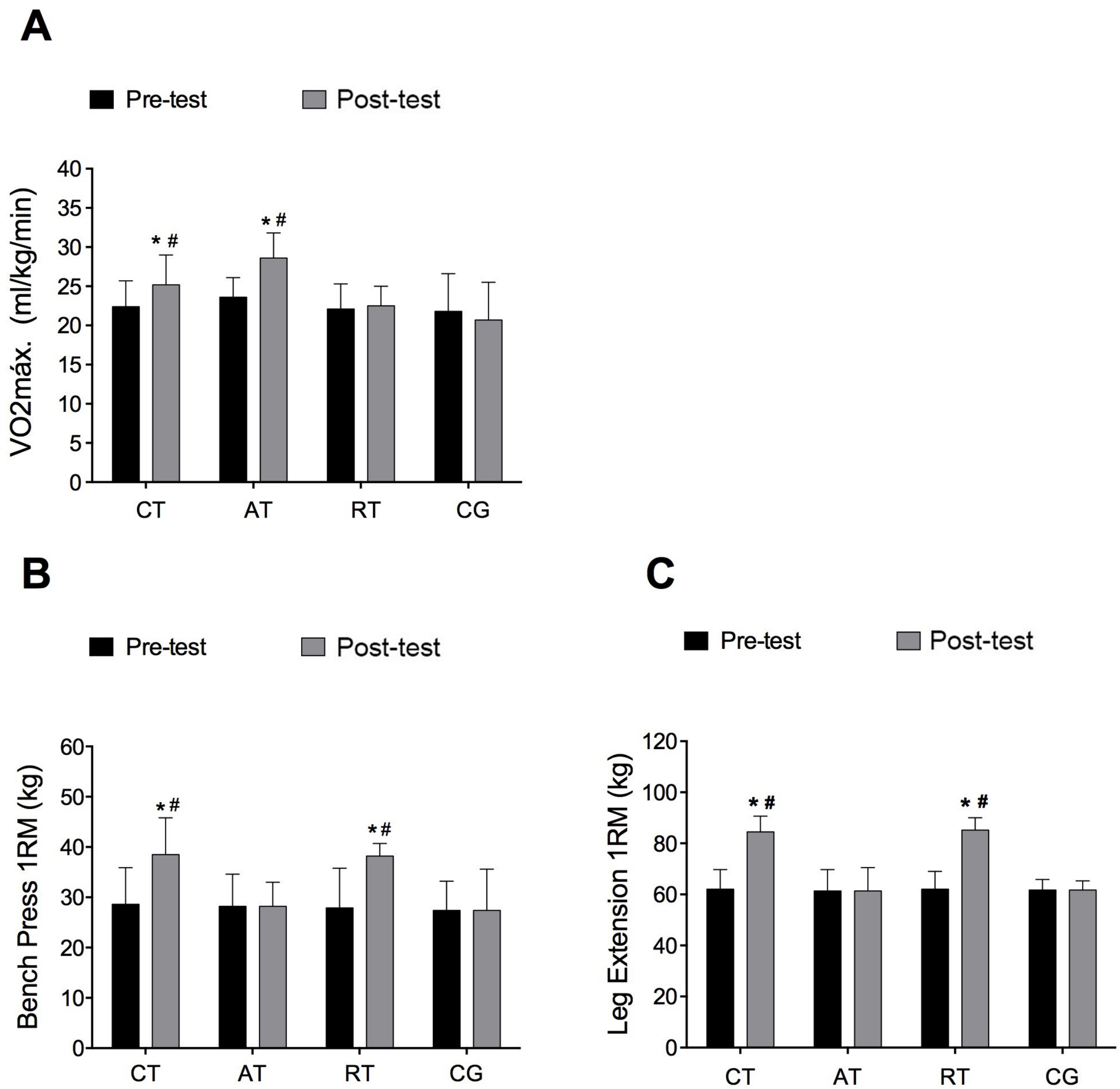

Figure 3. Comparison of VO_2max (A) and 1RM (bench press (B) – leg extension (C)) within- and between-groups. *Statistically significant within groups. # Statistically significant between groups. CT = combined training; AT = aerobic training; RT = resistance training.

DISCUSSION

Our main findings showed that the participants who self-select intensities obtained representative physiological adaptations in the different training programs. In the CT for the bench press and the leg extension, the loads were ~ 33% and ~ 35% of 1RM, respectively, and the walk remained below the ventilatory threshold (~ 45% of VO_{max}; ~ 47% of VO_{peak}). In addition, our results showed a significant decrease in body fat percentage and body fat mass for the CT.

To our knowledge, this is the first study that aimed to compare the chronic effects of different training programs at self-selected intensity on body composition, RPE and FPD. Despite this, the RPE and FPD responses were consistent with previous research that examined these conditions in an acute design. The only study that conducted a CT (resistance exercise plus aerobic exercise) at self-selected intensities in obese participants showed a similar response to our findings (3). These studies, which investigated the acute effect of resistance training on RPE and FPD in obese participants, emphasized that the self-selected loads for all exercises were ~45% of 1RM, that is, lower than that recommended by the ACSM guidelines (22, 28) to promote physiological and health related outcomes. The results showed that one hour of CT at intensities below the ACSM guidelines (22, 28) is able to significantly decrease body fat percentage and body mass. CT showed simultaneous increase of VO_{max} and 1RM values, while both AT and CT showed increases in VO_{max}, and RT and CT showed increases in 1RM, providing specificity for these outcomes (11). The increases in fitness outcomes and similar decreases in body fat percentage and body fat mass attributed to CT can be explained by the higher training duration compared to RT or AT. The increase in training duration associated with CT may have promoted a training-related increase in energy expenditure and, subsequently, an increase in daily energy expenditure resulting in additional favorable changes in body composition in the CT group, on this way aiding fat loss (31).

Conceptually, the dual-mode model assumes that a feeling is determined by cognitive factors (personality, self-efficacy, determination, etc.) (16, 17). This theory assumes that exercises performed at the intensity below the anaerobic threshold, promote feelings of pleasure due to the reduced perturbation of the organic systems and the maintenance of cellular homeostasis. On the other hand, exercise performed at the anaerobic threshold (severe domain) increases the participation of the cognitive processes, observing high inter-individual variability in the affective responses. Some individuals interpret effort as pleasant and others find it uncomfortable at the moderate domain. At or above the anaerobic threshold (severe domain) where interoceptive cues act decisively, feelings are more unpleasant for most individuals (14, 16). Thus, untrained subjects have low levels of pain tolerance and for the most of the training session, perceive the discomfort generated by training as something unpleasant, which leads them to not select vigorous intensities. This situation could justify our findings related to RPE and FPD, and make it reasonable to suggest that obese individuals might rarely self-select intensities at the thresholds proposed by the ACSM (28).

Further research is needed to determine if increases in AT and RT volume could produce similar results as the CT protocol in this study. Although our findings contribute to the knowledge of chronic psychophysiological adaptations during different training programs and their effects on body composition in obese subjects, there are some limitations that should be considered in the extrapolation of the data. The menstrual cycle was not controlled and training volume was not equalized. Additionally, although the measurement of FPD was performed with the most adequate scale for this purpose, the circumflex model advocates the use of the perceived activation scale, which was not incorporated in this study. Finally, further research is needed to determine if the results from this study can be replicated in other populations.

The present study showed promising findings, which have important practical applications. Obese women maintained low RPE responses and high feelings of pleasure during 24 sessions of different training programs at self-selected intensity. From a practical standpoint, and taking into account the positive effects that self-selected intensity has on intrinsic motivation and adherence to exercise, the CT should be considered as a feasible strategy to elicit more prominent changes on body composition in obese women. This fact, associated with feelings of pleasure, possibly could contribute to adherence, not only to exercise but also to a healthy lifestyle due to the satisfaction with the results obtained. Finally, the present study also reinforces the importance of using psychophysiological assessment during exercise for exercise monitoring, particularly for beginners when the primary goal is to increase adherence and health outcomes.

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