RESEARCH ARTICLE

DOI: 10.34256/ijpefs2144

International Journal of
PHYSICAL EDUCATION, FITNESS AND SPORTS

The acute effect of different intensity aerobic and resistance training exercise on the body image in adult women

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DOI: https://doi.org/10.34256/ijpefs2144
Received: 09-09-2021, Revised: 04-11-2021; Accepted: 06-11-2021; Published: 11-11-2021

Abstract: The purpose of the study was to evaluate the acute effect of different intensity aerobic (AE) and resistance training (RT) exercises on BI in adult women. Participants were 62 adult women (19.47 ± 2.53 yr., range 18 a 33 yr.), who were randomly assigned to three sessions of either: 1) Control group, 2) Low-intensity AE, 3) High-intensity AE, 4) Low-intensity RT, or 5) High-intensity RT. Before and immediately following each experimental intervention, BI, body weight, and arm and leg circumferences were measured. Three familiarization sessions were performed every 7 days before the AE and RT experimental interventions. Also, 5-RM tests were performed one week before the RT experimental interventions. Data were analyzed using mixed 3-way ANOVA, mixed 4-way ANOVA, and post-hoc analysis. An acute effect of RT on BI was observed, regardless of the exercise intensity, women felt more muscular immediately following the RT session. Regardless of the exercise intensity, 30-min of acute RT exercise changed BI perception, contrary to 30 min AE.

Keywords: Body image, Aerobic exercise, Resistance training, Exercise intensity, Women

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1. Introduction

The body image (BI) is a multidimensional construct that considers features related to a person's external physical appearance, including body size, weight, and shape [1, 2]. It is considered a dynamic concept that can be modified following body shape changes resulting from natural growth and maturation, physical training, and diet, among others [3, 4]. The BI is also a psychological construct directly influenced by the media, relatives, peers, and friends [5, 6].

Evidence has shown that both chronic aerobic (AE) and resistance training (RT) exercise, improve self-perceived BI [7-10], following 4 to 52 sessions of exercise performed from 1 to 5 times/week [8]. A single training session (i.e., acute or immediate effect) of AE also improves BI perception [11, 12], although the number of studies is scarce. Factors related to self-perceived BI changes following chronic exercise include improvements in physical appearance, reductions in body weight, perceived improvements in body figure or shape, changes in self-perceived body adiposity, and improvements in aerobic endurance and strength [7, 13, 14]. The BI modification following acute AE training has been explained by self-perceived changes in strength and body adiposity [11].

However, despite the evidence showing that exercise modifies BI perception, there is still limited information related to the effect of a single session (i.e., acute effect) of different exercise prescriptions (e.g., mode, frequency, intensity, duration). For instance, a greater quantity of studies has been published where the chronic (i.e., interventions between 4-52 weeks, 1-5 sessions /week, 20-75 min length) effects of exercise were reviewed [8] compared to the small number of studies in which the acute effect of the exercise on BI have been evaluated [12]. From those studies evaluating the acute effects of exercise on BI, there are only studies using the AE paradigm [1, 11, 12]; therefore, it seems necessary to evaluate the acute effect of other exercise modalities (e.g., RT) on BI. Furthermore, meta-analytic evidence [8, 9] on the chronic effects of exercise on BI shows that women showed higher changes in BI perception following exercise interventions. However, this finding has not been verified in acute effect studies. Therefore, the purpose of this study was to determine the acute effect of different intensity AE and RT exercise on the BI and selected biometrics of adult women.

2. Methods

2.1 Participants

Volunteers were 62 physically-inactive women recruited from a public university. Inclusion criteria to participate in the study were being an adult woman according to the age group definition of the World Health Organization [15], not participating regularly in any exercise or physical activity program, and to read and sign an informed consent approved by the Scientific Ethics Committee of the University of Costa Rica. Volunteers having some physical and/or cognitive impairment were excluded from the study.

2.2 Measurement instruments

Body weight (kg), arm and leg circumferences (cm) were measured using an e-Accüra scale model DSB 921 and a MABIS fiberglass measuring tape, respectively, by following standard protocols [16]. A heart rate (HR) monitor Polar model FT7 (Polar Electro, Oy, Finland) was used to control the session exercise intensity in the groups performing AE, an instrument previously used in the Costa Rican population with similar characteristics of our sample [17].

Self-perceived BI was assessed using the Contour Drawing Rating Scale [18]. This pictorial scale consisted of nine ascending figures, from the silhouette representing the most ectomorphic person to the most endomorphic. In addition, the Muscularity Rating Scale [19] was used, also with nine ascending figures, from the silhouette representing the thinnest woman to the figure representing the most muscular woman. These scales were used to provide participants with more BI classification options regardless of whether they perceived themselves as being ectomorphic, mesomorphic or endomorphic.

2.3 Measurement instruments

2.3.1 Study Design

The randomization process depicted in Figure 1 was carried by following the procedures described by CONSORT 2010 Statement [20]. Participants were randomly assigned to one out of five experimental groups: a) control group (CG), b) low-intensity AE (LIAE), c) high-intensity AE (HIAE), d) low-intensity RT (LIRT), and e) high-intensity RT (HIRT).

2.3.2 Intervention

Participants in the CG (n = 14) played a passive table game "Jenga" (Hasbro, Inc., Rhode Island, USA) for 30-min. Participants took turns removing one wooden block at a time from a tower constructed of 54 blocks. Each block removed was placed on top of the tower, creating a progressively taller and more unstable structure. The game stops when the tower falls.

Participants in the LIAE group (n= 12) pedaled 30-min on a cycle ergometer, maintaining an intensity of 50% of the maximum heart rate (HRmax) [11, 21, 22]. In the HIAE group (n = 12), participants pedaled 30-min on a cycle ergometer maintaining an intensity of 80% HRmax [11, 21, 22].

Participants in the LIRT group (n = 10) performed six RT exercises: 1) knee extension, 2) knee flexion, 3) horizontal bench press, 4) inclined press, 5) neutral grip pull-down, and 6) neutral grip seated row. The participants performed four sets of 16 repetitions for each exercise, using a tempo of 2:2 (i.e., two concentric phase movements and two eccentric phase movements), 50% of five maximal repetitions (5-RM), and 60-s rest between sets and exercises. The 5-RM were assessed following procedures described by others [23]. Finally, participants in the HIRT group (n = 14) performed the same six RT exercises described above in four sets of 10 repetitions for each exercise using a tempo of 2:2, 80% of 5-RM, and 60-s rest between sets and exercises. To the best of our knowledge, the proposed RT protocols were not tested in previous research. However, the choice of RT protocols obeyed the American College of Sports Medicine [24] recommendations for untrained individuals (i.e., working larger muscle groups, alternating exercises that work the lower body and upper body, allowing the trained muscle groups to rest). Participants in the AE and RT groups performed three familiarization sessions before the start of the experimental interventions. These sessions were separated by 7-days, and in the RT groups, neuromuscular coordination was stimulated by using weight-free machines. Finally, the participants in the RT groups performed the 5-RM test [23] on each of the six exercises comprised in the experimental protocols one week following the last familiarization session.

2.3.3 Measurements

Participants completed the respective experimental condition on three different sessions separated by 7-days apart. Before and immediately following each exercise session (sessions 1, 2, and 3), participants completed their self-perceived BI using two instruments (Contour Drawing Rating Scale and Muscularity Rating Scale). In addition, body weight, arm, and dominant leg circumferences were assessed by following a protocol described previously in the literature [16]. These assessments were also performed before and immediately after each of the three exercise sessions. Also, before starting each of the three sessions, each participant was asked if they had performed any other exercise during the week. This question was asked to control that the participants who made up the experimental groups and the control group did not carry out an activity unrelated to the training protocols of the research. For this question, the participants declared that they had not carried out any other exercise and thus continued participating in the present study.

2.4 Statistical analysis and sample size calculation

Statistical analyses were performed with the IBM-SPSS Statistics, version 18 (IBM Corporation, Armonk, New York). Descriptive statistics are presented as mean and standard deviation (M ± SD) unless otherwise noted. In this study, a control group was used to compare against the other experimental groups; therefore, a nested design was chosen [25, 26]. Three-way mixed ANOVA on dependent variables BI, body weight, arm, and leg circumferences were computed. The factors were the experimental groups (CG, AE, RT), sessions (first, second, third), and measurements (pre-test, post-test). Four-way mixed ANOVA on dependent variables BI, body weight, arm, and leg circumferences were computed. The factors were the experimental groups (CG, AE, RT), sessions (first, second, third), measurements (pre-test, post-test), and exercise intensities (50%, 80%). Follow-up analyses using the Bonferroni *post hoc* test were carried when significant interactions and main effects were found. Statistical significance was set *a priori* at p<0.05.

A *posteriori* sample size calculation was computed using an alpha level of 0.01, a beta power of 80%, and a minimum difference to detect 1.1 points in the perception of BI with a standard deviation of 1.06. We found that at least eight individuals were necessary for each experimental group. This sample size was exceeded, since as reported, the groups consisted of 10 (LIAE), 12 (HIAE), 10 (LIRT), 14 (HIRT), and 14 (CG) participants. Also, the statistical power calculation was carried out *a posteriori*. This computation showed that a minimum difference to detect of 1.1 points in BI perception, using an alpha level of 0.01, a variability of 1.06 points in the SD, and a sample size of 10, 12, and 14 participants, respectively, the statistical power was 99% [27].

3. Results

The study was completed by 62 women (Figure 1). Table 1 shows the descriptive statistics of the characteristics of the participants, according to experimental group.

Descriptive statistics (M ± SD) for BI using two scales are presented in table 2. Figures are presented by experimental condition and exercise session. Similarly, the summary of the descriptive statistics for the body weight, leg circumference, and arm circumference are presented in table 3.

Self-perceived BI (Contour Drawing Rating Scale). No statistically significant acute effect of AE and RT were found on BI by 3-way (F=0.57, p=0.69) or 4-way (F=0.23, p=0.79) ANOVA. A significant double interaction was found between measurement and physical activity type (F=11.71, p<0.0001). Simple effects *post hoc* analysis revealed that the differences were found only in the post-test measurement. Women in the LIAE group self-perceived themselves as being more endomorphic than women in the LIRT group (F=53.76; p<0.05); women in the LIRT group self-perceived themselves as being more endomorphic than women in the HIRT group (F=52.09; p<0.05), and women in the HIAE group self-perceived themselves as being thinner than women in the LIAE group (F=11.36; p<0.05).

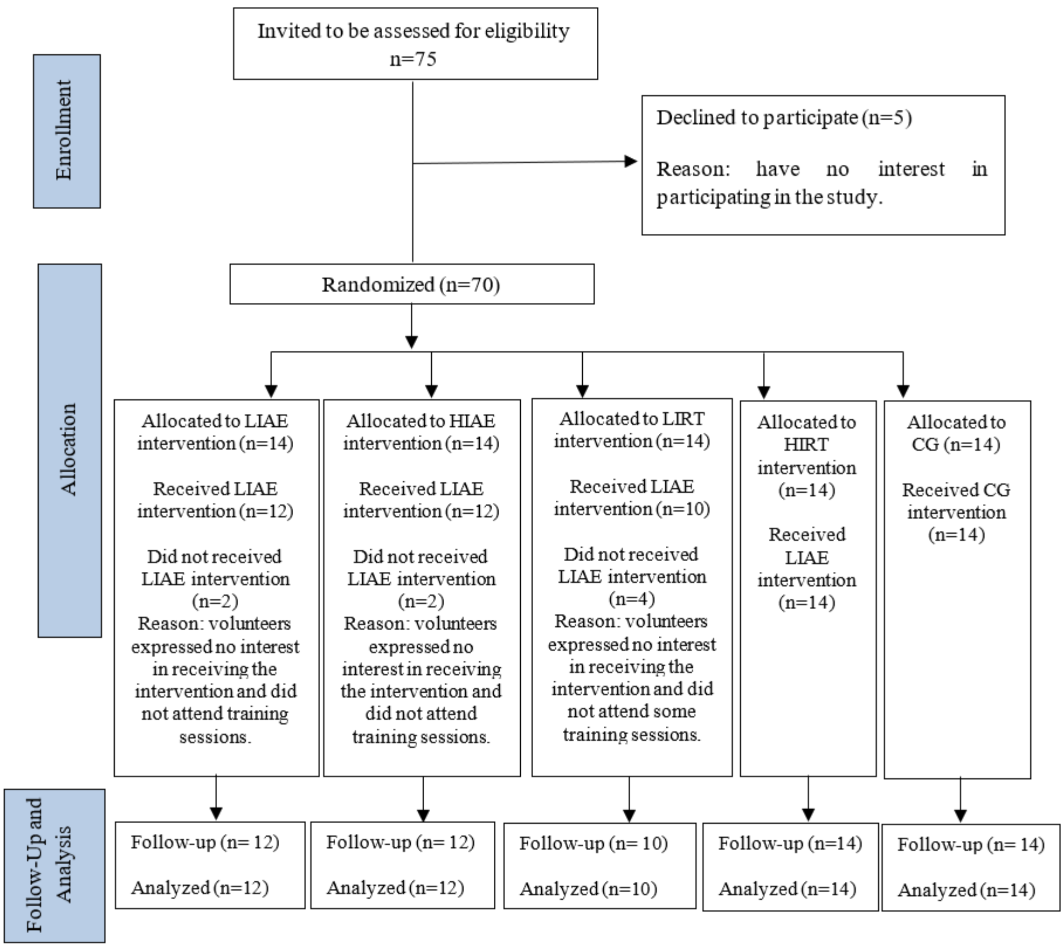

Figure 1. Flow diagram of the progress through the phases of a parallel randomized trial of five groups [20].

Table 1. Descriptive statistics for the sample.

Variable	Group	n	M ± SD	Minimum	Maximum	95%CI	p =
Age (years)	LIAE	12	19.83 ± 1.95	18.00	23	18.60 - 21.07	0.470
	HIAE	12	19.00 ± 1.13	18.00	21	18.28 – 19.72	
	LIRT	10	19.00 ± 1.70	18.00	23	17.78 – 20.22	
	HIRT	14	18.93 ± 1.27	18.00	22	18.20 – 19.66	
	CG	14	20.23 ± 4.52	18.00	33	17.82 – 23.04	
	Total	**62**	**19.47 ± 2.53**	**18.00**	**33**	**18.82 – 20.11**	
Weight (kg)	LIAE	12	58.93 ± 11.70	41.83	77.07	51.50 – 66.36	0.510
	HIAE	12	57.51 ± 9.11	46.44	78.30	51.72 – 63.30	
	LIRT	10	59.77 ± 7.21	48.25	69.00	54.62 – 64.93	
	HIRT	14	53.25 ± 6.96	42.50	65.45	49.23 – 57.27	
	CG	14	58.99 ± 14.32	44.56	94.00	50.72 – 67.25	
	Total	**62**	**57.52 ± 10.35**	**41.83**	**94.00**	**54.89 – 60.15**	

Note: LIAE: low-intensity aerobic exercise (50% HRmax), HIAE: high-intensity aerobic exercise (80% HRmax), LIRT: low-intensity resistance training (50% 5-RM), HIRT: high-intensity resistance training (80% 5-RM), CG: control group, 95%CI: 95% confidence intervals, p-values are shown for between-groups comparisons.

Table 2. Descriptive statistics for body image by experimental condition and session. Data are presented as mean ± SD.

		Exercise Session			
Measurement	**Group**	**1**	**2**	**3**	**n**
Contour Drawing Rating Scale					
Pre-test	LIAE	5.67 ± 1.92	5.75 ± 1.91	5.67 ± 1.83	12
	HIAE	5.33 ± 1.30	5.25 ± 1.42	5.33 ± 1.44	12
	LIRT	5.50 ± 0.97	5.50 ± 1.08	5.50 ± 1.08	10
	HIRT	4.86 ± 1.51	5.07 ± 1.21	4.79 ± 1.19	14
	CG	4.64 ± 1.50	4.86 ± 1.41	4.86 ± 1.35	14
Post-test	LIAE	5.67 ± 2.10	5.75 ± 1.66	5.75 ± 1.60	12
	HIAE	5.00 ± 0.95	4.83 ± 1.19	5.08 ± 1.24	12
	LIRT	5.00 ± 1.41	5.00 ± 1.15	5.00 ± 1.15	10
	HIRT	4.86 ± 1.46	5.21 ± 1.25	4.71 ± 1.14	14
	CG	4.79 ± 1.48	4.86 ± 1.35	4.86 ± 1.35	14
Muscularity Rating Scale					
Pre-test	LIAE	3.75 ± 0.62	4.00 ± 0.85	4.08 ± 0.90	12
	HIAE	4.33 ± 0.66	4.17 ± 0.72	4.25 ± 0.87	12
	LIRT	4.50 ± 0.97	4.30 ± 1.06	4.30 ± 1.06	10
	HIRT	4.00 ± 0.88	3.93 ± 0.92	4.14 ± 0.95	14
	CG	3.86 ± 0.53	4.14 ± 1.03	3.86 ± 0.66	14
Post-test	LIAE	4.17 ± 0.83	4.00 ± 0.85	4.08 ± 0.79	12
	HIAE	4.33 ± 0.65	4.50 ± 0.90	4.50 ± 1.00	12
	LIRT	4.90 ± 1.10	5.40 ± 1.35	5.10 ± 0.99	10
	HIRT	4.14 ± 0.95	4.57 ± 1.16	4.86 ± 1.29	14
	CG	3.86 ± 0.53	4.14 ± 1.03	3.86 ± 0.66	14

Note: LIAE: low-intensity aerobic exercise (50% HRmax), HIAE: high-intensity aerobic exercise (80% HRmax), LIRT: low-intensity resistance training (50% 5-RM), HIRT: high-intensity resistance training (80% 5-RM), CG: control group.

Table 3. Descriptive statistics for body weight, leg circumference and arm circumference by experimental condition and session. Data are presented as mean ± SD.

		Exercise Session			
Measurement	**Group**	**1**	**2**	**3**	**n**
Body Weight					
Pre-test	LIAE	58.93 ± 11.70	58.80 ± 11.67	58.89 ±11.48	12
	HIAE	57.51 ± 9.11	57.56 ± 9.23	57.43 ± 9.20	12
	LIRT	59.77 ± 7.21	59.92 ± 7.04	59.98 ± 7.26	10
	HIRT	53.25 ± 6.96	53.30 ± 7.01	53.36 ± 7.10	14
	CG	58.99 ± 14.32	58.89 ± 14.35	58.98 ± 14.40	14
Post-test	LIAE	58.88 ± 11.72	58.76 ± 11.66	58.86 ± 11.45	12
	HIAE	57.47 ± 9.06	57.45 ± 9.22	57.36 ± 9.18	12
	LIRT	59.80 ± 7.18	59.85 ± 7.02	59.89 ± 7.25	10
	HIRT	53.19 ± 6.97	53.25 ± 6.97	53.34 ± 7.08	14
	CG	58.95 ± 14.33	58.95 ± 14.33	58.93 ± 14.36	14
Leg Circumference					
Pre-test	LIAE	46.57 ± 3.99	46.95 ± 4.89	46.96 ± 4.41	12
	HIAE	45.78 ± 5.45	45.18 ± 5.37	45.03 ± 5.58	12
	LIRT	46.66 ± 3.52	47.01 ± 3.55	47.05 ± 3.79	10
	HIRT	45.86 ± 3.01	45.96 ± 3.56	46.17 ± 3.04	14
	CG	47.68 ± 5.34	47.14 ± 5.13	47.14 ± 5.18	14
Post-test	LIAE	46.86 ± 3.75	46.91 ± 4.60	47.16 ± 4.37	12
	HIAE	46.03 ± 4.78	45.74 ± 5.05	45.49 ± 5.85	12
	LIRT	47.07 ± 3.57	47.36 ± 3.57	47.25 ± 3.72	10
	HIRT	45.79 ± 3.99	46.56 ± 3.51	46.39 ± 3.84	14
	CG	47.61 ± 5.43	47.25 ± 5.18	47.21 ± 5.25	14
Arm Circumference					
Pre-test	LIAE	23.73 ± 2.80	24.05 ± 2.90	23.95 ± 2.99	12
	HIAE	22.54 ± 2.49	22.63 ± 2.53	22.41 ± 2.84	12
	LIRT	24.36 ± 1.37	24.10 ± 1.26	24.24 ± 1.35	10
	HIRT	23.57 ± 1.77	23.11 ± 2.03	22.93 ± 1.82	14
	CG	23.68 ± 3.08	23.79 ± 2.96	23.79 ± 2.96	14
Post-test	LIAE	23.83 ± 2.94	24.23 ± 3.01	23.88 ± 3.05	12
	HIAE	22.63 ± 2.57	22.73 ± 2.68	22.54 ± 2.83	12
	LIRT	24.72 ± 1.78	24.62 ± 1.05	24.36 ± 1.15	10
	HIRT	23.97 ± 1.81	23.36 ± 1.95	23.14 ± 1.79	14
	CG	23.75 ± 3.07	23.82 ± 2.95	23.82 ± 2.95	14

Note: LIAE: low-intensity aerobic exercise (50% HRmax), HIAE: high-intensity aerobic exercise (80% HRmax), LIRT: low-intensity resistance training (50% 5-RM), HIRT: high-intensity resistance training (80% 5-RM), CG: control group.

Self-perceived BI (Muscularity Rating Scale). A statistically significant acute effect on BI was found when performing RT between the pre- and post-test measurements during the second (F=49.32, p<0.05) and third (F=39.94, p<0.05) sessions. Women felt more muscular at the end of the exercise in both exercise sessions. In addition, post-hoc analysis showed that in the post-test, participants felt more muscular as the RT sessions progressed. There was no effect of the RT and AE exercise intensity on the BI (F=1.73, p=0.18). The change (Δ%) from pre- to post-test in muscularity and contour perception showed a similar pattern across experimental conditions (Figure 2).

Body weight. A statistically significant acute body weight reduction was found in the three exercise sessions by 3-way (F=12.82, p<0.001) and 4-way (F=15.72, p<0.001) analyses. The acute reduction was observed in all participants, including women in the CG, resulting in a mean weight reduction of 4 g during the first session, 4 g during the second session, and 5 g during the third session.

Leg circumference. The 4-way ANOVA showed a main measurement effect statistically significant (F=4.82, p=0.03), which demonstrates an acute increase in leg circumference in the three exercise sessions. The increase was observed in all participants, including women in the CG, resulting in mean increments of 0.14 cm during the first session, 0.32 cm during the second session, and 0.23 cm during the third session.

Arm circumference. A significant acute increase in arm circumference was observed in participants in the RT groups as detected by 3-way (F=5.48, p=0.007) and 4-way (F=6.33, p=0.02) analyses. Regardless of the exercise intensity, the increase in arm circumference was found in the three sessions, with mean increases of 0.38 cm during the first session, 0.36 cm during the second session, and 0.17 cm during the third session. This acute effect was not observed in the other experimental groups (LIAE, HIAE, CG).

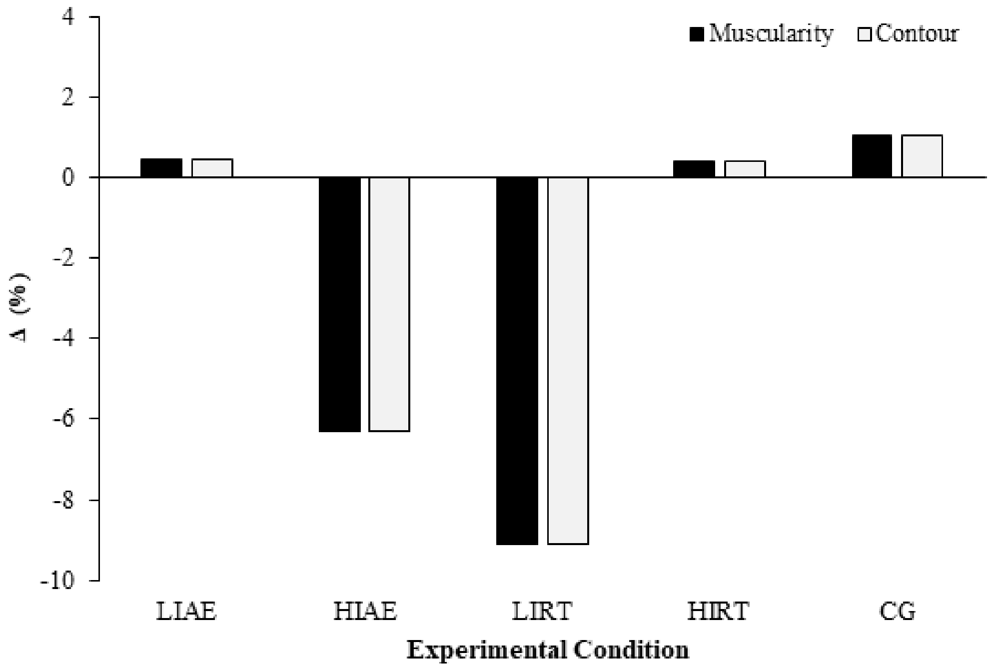

Figure 2. Change (Δ%) from pre- to post-test in muscularity and contour perception in women on the experimental conditions. LIAE: low-intensity aerobic exercise (50% HRmax), HIAE: high-intensity aerobic exercise (80% HRmax), LIRT: low-intensity resistance training (50% 5-RM), HIRT: high-intensity resistance training (80% 5-RM), CG: control group.

4. Discussion

This study determined the acute effect of AE and RT exercises performed at low- and high-intensity on the self-perceived BI of young women. The responses to acute exercise in this study indicated that a single session of 30-min of AE was insufficient to change BI in young women. This finding was similar to those reported by others [1], and in the opposite direction as reported by others [11, 12]. The training session duration might be a plausible explanation for the differences detected between studies [1] since it has been demonstrated that when implementing AE sessions lasting between 38-min to 60-min, participants reported significant changes in BI [11, 12]. Therefore, the duration of an AE session seems to play an important role in the acute changes in the self-perceived BI.

Salci and Ginis [11] attempted to explain which variables could be responsible for mediating the acute effect of AE on BI. The authors found that similar to the chronic AE effect, the factors allowing significant changes in BI were improved self-perceived strength and body adiposity. However, these variables were not assessed in this study, limiting the possibility of corroborating whether 30-min of EA were enough to generate changes in these factors and consequently modify BI perception in young women.

A significant acute exercise effect was found on the BI in the present study; young women's perceptions regarding their muscularity increased immediately following a RT session. The mean Δ% across three exercise sessions in the HIAE and LIRT conditions were reduced in perceived muscularity and contour. This reduction means that women felt thinner and muscular after exercising at 50% and 80% aerobic and resistance training, respectively (Figure 2). This is the first study (that we are aware of) determining the acute effect of RT on self-perceived BI. No mediator or moderator psychological and/or physiological variables are available at this time that might explain the findings in this study; therefore, more research on the acute effects of RT on BI is warranted. Yet, we reviewed a physiological mechanism related to acute muscle inflammation to explain this finding. Following a RT session, there is a sensation of swelling (edema) caused by body fluids displacement from the blood plasma to the working muscle tissues; this response is also explained by an accumulation of metabolic by-products of exercise. The acute muscle inflammation is transient, and it lasts for a short period of time when fluids return to the blood shortly after the end of the exercise session [28].

Thus, the association between the acute perception of young women feeling more muscular and the acute muscle inflammation is supported. This finding was observed with the acute increase in arm circumference only in the participants performing the RT program (LIRT and HIRT). The variables body weight and leg circumference failed to explain the effect of exercise on self-perceived BI. The RT exercise stimulus on these two variables (body weight and leg circumference) was not strong enough to change the BI compared to the CG. It is important to note that the acute effect of the RT program (LIRT and HIRT) was found only with one BI scale (i.e., Muscularity Rating Scale). This result outlines the importance of being cautious in the selection of the BI instrument because the measurement instruments based on figures can limit the participant's choice to identify with any of the body silhouettes [29-31].

In the present study, we demonstrated that the intensity of the AE or RT may not affect the self-perceived BI. This finding confirms previous meta-analytical evidence [8, 9], showing that exercise intensity at which the exercise is performed does not acutely affect the self-perceived BI. The main strength of this study was to evaluate the acute effect of AE and RT of different intensities on body image since, as previously mentioned and as far as is known, it is a pioneering study on the subject. This allowed advancing the study of this line of research. However, it is essential to mention that limitations should be considered in future studies. For example, it would be necessary to conduct *a priori* analysis of the sample calculation and statistical power, include male participants, and complete sessions involving longer training sessions. These limitations could be recommendations or methodological improvements to be used in future research, mainly considering the need to develop studies that deepen the acute effect that different types of exercise can generate and possible variables to be manipulated (e.g., session duration, sets, repetitions, volume, duration and type of rest) on the body image self-perception.

5. Conclusion

In conclusion, the results show that regardless of the intensity, the RT exercise causes an acute effect that allows the study participants to feel more muscular immediately after the session ends. In this way, our results agreed with previous literature, showing the importance of acute exercise as a possible intervention for people wishing to modify their self-perceived BI. In addition, the study also provides information for exercise-based interventions targeting improvements on the BI of people with BI dissatisfaction. Finally, the significant effect of RT on the BI of young women elicits further research on this topic.

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Funding

No funding was received for conducting this study.

Authors Contribution

All the authors equally contributed, read and approved the final version of this work.

Ethics Approval

This study was approved by Institutional ethics committee.

Informed Consent

Written consent was obtained from the participants

Conflict of interest

The Authors have no conflicts of interest to declare that they are relevant to the content of this article.

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